Sentimental Industry: the Society of Arts and the Encouragement of Public Useful Knowledge, 1754-1848

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I, Matthew Paskins, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Abstract

This thesis offers a reinterpretation of the activities of the Society for the Encouragement of Arts, Manufactures and Commerce, an economic society founded in London in 1754. Previous histories of the Society have attempted to accommodate it within normative accounts of industrial development; or have celebrated its philanthropic intentions; or have focused on one aspect of its multifarious activities. I argue that the Society should be interpreted as a place where a wide-ranging public ethos and the promotion of public knowledge were meant to coexist. This meant a collision between an ethos of gentlemanly many-mindedness and the particular interests of individual trades, fraught negotiations about the question of the public, and involvement in practices of natural knowledge which were intended to render tacit knowledge explicit. How far any of this activity actually encouraged manufactures or commerce is debatable: nevertheless, the Society offers a vantage point from which we can see the difficulty of coordinating and aggregating local exemplary achievements and inventions. Individual chapters consider the Society's efforts in the fields of mechanics, import substitution, agriculture, and tree planting.

For my parents, and my brother, and to the memory of Peter Paskins.

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This thesis is dedicated to my family. I owe more than I can say in practical and intellectual terms to their influence, example, and love.

I did much of the final writing of this thesis in coffee shops and hotels dotted around Leeds City Centre, around New Year 2014. I was there to see Anna Rogers and it has been an amazing blessing to be able to do so. Love and thanks to her.

The last time the Contrast took the liberty of troubling the public, it was to inform them that he was DEAD, DEAD, DEAD! He now hopes they will not be offended to be informed, in one word, that he is ALIVE. He is conscious, that being dead, and then alive, is so strange and rare a circumstance, that it is enough to puzzle the antiquarians, even those antiquarians who swallowed five Neapolitan brick-bats *for HERCULANEAN CURIOSITIES. But to that learned Society, who meet in Crane-court, he makes no doubt but it will be a fund of entertainment; and, like many other ridiculous foolish affairs, fill the next volume of transactions. The most profound botanist, Dr. Thing-a-me, the apothecary, will take the Contrast for a vegetable, and therefore see nothing wonderful, that he should die in December, and in May, by the refreshing showers, be brought to life; and will, with the velocity of lightning, repeat five hundred hard names of plants, all which do the same.* […] *The proceedings of the F.R.S.'s will fall far short of the Society of Arts, Manufactures, and FISH; who, on hearing that the dead Contrast is now alive, will, after very many debates (for those that pay two guineas have a right to speak) determine, that on account of the war, men having become scarce; and it appearing, that John Contrast, who died in December last, is now alive; they will therefore give to the person, who brings to life the greatest quantity (not less than an hundred) of stout, able bodied, good-looking dead-men; then guineas.*

To the second-best quantity of dead men, all alive; five guineas.

To the third; two guineas.

-----Gazetteer and New Daily Advertiser, Wednesday June 6, 1764

Stepping into the model room of the Society at the Adelphi, one might be tempted to ask whether there are any limits to its field of exertion; whether in short, it is not a society for the encouragement of everything. What a glorious confusion there is amidst all the orderly array of glass-cases that extend horizontally in rows across the room, or that perpendicularly line the walls. Hands for the one-handed, to give them again two, and other instruments for those who have lost both – cloths of all sorts of materials from all sorts of countries – medals of Charles the First's reign and the last new stove of Victoria's – fire-escape ladders to run down from windows, and scaffolds, rising telescope-fashion out of a box, to mount up to roofs (a most ingenious machine, and worthy the admiration which we understand his Royal Highness the President recently expressed in regard to it) – bee-hives and instruments to slice turnips – ploughs, and instruments to restrain vicious bulls – pans to preserve butter in hot localities, and safety-lamps to preserve men in dangerous ones – models of massive cranes, and of little tips for umbrellas – life-buoys, and maroon-locks to give notice of thieves in gardens – diving-bells and expanding-keys – safe coaches and traps – clocks, and improved tail-pieces for violoncellos – instruments to draw spirits, and instruments to draw teeth – samples of tea, sugar, cinnamon, and nutmegs, in different stages of growth – models of Tuscan pavements – beds for invalids – methods to teach the blind how to write – but the list is interminable, and were we to continue it for half-a-dozen pages further, we should be in no appreciable degree nearer the end.

-------Charles Knight, *London,* (Henry G. Bohn, London, 1851), p. 356.

Abbreviations

Where footnotes specify a reference to "Transactions" with a volume number, and no further details, the source is the *Transactions of the Society, Instituted at London, for the Encouragement of Arts, Manufactures, and Commerce***.** This was published between 1783 and 1844. There are 55 volumes in total. I give full references to individual submissions to the *Transactions*; many of these were titled, somewhat idiosyncratically, "Paper in Mechanicks", "Paper in Manufactures", and so on.

The Society for the Encouragement of Arts, Manufactures and Commerce is known by a number of different names. I have generally referred to it as the Society of Arts, as this was the most common. There were several Societies of Arts during the eighteenth century. Where I have not referred to a specific Society, I mean the one based in London.

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1. Existing Histories, Shifting Contexts

> The first impression, on a survey of the Society's work, is one of some bewilderment at the multiplicity and diversity of the subjects with which it has dealt in rapid succession or even simultaneously. Nothing seems to have been regarded as too homely for its attention. Side by side with the account of efforts to encourage improved systems of industrial hygiene, of saving life at sea, of the ventilation of mines, of producing coal gas, we find the notice of a gold medal awarded for the invention of the transparent slate which was the delight or torment of our childhood. […] At one moment the Society is endeavouring the further the improvement of labourers' cottages, at another it is proposing a reform in the standard pitch of musical instruments. It encourages with equal energy the planting of osiers for basket-making, the development of the Dutch system of curing herrings, the use of machines for sweeping chimneys in substitution for boy chimney-sweeps, the introduction of artistic designs in household crockery, and

> the placing of memorial tablets on London houses connected in the past with eminent men.[1]

> In consequence of information that Government wanted intelligence respecting the best mode of dibbling acorns, I have made an improvement on the acorn dibble in the Society's Repository, […] Thorn bushes and thickets are the natural guardians of young oaks from the depredations of cattle of all kinds, on forests and other grounds on which they pasture. By means of this implement, acorns may be deposited in the interior of bushes, as well as in open grounds, with rapidity and accuracy. And presuming that such an implement would be of great utility to many individuals, and also to Government, I wish much to have it made known as generally as possible among those who are most likely to profit by it.[2]

The *Transactions* of the Society for the Encouragement of Arts, Manufactures and Commerce, which were published between 1783 and 1844, contain an almost interminable variety of descriptions of tools, processes, samples, models, stuff. These were submitted to the Society in response to its offers of "premiums", small financial or pecuniary awards for specific subjects.

The Society was founded by a group of improvers, philanthropists, aristocrats and natural philosophers associated with the Newtonian physiologist and inveterate campaigner Stephen Hales, amid the patriotic fervour and high imperial hopes of mid-eighteenth-century Britain. Patriotic in intent, it sought to encourage domestic manufactures, designs, and discoveries of raw materials. Meeting initially in coffee houses, the Society's members progressed to their own building in 1772, in a part of the Adam Brothers new development in the Adelphi. Its membership ballooned during its first decade, including people from many social ranks; but began to collapse at the end of the 1760s. The Society gradually rebuilt itself, becoming fashionable again in the early nineteenth

[1] Henry Trueman Wood, *A history of the Royal Society of Arts*, (London, 1913), ix.
[2] Charles Waistell, "Improvement on an Acorn Dibble", *Transactions*, 1812, **29**: 60.

century for its public prize-givings at which the premiums were awarded, and which glittered with aristocratic patronage. By the end of the 1820s, the Society was often represented as past its prime, although its members continued to contribute to parliamentary select committees and congratulate themselves on their acts of patronage. Struggling again during the 1830s, the Society languished until a new group of civil servants associated with Henry Cole were able to persuade its President, Prince Albert, to support a new "Great Exhibition", which was intended to bring together the works of all nations. Reinvented several times subsequently, the Society remains a going concern as the modern RSA.

Charles Waistell's description of his improvement to a dibbling stick, from 1808**,** is quite typical of the submissions which the Society received, in that it recounted a small improvement to an innocuous and primitive tool in terms of a national benefit. This variety, and these connections, are the subject of this thesis. Throughout the chapters which follow, I will argue that the Society's annals ultimately represent a meeting place of the high and low, the material and the abstract, and the particular and the general. Here, the Society speaks with many voices: from its contributors, members, officers and critics. In pamphlets, letters to newspapers, personal letters and at public meetings they addressed the Society and shaped their visions of its public role.

In this opening chapter, I want to set the scene for what follows by locating the Society in the historiography of public science and voluntary associations in the eighteenth century. I will begin by setting out the problem by reviewing existing histories which deal specifically with the Society, and then set out the terms in which I want to discuss its ethos and activities. Existing histories, I will suggest, give suggestive accounts of partial aspects of its activities without addressing the ways in which the Society's members sought to fit them together, and without delving into the practices which its awards were meant to encourage. The following sections then offer my own way of understanding the Society, in relation to major questions within eighteenth-century history.

It is also worth highlighting the periodization of this work. I am interested with the scope of the Society's activities over almost one hundred years. Obviously this is a long time, and I cannot claim to have covered the whole period in equal detail. There are good reasons, however, to deal with the relatively extended period. The first is the long-term persistence of the Society's projects. They

continued and recurred over this period; in some cases, as in tree-planting, specific reference was made to the advantages which accrued from the fact that the Society's concern had lasted for such a long time. The second is that we see the Society in some detail in the period before the Great Exhibition. The role of its members and officers in the aspiration of that event to put "the nation on display" has been well-documented by historians.[3] We have, however, much less feel for the public role which the Society played earlier on, and for the implication of its expansive projects, and how it changed from its inception to its later years. The organisation which I want to describe is much more fractious than existing histories have suggested.

Contextualising the Society is difficult, because of the enormous range of its activities. All of its historians have faced this problem, as is indicated by the quotation from Trueman Wood's 1913 official history with which this chapter opens. Trueman-Wood concludes that the Society's "ubiquitous energy presents obvious difficulties to the historian, who finds himself confronted with the task of arranging a patchwork quilt into some kind of ordered pattern."[4] He indicates that his own procedure, which was "partly chronological, but in the main of classification into subjects" has "necessitated some repetition and numerous cross-references, but it was the only practicable method of making the story clear and consecutive in its various portions."[5] In practice this meant individual chapters on "The Society and the Colonies", "The Society and Forestry (1754-1835)", and so on. On closer inspection, however, these chapters do not really describe the Society in its own terms. Instead, all of the Society's projects are evaluated according to an implicit inventive and technical chronology which provides the context for its activities and indicates the kinds of topics with which it should have been concerned.

Thus, discussing the Society's mechanical premiums, Trueman Wood notes that "[a]n examination of the old prize-lists, especially those between 1760 and 1800, affords an interesting

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[3] For example, Jeffrey Auerbach, *The Great Exhibition: A Nation on Display*, (New Haven and London, 1999); Hermione Hobhouse, *The Crystal Palace and the Great Exhibition: Art, Science and Productive Industry, A History of the Royal Commission for the Exhibition of 1851*, (London and New York, 2002).
[4] Trueman Wood, *A History,* p. ix. The other official histories of the Society of Arts are Derek Hudson and Kenneth Luckhurst, *The Royal Society of Arts, 1754-1954,* (London, 1954), and D.G.C. Allan, *RSA: A Chronological History of the Royal Society for the Encouragement of Arts, Manufactures, and Commerce: founded 1754, royal charter 1847, royal "prefix" 1908,* (London, 1998).
[5] *Ibid.*

indication of the state of scientific and industrial knowledge and the time, "[6] then goes on to lament "[t]hat in the lists so many familiar names are missing is certainly disappointing. One would like to have found the names of Watt, Hargreaves, Crompton, Roebuck, Arkwright, and Cort, amongst those whose inventions were recognised and rewarded by the Society of Arts. But in the early records none of these names appear."[7] As the chapter continues, the lament shifts into resigned acceptance, as the historian offers some consoling thoughts that inventors are always ahead of their times, have often faced resistance, and the Society did not support patents, which were the only really effective way of encouraging new inventions anyway. Thus there *was* a technological history "out there" to which the Society could have contributed. Its failure to do so can be pardoned, but is sad. A similar narrative is implicit in those economic histories and sociologies which have opposed the Society's model of encouragement to that of patents and other economic instruments for encouraging industry and invention.[8]

We might be inclined to dismiss Trueman Wood, on the grounds that he has adopted a Whiggish narrative of straightforward technical improvement. However, similar problems arise in the recent histories which have given accounts of the Society. These are characterised either by selective readings of its activities, or generalisations of its ethos which overlook its fractious, public nature. The one recent overview of the Society's ethos and activities is in Liliane Hilaire-Perez's *L'Invention technique au Siècle des Lumières*.[9] Hilaire-Perez regards the Society as a complement to the Royal Society, which "wove connections between rulers, industrialists, bankers, but also artists, inventors, and other societies, English and foreign."[10] Throughout, she argues, the Society sought to achieve a "philanthropic compromise" in the name of an ethos of "conciliation and harmony".[11] Included in its membership were representatives of the English enlightened elite, "savant and philanthropic, sometimes radical, who renewed English public opinion at the end of the century."[12]

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[6] Trueman Wood, *A History,* p. 240.
[7] *Ibid.*
[8] Christine Macleod, *Inventing the industrial revolution: The English patent system, 1660-1800*, (Cambridge, 2002); Neil J. Smelser, *Social change in the industrial revolution: An application of theory to the British cotton industry, 1770-1840*, (London, 1967).
[9] Liliane Hilaire-Perez, *L'Invention technique au Siècle des Lumières*, (Paris, 2000).
[10] *Ibid.,* p. 191.
[11] *Ibid.*
[12] *Ibid.,* p. 195.

In this setting, novel inventions were not evaluated solely in terms of economic success; they were meant to be the "guarantee of economic equilibrium and social peace."[13] This gives a fine sense of the Society's aspirations, and the rhetoric which its members and officers often employed. However, like Trueman Wood, it also makes the Society's goals appear more coherent than they actually were, as if it spoke with a single voice instead of the huge number of contending views which it embodied, and it neglects the significant shifts in ethos and approach which occurred over the course of its history. In line with Hilaire-Perez's primary interest in mechanical invention and manufactures, it also neglects the Society's involvement in other fields.

Other histories have drawn on one aspect of its activities, in support of their own specific concerns. Thus, in a study of British patriotism, Linda Colley describes the Society as a typical patriotic organisation of the mid-eighteenth century.[14] In a book about luxury, Maxine Berg describes how its foundation "was based in the movement to create an English style in manufactures, and to establish an appropriate national commercial identity", and associates its premium offers with the move towards inventive imitation of Asian and European luxury goods.[15] In a lavish and expansive work on *The Arts of Industry in the Age of Enlightenment,* Celina Fox uses the Society to exemplify the inseparability of different forms of "art" during the eighteenth century.[16] Richard Grove allows the networks around the Society to play a role in the diffusion of ideas about deforestation, and on behalf of colonial tree planting initiatives.[17] For John Gascoigne, the Society was one of the "informal institutions of government" alongside the Royal Society, the Board of Agriculture, and others.[18] Discussing the long-term history of "alternative agriculture" in England, Joan Thirsk describes why the Society's projects to encourage certain crops failed, while equivalent efforts in France, sponsored directly by the crown, succeeded. The papers in Susan Bennett's edited collection *Cultivating the Human Faculties* describes the Society's encouragement of fine arts, and the

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[13] *Ibid.,* p. 197.
[14] Linda Colley, *Britons: forging the nation, 1707-1837* (New Haven, 1992).
[15] Maxine Berg, *Luxury and Pleasure in Eighteenth Century Britain*, (Oxford, 2006). See also her "From Imitation to Invention: Creating Commodities in Eighteenth-Century Britain," *The Economic History Review,* 1992, **55**: 1-30.
[16] Celina Fox, *The Arts of Industry in the Age of Enlightenment*, (New Haven, 2009).
[17] Richard Grove, *Green Imperialism: Colonial Expansion, Tropical Island Edens and the Origins of Environmentalism, 1600-1860*, (Cambridge, 1996).
[18] John Gascoigne, *Science in the Service of Empire*, (Cambridge, 1988), p. 112.

attempts of its members to define a place between the market and more "academic" values.[19] For Sarah Lowengard, writing about understandings of colour and practices of producing them, the Society was interested in the intersection between learned knowledge about colour and the more artisanal questions about its productions.[20] James Harrison charts the Society's attitudes towards patents: initially hostile, and offering an alternative model of support through the offer of premiums, during the 1820s its members became heavily involved in patent reform.[21] Studies of colonial science describe the Society's activities and example in promulgating ideals of improvement throughout the British colonies, and its recurrent failure to introduce alternative industries.[22] All of these works (and there are others) offer valuable perspectives on the Society and its activities, and they are joined by the wealth of studies of particular projects which it undertook, and biographies of individual members tirelessly assembled by D. G. C. Allan.[23]

The specificity of these studies is an obvious boon, but it comes at the cost of considerable incoherence. Of course, some connections are made: the view which associates the Society with patriotism also notes how fine art and English manufactures had closely related goals. We can also locate its activities within the nexus of "improvement", which, recent histories have insisted, shaped enlightenment practices in England.[24] But the problem of contextualisation goes deeper than this. The interests of the Society's membership, and its wider circle of contributors, could not be assimilated to any single coherent ethos, and the different subjects of the histories reflect this. They are, in essence, about different things. This offers richness and variety, but it also makes it very

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[19] Susan Bennett, ed., *Cultivating the Human Faculties: James Barry (1741-1806) and the Society of Arts*, (Cranbury, NJ, 2008).
[20] Sarah Lowengard, *The Creation of Color in Eighteenth Century Europe*, (New York, 2003).
[21] James Harrison, *Encouraging Innovation in the Eighteenth and Nineteenth Centuries: The Society of Arts and Patents 1754-1904*, (Gunnislake, Cornwall, 2006). A very similar line is taken in Max Louis Kent, *The British Enlightenment and the Spirit of the Industrial Revolution: The Society for the Encouragement of Arts, Manufactures and Commerce (1754-1815)*, (Unpublished PhD thesis, University of California, 2007).
[22] Joyce E. Chaplin, *An Anxious Pursuit: agricultural innovation and modernity in the Lower South, 1730-1815*, (Chapel Hill, 1996); Brooke Hindle, *The pursuit of science in Revolutionary America, 1735-1789*, (Chapel Hill, 1974).
[23] D.G.C. Allan and R.E. Schofield, *Stephen Hales: Scientist and Philanthropist*, (London, 1980); D.G.C. Allan, *William Shipley: Founder of the Royal Society of Arts; A Biography with Documents*, (London, 1968); D.G.C. Allan and John L. Abbott (eds) "*The Virtuoso tribe of arts and sciences*": *Studies in 18th-century work and membership of the London Society of Arts*, (Athens and London, 1992). The many studies in the Society's journal are recorded in Allan, *RSA*.
[24] See, in particular: Gascoigne, *Science in the Service of Empire*; John Gascoigne. *Joseph Banks and the English Enlightenment: useful knowledge and polite culture*, (Cambridge, 2003); T.M. Devine, ed. *Improvement and Enlightenment*, (Edinburgh, 1989); Stephen Daniels, Susanne Seymour, and Charles Watkins, "Enlightenment, Improvement and the Geographies of Horticulture in Later Georgian England," in David Livingtone and Charles Withers, eds., *Geography and Enlightenment*, (Chicago, 1999), pp. 345-71.

difficult to say what, exactly, the Society was – or to bound its activities, or define its own achievements, as compared to those which occurred in the world beyond. Because of its many projects the Society was baggy, shape-shifting, amenable to different views. While it had some concerns which cut across the range of its activities, it lacked the clarity of purpose which can be detected even in the other learned Societies in London, particularly the "Banksian learned empire" associated with the Royal Society, and the more directly advisory role which Humphry Davy pioneered at the Royal Institution.[25] Moreover, if we turn to general histories of scientific, learned, and economic societies during the eighteenth century, the Society of Arts is conspicuously absent.[26] It is also very rarely mentioned in histories of eighteenth-century science, even though its attempts to encourage different forms of public knowledge, and interactions between theorists and practitioners, touch on central concerns within that field.

The Society's absence from such narratives, and the difficulty of accommodating its wide range of activities is, I would suggest, what makes it interesting. The Society embraced all the activities noted above, and more. It did so in the name of "the nation" and "the public". At the same time, Trueman Wood's claim that "nothing was too homely for its attention", quoted above, captures a deeper truth than the mere miscellany of its awards. For, as we shall see, the Society's members prided themselves on what they, collectively, had achieved, and they regarded improvements and inventions of all sorts as personal in kind. The effects of this ranged from claims that the Society had been directly responsible for all kinds of improvement, to rewards for inventions which were inextricable from personal connections by which they were supported, to the desire on the part of premium candidates to publicise the most obscure, domestic, achievements. Moreover, their claims to be acting on behalf of the nation were refracted through the spaces of their own buildings in

[25] David Philip Miller, *The Royal Society of London 1800-1835: a study in the Cultural Politics of Scientific Organization,* (Unpublished PhD thesis, University of Pennsylvania, 1981); Morris Berman, *Social change and scientific organization: The Royal Institution, 1799-1844*, (Ithaca, 1978).

[26] It does not appear in James McClellan III, *Science Reorganized: Scientific Societies in the Eighteenth Century*, (New York, 1985); nor is it in Koen Stapelbroek, and Jani Marjanen, eds., *The Rise of Economic Societies in the Eighteenth Century: Patriotic Reform in Europe and North America*, (Basingstoke and New York, 2012). It is mentioned a princely total of three times in Roy Porter, ed., *The Cambridge History of Science: Volume 4, Eighteenth-Century Science*, (Cambridge, 2003).

London – where the committees met to read reports, and test models, and examine samples.[27] However expansive in intent, their public also depended on which people and objects they could bring together.

I have tried to capture this peculiar combination between expansiveness and homeliness, large-scale transformation and parochial concerns in the title of this thesis, "Sentimental Industry". It is meant to suggest two meanings. First, there is the heightened affective language through which the Society's projects were communicated. The agricultural improvement, enclosure, and colonial exploitation which they supported were clothed in a language of patronage, meant to unite the kingdom and its colonies, and act in the name of "social harmony and peace"; the Society's members styled themselves as patrons of the nation. During the Society's early years, these postures were associated with a discourse of emulation, and were meant to demonstrate the fine feelings of the Society's members as they sponsored workhouses, straw-plaiting, silk-worm schemes, and so on. The Society's wide-ranging public was meant to be encouraged through emulation; the premiums were intended to excite a "spirit of improvement". Historians of luxury have shown the fraught status of emulation within debates about sumptuary laws and the consumer revolution.[28] Second, "sentimental industry" should recall Adam Smith's *Theory of Moral Sentiments* of 1759, and particularly his account of sympathy. In that work, Smith argued that "[a]s we have no immediate experience of what other men feel, we can form no idea of the manner in which they are affected, but by conceiving what we ourselves should feel in the like situation", going on to claim that "[b]y the imagination, we place ourselves in his situation."[29] The significance of this image of sympathy as projective but limited identification is that it embodies the comic pathos of the Society of Arts. On the one hand, the Society's members reached out and envisaged a broad public transformed by the kinds of invention, improvement, and industry; on the other, they were confined to the often cranky, often parochial, discussions which could take place within the Society's own rooms. From

[27] With relation to fine art, Andrea Mackean, "Making a Place for Ornament: The Social Spaces of the Society of Arts", in Bennett, ed. *Cultivating the Human Faculties,* pp. 76-87, is particularly suggestive on this subject. I discuss her argument in detail in chapter two.
[28] Maxine Berg and Elizabeth Eger, eds., *Luxury in the eighteenth century: debates, desires and delectable goods*, (Basingstoke, New York, 2003); Maxine Berg, and Helen Clifford, eds., *Consumers and luxury: consumer culture in Europe 1650-1850*, (Manchester, 1999).
[29] Adam Smith, *The Theory of Moral Sentiments,* (London and Edinburgh, 1767), p. 2.

this limited scope, they were trying to imagine – to reconstruct – what "other men" might feel, or do, or want. Michael McKeon offers a suggestive generalisation of the significance of sympathy within Smith's thought overall:

> All (empirical) knowledge presupposes a detachment of the knowing subject from the object of knowledge. The aim of imaginative sympathy is, by acknowledging and exploiting it, to defeat this detachment. The virtual reality of "society" is produced by imaginative acts of sympathy, which transform the actual particularity of others into the concrete particularity of others-as-ourselves, who thereby become susceptible to collective generalization. […] Smith often figures this mental process as one of domestication, an imaginative act of the spectator's "bringing the case home to himself."[30]

I think this dynamic of projective identification and sympathetic domestication describes the peculiarities of the Society very powerfully, and connects its philanthropic ethos with its support for agriculture, invention and the arts. Rather than trying to cut off and systematise aspects of knowledge, the Society sought to bring them home – to encourage emulation which meant that others could undertake the same kind of sympathetic processes as the Society's members themselves. However, this was a much more fractious process than a language of philanthropic compromise suggests. I want to suggest that it involved two main aspects: first, the idea of fitting together a nation which was believed to be composed of widely divergent interest groups, imaginatively and through practical acts of encouragement, and according to an ideal of harmony. Second, by attempting to present local achievements in a form which would allow for them to be imitated in new places. I call these two aspects of the Society's aspirations the "expansive public" and "disembedding practices." Both touch on questions of general significance for eighteenth-century history. Section two is about the expansive project, offering a critical account of Jurgen Habermas' concept of the public sphere, and discussing its relevance to the Society; section three discusses historians' versions of "public science", and suggests how a study of the Society might

[30] Michael McKeon, *The Secret History of Domesticity: Public, private, and the division of knowledge*, (Baltimore, 2009), p. 377.

qualify these views; section four then brings a range of literatures together to talk about "disembedding practices". Section five, finally, offers an overview of the argument of subsequent chapters.

2. An Expansive Public

To think about the Society's aspiration to embody a public which included a wide range of different views, it is helpful to get a sense of the fractious contestations of the term "public" during the eighteenth century. Fortunately, the literature on this subject is very extensive and controversial. Rather than settling on any one version of "the public" during this period, I want to follow John Burrell's careful examination of how the concept was negotiated in practice.[31] In court, as Burrell shows, the difference between public and private could also be that between sedition and freedom. While the stakes were not as high as this in the Society's various negotiations of its public role, they did involve a number of different meanings. As we will see, the Society's members positioned it rhetorically as acting impartially, in the public good. At the same time, they were conscious of trying to incorporate contributions from a variety of different ranks and localities, with different preoccupations. We can understand appeals to "the public" as attempts to coordinate these different interests, to present them as though they were acting in step with each other. It was in the connection and gaps between the impartial ideal and the different interests from which it was composed that the Society's public took shape. In this, it followed the contours of eighteenth-century British culture more generally, and we can draw on the insights of works from different fields to get a sense of its contours, and significant areas of contention. I will begin by reviewing arguments about the public sphere, then look at the peculiarities and potentialities of the fiscal-military state; finally, I will look at work which analyses the tensions and interactions between local (often, "provincial", though London was in its own way a locality) and national culture.

Brooding above most discussions of the eighteenth-century public is Jurgen Habermas' 1964

[31] John Burrell, "Coffee House Politicians", *The Journal of British Studies*, 2004, **43**: 206-232.

book, *The Structural Transformation of the Public Sphere.*[32] Habermas' position is extremely enigmatic, but summarised schematically as follows. A mature critical "public sphere" emerged during the eighteenth century from shifts in available media, locations of sociability, forms of association, cultural expectations of openness, and genres of criticism. It developed through a dynamic interaction between family, market and state, though it could also be regarded as autonomous from all of them. Over the course of the eighteenth century the public sphere enabled the exercise of impartial critical reason by private men who assembled publicly, was in principle accessible to anyone; and it provided a forum within which the best argument could prevail.

The belated translation of Habermas' book is relevant to its Anglophone reception. Against a background of civil society resistance to tyrannical state power in the Soviet bloc, and a preoccupation in the North American academy with politics of identity, Habermas seemed to be offering a compelling account of the critical public's independence from other institutions, which was primarily limited by its blindness to the differences in privilege between social groups. As feminist and Marxist critics observed, his idea that the public sphere was genuinely egalitarian concealed its particular strategies of exclusion. Alternative publics have proliferated ever since – from feminine salons, to queer counter-publics, to colonial festivities, to the "non-conformist public sphere".[33] While all of these could be associated with a public role, few of them were characterised by the universalist aspirations to reason which Habermas espoused: this, indeed, was the pluralist point.

Habermas' public sphere has often been assimilated to the rise of civil society as such. Thomas Broman, for example, claims that the "public does not exist merely as an inert object of state control"; rather it "arises in opposition to the state's intervention" through "a self-consciousness

[32] Jurgen Habermas, *Structural Transformation of the Public Sphere*, (Cambridge, MA, 1989). The literature here is enormous; in addition to the studies discussed below, see Craig Calhoun's introduction to his edited collection *Habermas and the Public Sphere*, (Cambridge, MA, 1992). It's important to note that there is a significant literature on ideas of public life during the eighteenth century which does not refer to Habermas at all; for example, Paul Langford's monumental *Public Life and the Propertied Englishman, 1698-1798*, (Oxford, 1991).

[33] For example, Daniel E. White "The 'Joineriana': Anna Barbauld, the Aikin Family Circle, and the Dissenting Public Sphere", *Eighteenth-Century Studies* 1999, **32**: 511-533; John L. Brooke, "Reason and Passion in the Public Sphere: Habermas and the Cultural Historians", *The Journal of Interdisciplinary History*, 1998, **29**: 43-67.

among the members of civil society of themselves as the public."[34] Such a view runs the risk of neglecting the ways in which civil society remains dependent on, or implicated within, institutions of the state. Unpacking the tensions and points of contention which are masked by the inclusive, universal language of the public sphere, Nancy Fraser argues that invocations of "the public" concealed four crucial ambiguities: to describe something as public was to say that it was accessible to all; of concern to all; related to the state; and that it pertained to a common good or shared interest.[35] The effect of this argument is to push beyond the rise of an emancipated civil society, and to consider the implication of ideas of the public with other aspects of social life, including the state. This fits well with what historians have told us of how people during the eighteenth century made use of the British state.

Where the state should be located is a question in itself. J. W. Gunn captures the problem nicely in a chapter titled "Eighteenth Century Britain: In search of the State and Finding the Quarter Sessions."[36] That is, if we are looking for a centrist state directly analogous to continental European equivalents, Britain will be found wanting. However, as James McClellan argues, the character of "English government itself was different. It depended on a loose, *de facto* coordination among many bodies in theory separate but in fact linked together with a ruling class".[37] The connections which this entailed – through family, political alliance, neighbourliness – meant that governmental activity of various kinds percolated throughout society – including to the bottom. Carolyn Steedman and Lynn Hollen Lee have shown how servants and paupers, respectively, used knowledge of their legal status and the courts to contest injurious practices and frame their own life histories.[38] Clearly, these were not the direct impositions of the central state; nevertheless they involved forms of governance, encounters with law, and suggest that we should not think of the state as absent. (This was the reason for Gunn's title). Similarly, many voluntary societies took on

[34] Thomas Broman, "The Habermasian Public Sphere and 'SCIENCE in the ENLIGHTENMENT", *History of Science*, 1999, **36**: 123-150.
[35] Nancy Fraser, "Rethinking the public sphere: A contribution to the critique of actually existing democracy," *Social Text*, 1990, **25/26**: 56-80.
[36] J. A. W. Gunn, "Eighteenth-Century Britain: In Search of the State and Finding the Quarter Sessions", in John Brewer and Eckhart Hellmuth, eds. *Rethinking leviathan: the eighteenth-century state in Britain and Germany*, (Oxford, 1999), pp. 99-125.
[37] McClellan III, *Science Reorganized*, p. 34, quoted in John Gascoigne, "The Royal Society and the emergence of science as an instrument of state policy," *British journal for the history of science,* 1999, **32**: 171-184, at 181.
[38] Carolyn Steedman, *Labours Lost*, (Cambridge, 2009); Lynn Hollen Lees, *The solidarities of strangers: The English poor laws and the people, 1700-1948*, (Cambridge, 1998).

roles which might elsewhere be associated with government, and if their record of success in this was mixed, it was still a major part of everyday life.[39]

Recent work on the central state, and particularly on parliament, also suggests a dynamic interaction between local and national interest. Joanna Innes describes the apparent paradox between local autonomy and the involvement of the national parliament. On the one hand, she writes, "local communities were left very much to their own initiative'"; but on the other, "[t]he opportunity to obtain local legislation, authorizing actions that would not otherwise have been legal, or putting the coercive force of the law behind local projects, represented one of the most powerful resources available to those striving to exercise that initiative."[40] Innes charts the rise of the distinct projects of survey and enquiry which accompanied this local-national interaction. But association of private or local interest with the national parliament was the background against which people rationalised their claims to be acting in the public good. As John Brewer puts it:

> Lobbies, trade organisations, groups of merchants and financiers fought or combined with one another to take advantage of the protection afforded by the greatest of economic creatures, the state. They struggled for access to the corridors of power, for information that would enable them to thwart, create, or affect policy, and for the support of those parliamentarians who could hold the fiscal juggernaut in check. As their tactics grew more sophisticated they learned to transcend their sectionalism and to appeal beyond their self-interested ranks to the public at large.[41]

It was within this context of voluntary societies assuming governmental roles, surveys into the wealth and happiness of the kingdom, and lobbying of a central parliament that the Society of Arts came into being and attempted to perform its public role. D. G. C. Allan argues that it acted as a hybrid between lobby group and voluntary association, consciously imitating the ritual protocols of

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[39] Robert John Morris, "Voluntary societies and British urban elites, 1780-1850: an analysis," *Historical Journal*, 1983, **26**: 95-118; Peter Clark, *British Clubs and Societies 1580-1800: The Origins of an Associational World,* (Oxford, 2000).
[40] Joanna Innes, *Inferior Politics: Social Problems and Social Policies in Eighteenth Century Britain*, (Oxford: Oxford, 2009), p. 78.
[41] John Brewer, *Sinews of Power: War, Money and the English State,* (London, 1990), xxi.

Parliament.[42]

Similarly, studies of provincial societies have emphasised their contrasts with and imitations of the capital. In functionalist terms, historians have stressed how preferred forms of useful knowledge discussed within provincial societies were coloured by local needs: Hull, Bristol and Liverpool focused on navigation and mathematics, while Sheffield and Birmingham appealed to utilitarian manufacturing concerns. [43] Cultural histories focus instead on the value of membership to individuals, and on their connection with the local area as opposed to the values associated with the Metropolis. Early accounts attempted to establish what Roy Porter terms a "two nations" account, which contrasted the stuffy degeneracy of London to the vitality of the new industrial towns. Porter argues that instead we needed an account of provincial consciousness: "Painfully aware that they existed in the shadow of the metropolis, provincials' prime aim was to assimilate metropolitan culture and values. Provincial culture was more imitation than innovation."[44] Along these lines, Paul Elliot summarises the appeal of provincial institutions as follows: "individuals could buy into Enlightenment rationality and advertise their membership of the club of public rational discourse".[45;] They also "afforded opportunities for the provincial middling sort and gentry to transcend their localism and to adopt aspects of metropolitan culture".[46] On the other hand, learned provincials could also embrace local chorographical traditions or international scholarship, bypassing the need for authorisation by the Metropolis.

Dror Wahrman generalises the dispute between capital and province, and uses it to describe the culture at large, not only that within voluntary associations. He argues that the divisions within British elites during the eighteenth century should be regarded as being conducted "between an emerging wide-ranging 'national society' and an alternative polymorphous-provincial culture."[47] In

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[42] D.G.C. Allan, "The Society of Arts and Government, 1754-1800: Public Encouragement of Arts, Manufactures, and Commerce in Eighteenth-century England." *Eighteenth-century Studies*, 1974, **7**: 434-452.
[43] Ian Inkster and Jack Morrell, eds., *Metropolis and province: Science in British culture, 1780-1850*, (Philadelphia, 1983), 13.
[44] Roy Porter, "Science, Provincial Culture and Public Opinion in Enlightenment England," *Journal for Eighteenth-Century Studies*, 1980, **3**: 20–46.
[45] Paul Elliott, "The origins of the 'creative class': provincial urban society, scientific culture and socio-political marginality in Britain in the eighteenth and nineteenth centuries," *Social History,* 2003, **28**: 361-387.
[46] Paul Elliott, "Towards a geography of English scientific culture: provincial identity and literary and philosophical culture in the English county town, 1750–1850," *Urban History,* 2005, **32**: 391-412.
[47] Dror Wahrman, "National Society, Communal Culture: An Argument about the Recent Historiography of Eighteenth-Century Britain." *Social History*, 1992, **17**, 43-72, at 43.

this picture, the widening availability of cultural goods enabled a broadening of aristocratic culture, and left the middling sorts with a choice: "to join in and try to become assimilated to some degree in this novel and attractive culture, a culture which was London-centred and London-oriented; or to assert their distinct values and culture, focused on their local community, against this alien intrusion."[48] Both could operate anywhere within the country; the difference was not their actual distance from the capital but their imaginative engagement and the geography of their political engagement within different models of public life.

Wahrman's framework has the merit of suggesting why the Society of Arts might disappear from the discussion of eighteenth-century economic and learned societies which proliferated from the early nineteenth century onwards: based in London, it was closely connected with the "national" culture; and yet it had its own peculiarities, was shaped by its own surroundings, belonged to the city in an immediate and rather messy way. Similarly, the heavy involvement of landowners, members of Parliament, and others with significant stakes elsewhere in the country, as both members and correspondents, propped up the Society's pretences to be a national institution. This meant that they believe that it belonged to London society, while also acting as an institution of greater scope.

It is important to stress that people in London had no privileged access to knowledge about what was happening elsewhere in the kingdom or its colonies.[49] The Society received information from provincial and colonial correspondents, but they were few in number and self-selected, and there were whole swathes of industry which never received the Society's attention. Moreover, this lack of awareness of what was happening elsewhere maps precisely onto debates within economic history about the timing and pace of "the industrial revolution". In recent years, much debate on this subject has concerned the reliability of econometric reconstructions, and how far such reconstructions of growth figures actually describe what was happening on the ground during the late-eighteenth and early-nineteenth centuries.[50] Thus from the mid-seventies economic historians radically revised the picture of explosive take-off, technological transformation, and normative

[48] *Ibid.,* 45.
[49] It is *always* important to stress this about people in London.
[50] David Cannadine, "The present and the past in the English industrial revolution 1880-1980," *Past & Present,* 1984, **103**: 131-172.

accounts of how development occurred which had been a common feature of earlier histories, focusing on much lower growth figures; on reorganisations in household labour as the predecessor to the introduction of technological changes; on historical alternatives to typical industrial developments, such as mass production; and on the continued prevalence of hand labour all through the nineteenth century.[51] Summarising what they took to be the new consensus in 1992, Maxine Berg and Pat Hudson write that "England never experienced a period of commitment to industrial growth: the industrial revolution was a brief interruption in the great arch of continuity whose economic and political base remained firmly in the hands of the landed aristocracy and its offshoots in metropolitan finance."[52] They argue explicitly against the national growth version because the developments of the Industrial Revolution "are not amenable to study within the frame of reference of national accounting and aggregate statistics". In their view the gradualist account relies on "clear-cut divisions between the traditional and the modern" which is unwarranted because "there were rarely separate organizational technologies, locations, or firms to be ascribed to either."[53] This intermeshing of traditional and modern forms of production and organisation clearly complicates the question of the chronology of novel transformative inventions which I described above with reference to Trueman Wood, as does their focus on regional specialisation of industries:

> [i]ndustrialization accentuated the differences between regions by making them more functionally distinct and specialized. Economic and commercial circumstances were thus increasingly experienced regionally and social protest movements with their regional fragmentation can only be understood at that level and in relation to regional employment and social structures.[54]

Thus work on both provincial societies and regional difference in industrialisation indicates the challenges and potential blind spots in the Society's national conception of the public, and its goal

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[51] Charles Sabel and Jonathan Zeitlin, "Historical alternatives to mass production: politics, markets and technology in nineteenth-century industrialization," *Past & Present,* 1985, **108**: 133-176; for the earlier part of the period Maxine Berg, *The age of manufactures, 1700-1820: industry, innovation and work in Britain*, (London, 1994); Raphael Samuel, "The Workshop of the World," *History Workshop Journal*, 1977, **3**: 6-73.
[52] Maxine Berg and Pat Hudson, "Rehabilitating the Industrial Revolution", *The Economic History Review*, 1992, **45:** 24-50, at 25.
[53] *Ibid.,* 31.
[54] *Ibid.,* 39.

to speak for the nation as a whole. Much in public associational life was focused on connections to regions which were increasingly assertive and individuated from each other.

In this picture, the public is composed of an immense variety of contending interests, each claiming to act for the good of all others by adopting a rhetoric of impartiality. This aligns with those views which emphasise the "contested terrain" of the public sphere. For Harold Mah, haunted by the mobs into which "the public" of the French revolution degenerated, "any projection of the public as a mass subject is necessarily unstable. The appearance of unity in the image of a collective subject is always belied by the reality of disagreeing social groups."[55] In this view, society is always really agonistic, controversial, and plural; any identification which claims to overcome this – however reasonable it may sound – is a precarious and ephemeral achievement. But exactly because it was not an object, the public could be configured in many different ways, with its freight of opposing meanings. At the Society of Arts, a language of the public spanned everything from the claim that activity in obscure areas could, with the right publicity, transform the nation as a whole, to the view that certain forms of support would transform the nature and activities of subjects throughout the kingdom and its colonies, to the claim that the organisation and its members were acting with utter impartiality, to a description of the audience which attended the Society's prize-givings. All these ideas clashed and re-emerged in different forms over the course of the Society's history. But throughout, the ideal that the Society could embody an encompassing public, able to unite different interests and forms of knowledge remained a constant concern.

3. Public Science

I now want to turn to the use which historians of science have made of the concept of the public sphere. There have been three major approaches here: those who have argued for the "public sphere" as a surrogate for encompassing concepts of the enlightenment; those who have

[55] Harold Mah, "Phantasies of the Public Sphere: Rethinking the Habermas of Historians," *The Journal of Modern History,* 2000, **72**: 153-182. On the phantasmal and identificatory roles of ideas of the public, see also Charles Taylor, *Modern social imaginaries*, (Durham, NC, 2004) and Michael Warner, "Publics and counterpublics," *Public culture,* 2002, **14**: 49-90.

focused on rhetorical appeals to the public; and those which have considered the concept of the public to be in conflict with the concerns of the market. I will review each in turn.

To understand the appeal of public sphere language as a way of interpreting the enlightenment, we need to understand that concept's fragmentation. Over the last thirty years, historians have localised the concept of the "enlightenment", describing it in terms of different national and regional styles and forms of participation.[56] This accentuates differences in national culture and reception: thus John Gascoigne, for example, identifies the English form of enlightenment with practicality rather than speculation.[57] The geographers David Livingstone and Charles Withers push further towards the level of locality, conceiving of "the Enlightenment as being sited, produced, debated in *local spaces and circumstances* as well as being apparent at national levels."[58] This fragmentation has raised concerns that the concept lacks explanatory power. Jan Golinski, for example, cautions that the trend of work on the Enlightenment has been to focus

> firmly on the specificity of local contexts, their temporal and geographical variability. This has been the case whether the focus has been on the popularization of science […], on the formation of scientific clubs and societies, or even on science's relations with the dominant social structures of aristocracy and state. In each area studied, the limits of possible generalisations have been stressed, the uniqueness of individual situations insisted upon, and the role of overarching concepts such as "the Enlightenment" consequently reduced."[59]

Because the emergence of the public sphere relied on structural transformations which occurred on more than a local scale, some historians have believed that it can be used to regain a more general picture. Thus Margaret Jacobs argues that public sphere language is a way of articulating an "expansive reconceptualization of the Enlightenment", wherein the historian's task is to describe

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[56] Jeremy Carradonna, *The Enlightenment in Practice: Academic Prize Contests and Intellectual Culture in France, 1670-1794*, (New York, 2012). I engage with Carradonna's arguments in detail in chapter nine. Daniel Roche, *France in the Enlightenment*, (Cambridge, Mass; London, 1998). Roy S. Porter, and Mikuláš Teich, eds. *Enlightenment in the National Context*, (Cambridge; New York, 1981).
[57] John Gascoigne, *Joseph Banks and the English Enlightenment: useful knowledge and polite culture*, (Cambridge, 2003).
[58] C. W. J. Withers and D. N. Livingston, "Introduction: On geography and enlightenment," in Livingstone and Withers, eds., *Geography and Enlightenment,* 1-28.
[59] Jan Golinski, "Science in the enlightenment", *History of Science,* 1986, **24**: 411-24, 416, quoted in Broman, "The Habermasian Public Sphere," 124.

"the richness of enlightened cultural practices, identifying their origins and turning points, and relating them to the late-eighteenth-century political transformations that articulate Western democratic ideals and institutions."[60]

Broman argues for the crucial role of "openness" in the emergence of public science; he understands this as "a particular category or subset of culture according to which institutions, actions, or statements in discourse assume the quality of being public or 'open' (*öffentlich*), instead of being secret or private."[61] Hence Broman is concerned with "the role of the press as the medium of what can be considered 'public knowledge'", and studies a scientific controversy conducted in the press, in which the contributors apostrophised a reading public.[62] Here the public appears primarily as the audience, and arbiter, of scientific disputes. While he does not use Habermasian language, Golinski's *Science as Public Culture* focuses on similar questions, emphasising the intended audience of different forms of science during the eighteenth century. Thus Golinski contrasts the chemistry of Joseph Priestley – who published experiments meant to be easily replicable in a wide range of places – with Humphry Davy's more socially conservative approach towards science as a socially stabilising factor, intended for the elite audience of the Royal Institution and intimately involved with the state.[63] Criticising this approach to public science, Roger Cooter and Stephen Pumphrey complain that "it is less upon the audiences themselves that this work concentrates, than on the sites, the methods – the theatrics – and the individuals involved in the different social tailorings and legitimations of scientific knowledge".[64] That is, the public is seen from the perspective of those who were trying to reach it, rather than from the points of view of those of whom it was composed. Cooter and Pumphrey argue instead for a history which is more directly attentive to the practical effects of reception and appropriation of science by actual audiences.

Of course, much depends on how those audiences are understood: eighteenth-century audiences

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[60] Margaret C. Jacob, "The Mental Landscape of the Public Sphere: A European Perspective," *Eighteenth-Century Studies*, 1994, **28**: 96.
[61] Thomas Broman, "Metaphysics for an Enlightened Public: The Controversy over Monads in Germany, 1746-1748," *Isis*, 2012, **103:** 1-23, at 5.
[62] *Ibid.* Cp. David Zaret, *Origins of Democratic Culture: Printing, Petitions and the Public Sphere in Early-Modern England,* (Princeton, 1999).
[63] Jan Golinski, *Science as public culture: Chemistry and enlightenment in Britain, 1760-1820*, (Cambridge, 1999).
[64] Roger Cooter and Stephen Pumphrey, "Separate Spheres and Public Places: Reflections on the History of Science Popularization and Science in Popular Culture", *History of Science,* 1994, **32**: 237-67, 243.

for science have often been understood as consumers, acting within a marketplace. Andreas Daum, for example, describes public knowledge as

> a changing set of material, cultural, and intellectual practices and presentations – and the consumption thereof – aimed at creating and communicating knowledge as a commodity in public enterprises that are defined by mechanisms of inclusion and exclusion, generate market-like situations, and respond to and themselves articulate cultural, social and political preferences.[65]

This view aligns with the connections which historians have drawn between the production, circulation and consumption of eighteenth-century science and the consumer revolution and "world of goods" during the same period.[66] Roy Porter alludes to the emergence of "something like a marketplace in ideas", which meant that "[c]onsumers might buy into any aspect of science that they chose."[67] In this vein, historians have focused on spectacular displays, and how they were evaluated according to different standards of value in "public" spaces such as the Royal exchange away from the Royal Society[68]. Other studies have described the "entrepreneurial" culture of experimental lectures, and the "commerce of rationality" through which their wares were consumed, with its focus upon "the concrete, the practical, and the entertaining."[69]

This line of argument engages with Habermasian ideas by claiming that they are too remote from the operations of the marketplace. Larry Stewart is explicit on this point: "quite unlike the idealized suspension of the 'laws of the market' supposed by Habermas, the promotion of science operated not in the cultivation of genteel social intercourse across classes; rather, it was a market

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[65] Andreas W. Daum, "Varieties of popular science and the transformations of public knowledge: some historical reflections." *Isis,* 2009, **100**: 319-332, at 331.
[66] John Brewer and Roy Porter, eds. *Consumption and the World of Goods*, (London and New York, 1993).
[67] Roy Porter, "Introduction," in *The Cambridge History of Science, volume 4: Eighteenth-Century Science,* (Cambridge, 2003), p. 9.
[68] Simon Schaffer, "The Show that Never Ends: perpetual motion in the early eighteenth century," *British journal for the history of science*, 1995, **28**: 157-190; Simon Schaffer, "The consuming flame: Electrical showmen and Tory mystics in the world of goods", in Brewer and Porter, eds. *Consumption and the World of Goods*, 489-526.
[69] Larry Stewart, *The rise of public science: rhetoric, technology, and natural philosophy in Newtonian Britain, 1660-1750*, (Cambridge,1992), 16.

that was redolent with social transformation."[70]According to Stewart, even those who cultivated aristocratic patrons were "led into the world of entrepreneurs and financiers in the warrens and alleys around the Royal Exchange", and their experimental demonstrations occurred in commercial, insurance and engineering locations.[71] Stewart also notes that this produced a rhetoric of public action:

> in the language of the eighteenth century, the profit-taking basic to industrial activity and the application of machines to manufacturing and transportation could be rationalized as activity undertaken for the public good; machines were thus more than engines of private advantage to be preserved by patents […] both the machine and industry were seen to benefit the public at the expense of private, oligarchic interests.[72]

We can accept the view that, in such contexts, appeal to the public was a rationalisation of private interest while also still regarding the eighteenth-century public as potentially more encompassing than the market.

Overall then, discussions of "public science" have usually conflated it with popular science, and understood it in terms of the emergence of different kinds of media and of consumption of goods within a marketplace; in this context, some individual natural philosophers sought to legitimate their activities by adopting a language and critical stance of impartial judgment, able to evaluate the schemes of projectors, or claim that they were acting on behalf of the public good. In this respect they resemble Brewer's lobbyists. As we shall see, public science at the Society of Arts was rather different: it included different practices (particularly agricultural), different locations; it was much closer to the interests of the state in everything from tariffs to wheel-carriages. Above all, it was extremely difficult for natural philosophers who were involved with the Society to define a privileged space for their enquiries, away from the wider public world of uses.

They tried, of course: and their attempts to record and codify improvements lead to the other

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[70]Larry Stewart, "A Meaning for Machines: Modernity, Utility, and the Eighteenth-Century British Public," *The Journal of Modern History*, 1998, **70**: 259-294, at 267.
[71] Larry Stewart, "The Selling of Newton: Science and Technology in Early Eighteenth-Century England," *Journal of British Studies*, 1986, **25**: 178-192.
[72] Stewart, "A Meaning for Machines", 264.

major aspect of the public at the Society – turning local achievements into more general knowledge. Such disembedding efforts are the subject of the next section.

4. Disembedding Practices

The goal of the Society of Arts premiums was to reward reports and samples of successful local practices: such reports had to attempt to describe what had been done. This can be considered as a question of how to make knowledge public, and once again it touches on questions raised in histories of many kinds. I have found it helpful to think about this subject in the terms which Michael Mckeon proposes in his monumental reworking of Habermasian themes, *The Secret History of Domesticity*, from which I quoted above. Mckeon argues that the period from the early seventeenth century onwards sees the rise of "modern" knowledge which is "disembedded from the matrix of experience it seeks to explain".[73] Mckeon contrasts this with earlier, "traditional" forms of knowledge, which did not recognise the need for explicit justification. Beginning with an awareness of the need to justify practices which could previously have assumed their own legitimacy, such as theories of absolute kingship, such disembedding gathered force over the eighteenth century.[74]

In this picture, what characterises modern knowledge is that it cannot assume that it is legitimate on the basis of existing practice, and is open to criticism. In consequence, such knowledge attempts to stand apart, to delineate clear and separate objects of enquiry; it is "defined precisely by its explanatory ambition to separate itself from its object of knowledge sufficiently to fulfil the epistemological demand that what is known must be divided from the process by which it is known"; that is, it aspires to be reasonable in the view of criticisms from outside.[75] Arising amid separations of interest and knowledge, it aspires to the "formulation of a conceptual abstraction that is 'indifferent' to any concrete instance because it grows out of a multiplicity of instances whose number and variety preclude the dominance of the concrete and provide the basis for

[73] Mackeon, *Secret History,* p. xix.
[74] *Ibid*
[75] *Ibid*

generalisation."[76] This argument has the great virtue of suggesting an aspiration to knowledge which can stand by itself and is able to generalise in ways which overcome the problems associated with partial particularity. It bears comparison with several other approaches – I want to contrast it with arguments about systematic knowledge as the domination and erasure of particular qualities, Joel Mokyr's ideas about the character of useful knowledge; and arguments which describe a more reciprocal relation between practice and theoretical knowledge.

The first view which we might compare with Mckeon's is the argument that the development of systematic knowledge requires the erasure of local properties, which is given in its more influential form by Foucault in *The Order of Things*. In his chapter "Classifying", Foucault describes the emergence of a new regime of power and knowledge associated with the knowledge practices of the eighteenth century, particularly the construction of large-scale systems associated with figures like Linnaeus. For Foucault, such "classical" knowledge involves the imposition of a grid-like conceptual schema: "[d]isplayed in themselves, emptied of all resemblances, cleansed even of their colour, visual representations will now at last be able to provide natural history with what constitutes its proper object, with precisely what it will convey in the well-made language it intends to construct."[77] Such systemic natural history spoke in a perfect but artificial language intended to delimit the ways in which the world might be known:

> to establish the great, unflawed table of the species, genera, and classes, natural history had to employ, criticize at new expense a language whose condition of possibility resided precisely in that continuum. Things and words are very strictly interwoven: nature is posited only through the grid of denominations, and […] it glimmers far off beyond them, continuously present on the far side of this grid, which nevertheless presents it to our knowledge and renders it visible only when wholly spanned by language.[78]

The picture of a closed circle of systematic ordering as the key aspect of eighteenth-century knowledge, delimiting what can be known according to quite rigid categories, has powerfully

[76] *Ibid.,* 9.
[77] Michel Foucault, *The Order of Things,* (New York, 2012), p. 134.
[78] *Ibid*., p. 160.

influenced histories of observation and classification. It remains a central narrative within histories of botany, though with certain qualifications: while historians emphasise the processes of erasure involved in processes like Linnaean collection, they also describe the aspiration to collect non-systematic uses of materials, and emphasise processes of material exchange which contribute to a more dynamic and personal form of classification than Foucault identified. Nevertheless, the idea of a system which stresses similarity and which cannot accommodate the purely local or particular remains central to our sense of the eighteenth-century episteme. This is perhaps somewhat less than Mckeon's vision of disembedding practices, because the generalisations allow for the inclusion of only certain features of the entities which are meant to be classified.

The Foucauldian grid can be regarded as unduly rigid, even "metaphysical" for making sense of concrete historical developments. Many historians have turned this to their advantage, by examining the specific uses to which systemic knowledge has been put in local contexts. For Sandra Sherman, for example, Count Rumford's writings on workhouse reform become a crucial way in which a paternalistic discourse of "the poor" – based ultimately on particularities of human relations – transformed into one of "poverty", which could be naturalised and founded on physics.[79] Simon Schaffer focuses on local negotiations of power and authority in natural philosophers' claims to be able to define practice, focusing on geographical specificities and rationalising attacks on customary economies of work. Thus, in a paper concerned with Charles Babbage's conceptions of "intelligence", Schaffer argues that "the account of the factory as a transparent and rational system was designed to demolish traditional and customary networks of skill and artisan culture".[80] Likewise, he describes how shifts in agronomic writing from the seventeenth to the eighteenth century saw the replacement of a "moral order" based upon "natural place" by "a political economy which transmuted such customs into cash-values and denied the godly origin of soil's fertility."[81] Overall, this represented an "assault on the moral economy and its

[79] Sandra Sherman, *Imagining Poverty: Quantification and the Decline of Paternalism*, (Columbus, Ohio, 2001).
[80] Simon Schaffer, "Babbage's intelligence: Calculating engines and the factory system," *Critical Inquiry,* 1994, **21**: 203-227.
[81] Simon Schaffer, "The earth's fertility as a social fact in early modern Britain," in Roy Porter and Mikuláš Teich, eds., *Nature and society in historical context* (Cambridge, 1997): 124-47.

displacement by new programme of calculation, surveillance and soil chemistry."[82]

Because the Society of Arts devoted a lot of attention to agriculture, I want to unpack this question a little. There is clearly a connection between the overall transformation of ethos which Schaffer describes and the activities of individual improvers, but it is not automatically clear what it is. Agricultural historians generally operate on a "diffusion" model, which is attentive primarily to how improved practices spread from one location to another, rather than focusing on the epistemic questions which preoccupy historians of other sciences.[83] At the beginning of the twentieth century, Lord Ernle supposed that publicists like Arthur Young and William Marshall, and aristocratic improvers like the Duke of Bedford, were responsible for the introduction and spread of improved practices.[84] Subsequent histories massively downplayed their significance, emphasising instead the role of land agents, informal communication networks, and practical farmers – whose activities were often not documented directly, and are in this sense tacit. This, of course, leaves the question of what we should make of the aristocrats and publicists.[85]

Experiments were not exactly the same thing as other aspects of improvement, because they were potentially wasteful. It is clear that one of the major problems which arose for writers on agriculture during the eighteenth century was the replicability of any experimental results.[86] This was much more than the usual challenge of the experimenters' regress, because agricultural experimental results were known to depend enormously on local conditions of soil and situation, and on other variable factors from the weather to the price of labour.[87] As Mary Morgan observes, this did not stop them being presented in the form of financial accounts, and indeed as serving as models for numerical economic writing – but it did mean their fallibility and dependence on circumstantial was recognised more than in the case of other kinds of experimental report. Several

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[82] *Ibid.,* 140

[83] Andre Bourde, *Agronomie et Agronomes en France au 18e siècle*, (Paris, 1967); Sarah Wilmot, *The Business of Improvement: Agriculture and Scientific Culture in Britain c. 1770-c. 1870,* (Reading, 1990).

[84] Rowland Prothero, *English Farming, Past and Present,* (London, 1913); see also the literature reviewed in the first chapter of Mark Overton, *Agricultural Revolution in England: the transformation of the agrarian economy, 1500-1850*, (Cambridge, 1996).

[85] Pamela Horn, "The Contribution of the Propagandist to Eighteenth-Century Agricultural Improvement," *The Historical Journal*, 1985, **25**, 313-329.

[86] Harry Collins, "The experimenter's regress as philosophical sociology." *Studies in History and Philosophy of Science Part A*, 2002, **33**: 149-156.

[87] Mary S. Morgan, *The World in the Model: How Economists Work and Think*, ch. 2, "Experimental farming and Ricardo's political arithmetic of distribution," (Cambridge, 2012).

historians, particularly Robert Allen and Liam Brunt, have argued for the significance of the agricultural surveys devised by Arthur Young to detail the varieties of local practice -- Brunt in particular claims that Young's data gives a robust and representative picture of eighteenth-century agricultural practice.[88] These surveys, while they resemble the attempts to codify practice described above, were rich and particular about local detail. They thus provide an interesting counterpoint to more straightforwardly experimental activities, or exemplary achievements of the sort which might be rewarded by premiums; this contrast is one on which I draw extensively below.

If we concede that the large-scale improvers were not the main agents of agricultural change, it is relatively difficult to get a sense of their contributions. Paul Smith's dissertation, *The Landed Estate as Patron of Scientific Innovation: Horticulture at Woburn Abbey 1802-1839*, scrupulously details the connections between experimental agriculture and developments in horticulture, but leaves the significance or impact of such activity broadly unaddressed.[89] Woburn is treated, implicitly, as a centre of innovative transformation, but there is no attention to how its experiments were regarded or recreated within the outside world. David Brown, by contrast, reads the experiments in ideological terms, as an attempt to defend the power of the landed interest by "reducing the poor to economic dependency; secondly, to justify the aristocracy's supremacy by the rational exploitation of their estates; finally to encourage methods to maximize production in order to feed the growing population and avoid social conflict".[90] In other words, experimentation was not solely about rationalisation and the straightforward pursuit of profit, but had significant additional symbolic and ideological aspects. Disaggregating improvement in this way, and thinking about the different sites and procedures which were involved in it, produces a less totalising sense of how it functioned. I will have much more to say about this over the course of this work.

Also emphasising the role of codification, but from a laudatory perspective, Joel Mokyr has

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[88] Robert C. Allen and Cormac Ó Gráda, "On the road again with Arthur Young: English, Irish, and French agriculture during the Industrial Revolution," *The Journal of Economic History*, 1998, **48,** 93-116; Liam Brunt, "Rehabilitating Arthur Young," *The Economic History Review,* 2003, **56**: 265-299; Liam Brunt. "The advent of the sample survey in the social sciences," *Journal of the Royal Statistical Society: Series D (The Statistician)*, 2001, **50**: 179-189; for Brunt's use of Young's data see his "Mechanical innovation in the industrial revolution: the case of plough design," *The Economic History Review*, 2003, **56**: 444-477 and "Where there's muck, there's brass: the market for manure in the industrial revolution," *The Economic History Review*, 2007, **60**: 333-372.

[89] Paul Smith, *The landed estate as patron of scientific innovation: Horticulture at Woburn Abbey, 1802-1839*, (Unpublished PhD Dissertation, Open University, 1983).

[90] David Brown, "Reassessing the Influence of the Aristocratic Improver: The Example of the Fifth Duke of Bedford (1765-1802)," *The Agricultural History Review*, 1999, **47**: 182-195.

influentially recast views from older economic history about the contributions of "science" to the take-off in economic growth from the late eighteenth century onwards. Mokyr is interested in the emergence of a broader "epistemic base" upon which improved techniques could draw. He argues that this was developed in three stages: first, through the systematic surveying of artisanal practices; second through their recording in works of useful knowledge; and ultimately through the abstraction of "propositional" (abstract, universally applicable) from "prescriptive" (tacit, how-to) knowledge.[91] Once it had been codified in this way, prescriptive knowledge could contribute to the further development of productive techniques – and by around 1800 this allowed, for the first time, for self-sustaining economic and technological growth.

When we turn to practices of codification, however, the relation between the particular and the general appear much more complex than Mokyr allows. Chris Evans and Alun Withey note that information about the production of steel was often copied unreflectively from one source to another; and conclude that "[t]here is little evidence that the circulation and codification of 'useful knowledge' among artisans […] had a discernible effect on the ways in which steel goods were made."[92] Similarly, studies of encyclopedias emphasise their rhetorical construction of ideals of knowledge and relations between theory and practice. Other studies have suggested how artisanal contributions were minimised in the Encyclopedia by pictures which excluded representations of workers' bodies; and Diderot's aspiration towards a perfect descriptive language for machines and other processes which could be employed by the learned. Richard Yeo analyses eighteenth-century encyclopedias not as direct catalogues of practice but rather as attempts to solve the problem of knowledge after humanism which was too broad for one person to take in; as such, they were intended to maintain the universalist aspirations of an "earlier cultural legacy" rather than ways to reform practice directly.

Despite the difficulties in establishing direct connections between encyclopedic works and changes to practice, the encyclopedists did offer influential formulations of the relation between theory and practice. Eric Schatzberg argues that for Diderot and d'Alembert, science was universal,

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[91] Joel Mokyr, *The gifts of Athena: Historical origins of the knowledge economy*, (Princeton, 2002).
[92] Chris Evans and Alun Withey, "An Enlightenment in Steel?: Innovation in the Steel Trades of Eighteenth-Century Britain," *Technology and Culture,* 2012, **53**: 533-560.

while art was "particular to the artist" – a modulation of Aristotelian distinctions between *episteme* and *techne* which were intended to set a reciprocal relation between them.[93] Thus for Diderot "one cannot advance the practical side of an art without speculation, nor fully grasp the speculative side without practice".[94] Despite such appeals, however, the interaction was loaded towards the learned, with complaints about "inarticulate artisans who 'work only by instinct' and could not explain their methods."[95] In general, attempts at codification raise questions about who can speak on behalf of practices, not only their direct improvement.

Recent work has sought to collapse the distinction between artisanal practice and scientific (or natural philosophical) theory. There is much more equanimity in the relations between "theory" and "practice" in these views than are suggested by either Foucauldian tradition or Mokyr's industrial enlightenment. Pamela Smith describes artisans as practising a "vernacular science", based around materials, and with a distinct vocabulary – preserved in written sources – for describing processes, which "appears to have underpinned and informed artisanal practices in pigment making and metalworking."[96] More broadly, Smith argues that the recovery of such knowledge can contribute to "a new history of science, one in which phenomena that used to be seen as local can be integrated into an overarching narrative of the making of knowledge. This history of science might in the broadest conception be written as the history of material life and the human entanglement with nature."[97] Likewise, Lisse Roberts, Simon Schaffer and Peter Dear's collection *The Mindful Hand* which relates the period between the "so-called Scientific Revolution" and the "so-called Industrial Revolution" as "a complex story of complicity between contemplation and manipulation", in which "[t]he history of material and knowledge production […] is a single, hybrid affair in which the work of the head and of the hand formed a complex whole".[98] In the introduction to their collection *Materials and Expertise in Early Modern Science,* Ursula Klein and Emma Spary record their debt to "recent approaches that interconnect the history of science and

[93] Eric Schatzberg, "From Art to Applied Science," *Isis,* 2012, **103**: 555-563.
[94] *Ibid.,* 558.
[95] *Ibid.,* 559.
[96] Pamela Smith, "Vermilion, Mercury, Blood, and Lizards," in Ursula Klein and Emma C. Spary, eds., *Materials and expertise in early modern Europe: between market and laboratory*, (Chicago, 2010), pps. 29-50, 30.
[97] *Ibid.,* 31.
[98] Lissa Roberts, Simon Schaffer, and Peter Dear, eds. *The Mindful Hand: Inquiry and Invention from the Late Renaissance to Industrialization.,* (Chicago, 2007), ix.

technology, highlighting early modern practitioners or sites which permitted an erosion of the older dichotomies between hand and mind, scholar and artisan, learned and practical knowledge about the material world."[99] The focus of their studies is on what they term hybrid-experts, skilled practitioners who at least sometimes recorded their practices and who "borrow[ed] skill, language and explanations from both the artisanal and the scholarly worlds."[100] Within these accounts, materials find a wide variety of knowers and users, which do not evince a hierarchy between head and hand, or practice and record, in the same way as the encyclopedists and their historical inheritors have claimed.

One focal point for "the human entanglement with nature" has been histories of materiality. The use and judgment of materials by different groups and users allows us to approach different canons of judgment. In their recent book *Materials in Eighteenth Century Science,* Klein and Wolfgang Lefèvre argue that eighteenth century chemistry was primarily a science based upon the knowledge of materials, which were "multidimensional objects of inquiry that could be investigated in practical and theoretical contexts and that amalgamated perceptible and imperceptible, useful and philosophical, technological and scientific, social and natural features". [101] The focus of their analysis, however, is on the "historical ontology" which they hold to be embedded in different classificatory regimes, rather than more directly upon the users of materials. The discipline which has lavished most attention on the shifting ways in which the properties of material things are judged by multiple groups, is history of food. What counts as adulteration, and what as a legitimate new product; judgments of quality of all kinds – are institutionally and epistemically contingent questions, based on the ability of the users of certain techniques to legitimate their own forms of analysis. Studies have also focused on the epistemic status of concepts such a *teroir,* which associate quality with local regions without being amenable to laboratory analysis.[102] This work has drawn on sociological studies on the ways in which judgments of food quality rely on a range of institutional and technical contexts. Again, however, historians have urged the need to incorporate the

[99] Klein and Spary, eds. *Materials and expertise*.
[100] Ursula Klein and Wolfgang Lefèvre, *Materials in eighteenth-century science: a historical ontology*, (Cambridge, Massachusetts, 2007).
[101] *Ibid*., 1.
[102] Elizabeth Barham, "Translating terroir: the global challenge of French AOC labelling," *Journal of Rural Studies*, 2003, **19**: 127-138.

viewpoint of many different users of materials. Thus Christoph Bartels advocates that these lessons of history of food can be applied to materials in the history of science, but cautions that "[m]odern standards offer one mode of evaluation, but the individual character of products and the points of view of consumers offer another. Each mode points to different interests, expectations, and aspects of knowledge which make the product what it is."[103] These approaches very helpfully multiply the range of users which materials might find, and allow us to trace the different forms of knowledge and practice involved in their manipulation. Clearly, any such approach will complicate the idea of codification, if this is taken as a straightforward transition from unregenerate practice to general theory.

Overall, then, the range of approaches which I have summarised under this heading demonstrate the problems with which an organisation like the Society of Arts was faced during the eighteenth century. How could they move from richly embodied particular practice to more general or codified knowledge, and what might be lost (or what perspectives might be excluded) when they did so? This worked out in different ways across the span of the Society's various activities; I will give an overview of how it did so in the next section.

5. Thesis Overview

What this review has suggested so far is that eighteenth-century appeals to "the public" were intended to fit together a wide range of different and often opposing interests which showed wide local variation; that as such the public was meant to be more encompassing than either the state or the market; that an organisation like the Society of Arts was concerned with this kind of coordination, which was not centrally directive but rather meant to encourage emulation of exemplary practices; and that this practically involved techniques for describing local practices, transferring them to new locations, and perhaps generalising from them too. Studying the Society of Arts suggests how fragmented aspects of both historiography and natural life might be assembled; but it also suggests that the unifying concepts of the public were embodied in individual

[103] Christoph Bartels, "The Production of Silver, Copper, and Lead in the Harz Mountains from Late Medieval Times to the Onset of Industrialization", in Klein and Spary, *Materials*, 71-100, at 72.

material things. I do not expect this claim to be very convincing yet, but it underpins each of the chapters which follows. I now want to give an overview of the argument of the rest of this thesis.

Chapter two, "The Society of Arts and Fish", analyses how concepts of the public were negotiated within the early Society. Drawing on satires, pamphlets, and newspaper reports, I argue that the aloof impartial public role which the Society's members attempted to project was repeatedly subverted by associations between materiality and the interests of particular trades: this appeared most ludicrously and decisively during the Society's scheme to bring fish to London by land carriage during the early 1760s, which provides the chapter with its name. Some internal measures were passed to try to claim the Society was above such accusations: and more decisively, from the 1780s onwards, the Society came increasingly to be presented as a polite and respectable concern.

Chapter three, "Rationales of Reward", reviews the premium awards which the Society gave. I begin by comparing the premiums with kindred eighteenth-century institutions: government bounties and rewards, the prizes of other societies, and patents. Because of differences in personnel and rationale, each of the premium committees has to be considered on its own merits, but the only one which gives a clear idea of reward for a public career is the committee of fine arts. By and large the others variously rewarded people in very particular occupations and those who sought to promote wide-ranging schemes. And while Agriculture, Mechanics, Fine Arts, Manufactures, Colonies and Trade, and Chemistry cover a huge amount of ground, there were still some significant overlaps between them: particularly in their interest in "domesticating" particular improvements, manufactures, and materials; and their association between singular, localised, improvements and broader national goals.

If chapter three is largely concerned with the expansiveness of certain visions of the public, chapter four, "Anecdotes and Experiments", turns the focus back onto some of the individual subjects of premium rewards, in their particularity. Many of the Society's correspondents imagined that their contributions could play a part in public life. At the same time, their reports were remarkably full of local, particular and personal detail; down to a heightened affective language concerning the production of flax cotton or the rearing of silk-worms. Such particularity and

personalisation clearly suggested problems for any attempts to make this knowledge more general, or transfer these material properties beyond their immediate context. In consequence, many of the premium awards were closer to the kinds of rarities associated with seventeenth century natural philosophy than the more orderly systems commonly ascribed to the eighteenth, though significantly they emphasised local variability rather than irruptions into the order of nature. There are good reasons (outlined above) to believe that eighteenth-century inquirers developed distinct strategy to deal with the balance between local particularity and collection of data on a larger scale. Historians have emphasised the role of surveys in achieving this balance, but for an organisation like the Society of Arts, *anecdotes* also provided a way in which the balance could be struck. Personal, particular, and disruptive of existing systems, anecdotes give a way of thinking about why local achievements could seem so remarkable. But they raised their own distinct problems about how anecdotal information might be aggregated.

Chapter five –"Simple Machines" – considers the rewards which the Society gave in the class of mechanics. I begin by noting that a great many of the devices and models which were submitted in the class were praised for their "simplicity", and then attempt to tease apart what this entailed. On one level, mechanical simplicity was an allusion to the possibility of decomposition into the Galilean simple machines of theoretical mechanics; but on another it spoke to an abundant range of local practices and preferences which demanded that machines should be legible, reliable, and cheap, but within which it was rarely possible to separate tools from machines, or distinguish the role of human or animal labour from the mechanical part. This tension between the aspiration towards a universal language for "simplifying" machines and the particularity of their manifestations runs through several examples with which the Society of Arts was closely concerned over sustained periods, and which often excited noisy controversy:

Chapter six, "Material Substitutions" addresses the Society's interest in import substitution. It discusses cases from chemistry, botany, and metallurgy, seeking common threads between them. Against those historians who argue that natural philosophers who were involved with the Society – such as Edward Bancroft and William Lewis – were primarily encouraging a view of theoretical domination and precision measurement, I argue that these efforts were characterised by a

precarious balance between the questions of judgment involved in substituting one thing for another, material provenance and properties associated with local circumstances. Was the new one as good as the old, were its products the same, and how should the human activity and the properties of place associated with it be analysed – particularly when they were associated with a broad, and unknown, community of existing users? The curious effect of this in many cases, I argue, was for those who were animated by the possibilities of substitution to regard their own localities as privileged sites for particular material properties.

Chapter seven, "The English Pan", discusses the Society's concern with the purification the British grasslands through the collection of pure strains of seeds, a project originally inspired by Benjamin Stillingfleet's translations of Linnaeus. While this goal seemed clear enough, it was rapidly confounded by confusions about the effects of local circumstances on the growth of particular varieties of grass, by the question of the identifying American and British species with each other, and by the desire to track existing uses for different species of grass. The purifying campaign also kept recurring throughout the late eighteenth and into the nineteenth century, sometimes associated directly with the Society of Arts and sometimes promoted through networks of landowners who were closely associated with the Society but did not operate directly within its auspices. I discuss George Sinclair's long experiments on grass-plots on Woburn, which were also connected with projects of the Society of Arts. Throughout the investigations on grass, the attempt to preserve radically local features in novel settings was a constant goal – one can regard experiments on grass-plots as a very literal attempt to fit the nation, and all its divergent soils and situations, back together.

Chapter eight, "A Planting Public", concerns the Society's interest in tree-planting. I argue that this should be regarded less as a direct encouragement of the growth of more trees, and more as an attempt to develop experimental accounts of how planting might work in different situations. Accounts provided the form in which plantation reports were submitted to the Society, but they were always discussed in terms of a generalising public benefit – related to the amorphous and tricky policy question of timber supply, and particularly whether private, unsurveyed, sources of timber could supply national needs. The timber supply problem was never entirely what it seemed,

however, for although debates about plantation were analysed according to it, plantation accounts were rationalised according to the hope of steady returns as well as ultimate profit. The language of these accounts, which described the accumulating growth of trees, was then used to construct regular yield tables – which were also submitted to the Society. During the 1820s, apparent differences in the properties of wood grown in different soils and under different regimes of cultivation, projected according to the tables, became the focus of a vituperative debate between William Withers, an attorney from Holt in Norfolk, and Scottish landowners including Sir Walter Scott and Sir Henry Steuart. This extremely aggressive debate suggested how questions of soil and situation, uncertainties about national supply, and attempts to investigate the physical properties of substitutable goods all contributed to the national question of plantation during this period.

As should be apparent from this overview, each of the chapters shows a different balance between the expansive public and the significance of disembedding practices, and each is also concerned with different specific topics. By way of conclusion, Chapter nine, "On Top of the Material", attempts to draw out their common themes, focusing on the tension between locale and generality, the question of wide groups of users, and the specific role of substitutability and imitation within the Society's approach towards materials. It also asks what the Society's particular efforts, so wide in their ambition and so narrow in their achievement, might tell us about the expansive public and disembedding practices – and the questions which they touch upon – in more general terms.

Chapter Two: The Society of Arts and Fish

1. **Introduction**
2. **Connective Schemes – Imagining a Public**
3. **Faction and Interest**
4. **The Society of Arts and Fish**
5. **The New Dispensation: Politeness and Respectability**
6. **Conclusion**

1. Introduction

As we saw in the last chapter, the Society of Arts was motivated by philanthropic goals, and its members spoke a language of the public good. About this, all its official histories agree. I now want to go beyond this account to ask *how* the idea of the public was imagined at the Society of Arts, and how it changed over time. The Society's public was initially conceived as a group of people beyond its immediate circle of members, who could contribute useful knowledge and workable schemes. Subsequently, the Society was conceived as an impartial arbiter of improving public schemes, which could harmonise different interests from throughout the kingdom and its colonies. By the early 1760s, however, this ideal of impartiality had come into conflict with the Society's support for schemes which were directly involved in the market. In their involvement with such projects, individual members and contributors could be presented as acting illegitimately, in pursuit of their own monopolistic interests. Critics and satirists parodied the idea of a respectable institution which descended to direct concern with material things, and claimed that impartiality could not survive the encounter; the Society's own members fought to define the nuances of its public role. Unable to resolve these tensions, the Society's membership collapsed at the end of the 1760s. When it returned to a certain prominence during the 1780s, it was as a rather different kind of institution: one which focused on politeness, respectability and personal patronage, with prize-givings which migrated from its own rooms to London theatres.

Although my approach is broadly chronological, the different ideas of the public overlapped with each other in any given period. During its expansive and inclusive phase, the Society's publicity still mentioned its respectable members; when politeness and respectability predominated, the Society's committees still worked to offer "impartial judgments". Nonetheless, the argument here should revise our picture of the Society's ethos, which has been formerly been presented as static over the course of the second half of the eighteenth century (before its decline in the nineteenth). Instead, I want to focus on the 1760s as the crucial decade for crystallising the Society's later emphasis on respectability, rather than a public role which was also directly involved in the market.

In section two, I draw on the minutes of the Society's earliest meetings to argue that at first, it was based upon the idea of a wealth of public activity "out there", which needed to be encouraged through widely-publicised rewards. As the Society grew, this shifted to the idea that its members could act as disinterested patrons of the whole nation, encouraging improving activity which would have wide-ranging transformative effects, which touched on national supply, production of luxuries, and defence of the kingdom. Section three draws out the tension which these goals entailed: on the one hand, the Society was meant to be impartial, acting for the interest of all; on the other, it was closely associated with particular market activities. This tension came to a head during the 1760s, when the Society was at the height of its powers, membership, and income – but when it was also repeatedly parodied and accused of factionalism and of acting in support of partial interests. Section four then describes the third phase in the Society's public role, which focused on politeness and respectability, fashionable prize-givings and displays of patronage. In conclusion, section five describes how the early Society's ethos of an inclusive public, and its attempt to recommend locally successful practices, persisted and shifted through the various conceptions of its public roles.

2. **Connective Schemes – Imagining a Public**

In its early years, the Society moved from a relatively narrow group of people, linked by ties of friendship, family, and common interest, to a much more encompassing vision of the public.

The drawing master and philanthropist William Shipley, who first proposed the scheme for the Society, was friendly with the microscopist Henry Baker through connections in Northampton.[1] Drawing on these links, Shipley was introduced to Stephen Hales, a friend of Baker's through the Royal Society; on moving to London, he then approached Robert Marsham, a relative of Hales, for further support. Shipley went on to canvass for further support among a group of potential aristocratic patrons, with little effect, until he approached Jacob Bouverie, first Viscount Folkestone (the husband of Romney's sister). Among the other founders, Isaac Maddox, the Bishop of Worcester, worked with Hales on the governing body of the Middlesex County Hospital; John Goodchild was Hales' neighbour in Teddington.[2] There were thus a range of ties between the founders, most of them personal. At the outset, then, this was an intimate social network.

From their first meetings at Rawthmills Coffee House in London in January 1754, the founders of started to imagine their public. Resolving to promote the cultivation of madder and the discovery of cobalt, they tried to establish what was already known about these things. So Stephen Hales, the Newtonian physiologist, governor of the colony of Georgia, "produced two abstracts which were read from Monsieur Geoffrey's treatise on Fossils, in which Cobalt is described & the places are mention'd where it is found, the other from Mr Miller's Dictionary which mentions the Cultivation of Madder".[3] Baker read a letter which confirmed "there is a manufacture of cobalt in England, who about ten years ago made smalt of an inferior sort from Cobalt dug up in Cornwall".[4] William Shipley, the drawing master who had originally come up with the scheme of the Society, read a report from the Customs House which described the imports of Smalt into England in the most recent date which was available, 1733. After what the minutes record as "several debates", an advertisement was decided to be placed in the press about the reward which the Society intended to offer:

[1] Information in this paragraph is taken from D. G. C. Allan, 'Founders of the Society of Arts, Manufactures, and Commerce (*act.* 1753–1783)', http://www.oxforddnb.com/view/theme/94594, (accessed 11 Feb 2014).
[2] D.G.C. Allan, *William Shipley*: *Founder of the Royal Society of Arts: A Biography with Documents*, (London, 1968), 53-4.
[3] RSA, Soc. Min. 22 Jan 1754
[4] *Ibid.*

> Cobalt having been already discovered in some parts of this Kingdom, for producing specimens, not less than 20lb in weight & for the best in quantity before 15th January with satisfactory Certificates of the place found, & reasonable assurances that it may be obtained in Quantity, £30.[5]

All through the year the Society established itself and the members looked forward with high hopes. Consideration of the support which the Society should offer for the production of silk in England was reserved for a time "when the Society is better established and their fund augmented".[6] It was resolved that letters received by the Society should be numbered, so that they could be referred to more easily, and that any time when the Secretary received a letter, he should establish an ad hoc committee of the Society to adjudicate on its claims. Again in April, Shipley brought abstracts taken from the Amsterdam gazette, which commended the Society's intentions; the members resolved to have them translated into English. By June, Shipley was anxious that the "common people" did not have the opportunity to compete for the cobalt awards, and "made a Motion to have the word Cobalt explained in our future Advertisements".[7] Baker supplied a definition:

> Cobalt is a mineral found in mines of copper, lead, and silver, tin and iron, in Sweden, Germany & Other countries. It has likewise been found in Cornwall, and will probably be discovered in other places in this Kingdom. 'Tis a heavy substance at times of a blackish, but more commonly of a bluish gray, some of it parts inclining to a silver colour, and that with much variety, according to its mixture with metallic, stony or other matter. It has also sometimes on its surface a red Efflorescence, which is called a flower of Cobalt.[8]

During these first months, the Society was a strikingly small group, who were excited by the possibility that their numbers would grow and keen to regularise procedures. They were also, notably, keen to publicise their activities to the world outside – recruiting a public of "common

[5] *Ibid.*
[6] *Ibid.*
[7] RSA Soc. Min., June 19, 1754.
[8] *Ibid.*

people" to grow madder and find cobalt, and seeking information about existing practice. Chemical procedures, reported in the newspapers, were meant to be sufficient to encourage this spirit of discovery. In this respect it is striking how much information they required: from pamphlets and encyclopedias, and letters reporting what was happening. London was a centre of news, connected to Amsterdam and with ready access to the customs house, but other information about production within the kingdom required correspondence from outside. This was the Society's first public: the common people and existing producers who would communicate the local information upon which their ideas of encouragement relied.

The Society's membership grew rapidly, from seventeen in 1755 to two thousand in 1764. New members proposed new members, some of them more active than others. The Society's membership grew, its founders regarded it as inclusive, giving direct access to the range of practices and knowledge which they hoped to encourage. Writing about their experiences of the Society, they described the organisation in terms which recall the language of the public sphere. Linda Colley has argued that in its inclusiveness the Society was a typical patriotic society of the mid-eighteenth century, the members of which "went out of their way to invite contributions from as many people as possible, irrespective of class, location, religion, party or gender."[9] In 1754 Charles Powell wrote to William Shipley that over time the Society would "not only unite in one common Bond all real Patriots, or as I should then call them the Patrons of the Nation, but will in time, I hope utterly extirpate all Party distinctions, the Bar of Society and Civil Government."[10] Baker claimed that "the disinterested application every one exerts to promote the Public Good is much beyond what I ever saw among any other set of People: […] we go on with the utmost Harmony, and the Greatest and the Meanest are equally industrious in the same Design, all Rank and Distance is laid aside, and everyone is listened to with due Attention."[11] In short, disinterested application through voluntary association as a way to overcome mere factionalism, and to establish the group as the patrons of

[9] Linda Colley. *Britons: forging the nation, 1707-1837*, (New Haven, CT, 2005), 94.
[10] C. Powell to Shipley, April 1754, quoted in Abbott and Allan, eds., *"The Virtuoso Tribe of arts and sciences": Studies in the eighteenth century work and membership of the London Society of Arts*, (Athens; London, 1992), "General Introduction", p. xvii.
[11] Baker to Rev. William Borlase, Rector of Ludgvan, Morrab Library, Penzance, *Borlase Letter-Books,* Quoted in J.V.G. Mallet, "Nicholas Crisp, Founder Member of the Society", in Abbott and Allan, eds, *Virtuoso Tribe,* pps. 56-74, at 62.

the nation.

As the Society grew, so did the scope of its plans. Increasingly the logic of its schemes, of uniting the kingdom in a common purpose, was described in terms which brought together production of goods and inputs, virtuous forms of emulation, and national defence. Where the first meetings had focused narrowly on the possibilities attendant on particular material goods, the Society now imagined that its encouragements could be transformative. This was in line with the view that it was uniting the nation as a whole. Such a language could be heard, for example, in Edward Wade's quarto pamphlet on tree planting, which Baker brought to the Society in 1756, arguing that plantation would make a tidy profit for landowners and employ weak soils, and also cause a relaxation of restrictions on the use of fuel, defend the kingdom by supplying timber, and beautify the landscape.[12] William Bailey, who hoped that the Society would encourage trades in workhouses, saw the cultivation of new industrious habits as a way to knit society together in harmonious emulation: "many Ladies of Distinction may chuse to amuse themselves sometimes in this way, rather than waste their whole Time and Spirits at Cards"; such high-ranking examples, he hoped, "would stir up the lower Sort of People to practise and delight in an Employment so beneficial to themselves and the Public."[13] By the 1760s, the naval captain John Blake managed to convince the Society that a regular supply of fish to the capital would feed the poor, sate the rich, and train up a generation of fishermen who could serve as sailors for Britain's wars.[14]

Summarising the general sense of interconnection, the Russian merchant and philanthropist Jonas Hanway moved in the same breath from questions of military supply to lauding the Society for its improvements of luxury goods. He listed the few imports required for war: masts from Poland; oak plank from Danzig; iron from Russia and Sweden; hemp and flax from Russia; salt-petre from India, concluding that "we can even make salt-petre upon an emergency; and we have lately revived the art of preparing Buff-leather, which by negligence we had lost for some ages", a re-discovery which owed to "the late established Society for the encouragement of Arts,

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[12] Edward Wade, *A Proposal for Improving and Adorning the Island of Great Britain: For the Maintenance of Our Navy and Shipping, Etc., by Parochial Plantations of Timber and Other Trees, Upon the Forests, Chaces, Commons, and Waste Grounds Throughout the Kingdom,* (London, 1755).
[13] William Bailey, *A Treatise on the Better Employment and More Comfortable Support of the Poor in Workhouses,* (London*,* 1758), 65.
[14] This was John Blake's fish-carriage scheme. See below.

Manufactures, and Commerce."[15] Several concepts are detectable in these arguments. First, they offered an ideal of improvement, in the national interest, which sought the involvement of a wide public. The Society could gather together all their interests and experiences, and allow them to surmount factional differences. And it would be useful, embodied in material things and activities, not idle polite sociability. Finally, the Society's members would be able to stand in judgment over the submissions which were made to them, offering judgments in the name of the public good which went beyond any member's particular interest.

All of this was talk and projection of course, but it was mirrored, at least to some degree, in the diversity of the Society's membership. Such an impartial and inclusive public was the Society's great promise. It posed several problems as well.

3. Faction and Interest

The Society of Arts posed as an impartial organisation, which could coordinate activities which allowed the kingdom to fit together through a new spirit of emulation. There were two major criticisms of this position: that it was not impartial, and that the connections it drew between different activities were really arbitrary. The two criticisms were connected through doubts about what it meant for a society of gentlemen to be so concerned with material and marketable things.

The satirical "sign-painters" exhibition of 1762, organised by Bonnell Thornton, displayed pub-signs as if they were works of high art, a defence of a robust English tradition of painting, which was directed against the Society's emulative attempt to promote painting on the model of French academies, as part of a culture of politeness. Describing the exhibition, the art historian Jonathan Conlin has written that

> [m]any visitors […] could not believe that the exhibition was really of signs. Assuming that nobody could insist on payment for a display of worthless trash, they dutifully attended. Thornton, however, had stripped out the content they

[15]Jonas Hanway, *A journal of eight days journey from Portsmouth to Kingston upon Thames, with miscellaneous thoughts, moral and religious, in a series of letters: To which is added, an essay on tea*, (London, 1756), 335.

> were expecting and replaced it with art off the street. The exhibition revealed the extent to which the "artificial connections" that bound together public utility, refinement, and public art had become a self-supporting matrix, in which any "art" could be displayed.[16]

In other words, confrontation with actual material things brought any claims to a loftier form of cultural consumption which could abstract from their particularities down to earth. These issues emerged with peculiar clarity in the case of fine art, but they extended to all the Society's activities. To claim to be impartial or indifferent invited a number of ambiguities, and possible accusations of bias.

Thus, over the course of the 1760s, the inclusive, public, ethos of the Society was challenged by its association with the projects of individuals, and its high aspirations were undercut by showing how they were embodied in lowly material things: a society whose high ideals "split on fish carriages". The sign-painters' exhibition had taken the approach of parodying the Society through direct imitations of its procedures, removing them from the improving ideas which gave them such significance for the Society's members. This was also the procedure of the most scathing satire of the Society which appeared during these years – a work which is instructive for the ways in which it challenged the idea of wide-ranging schemes and an impartial attitude to material and marketable things.

It was a pamphlet entitled *Some Projects Recommended to the Society for the Encouragement of Arts, Manufactures, and Commerce,* written by the botanist and editor John Hill, one of the most magnificent haters of mid-eighteenth-century London. As George Rousseau's recent biography has made clear, Hill's violent and dissolute moralising was often unclear in its objectives, motivated by petulant spite as much as any cultural critique. Hill also loathed Henry Baker, and had been refused membership of the Society of Arts following an unsuccessful attempt to use the name of his patron, Lord Northumberland, to obtain a place within its membership. Thus his satire had the tone of a mocking, belligerent outsider, rather than a friend who sought to reform its conduct from

[16] Jonathan Conlin, "'At the Expense of the Public': The Sign Painters' Exhibition of 1762 and the Public Sphere," *Eighteenth-century studies*, 2002, **36**: 1-21, at 18. Conlin associates this with later movements in "anti-art."

within. He also drew on the approach of his beloved Augustans. Hill advanced a "modest proposal", intended for the Society of Arts, for the improvement of leather production by tanning human skin. His pamphlet opened with a list of parody premium awards, offering gold medals for jackboots made from the hides of French soldiers, and silver medals for dancing gloves formed out of officers' skin. Like the Society's advocates, Hill accepted a link between war and the production of goods, but he extended their logic to suggest that war provided fine materials for polite society -- a connection which was forgotten only through habituation: "At Bath and the Races, the Officer would be fond of displaying these marks of his valour. The ladies by handling the Gloves, would soon conquer any Aversion they might at first entertain."[17] Skins did not have to be supplied exclusively by war however; they could come from any social rank or station:

> All the skins stripped from Bodies of different Ages, Conditions and sexes are applicable to various uses. The Hides of Brawny Porters, Sailors and Common soldiers will make stout Jack-boots and strong Harnesses. The Hides of the middling kind of People are fit for light Summer boots, thin pumps, leather breeches and ringing gloves. But the finest Gloves and mittens are to be cut from the delicate skins of the fair sex and Infants: Such Gloves will be softer and more supple than those made of kid, because the skins from whence they are to be made, are less exposed to the inclemencies of the Air.[18]

This reads as a direct parody of the notion that rank and station could be set aside in the context of public association, which Baker had expressed. Hill's satire expressed the tension at the heart of the Society's vision of the public: how could the material things which composed the Society's inclusive public be regarded impartially, when their indurations were marked on their skins? And how could any ideal of impartiality survive exposure to ideas of use which measured skins for wear?

Even for more sober observers there was some tension between the Society's propriety and

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[17] John Hill, *Some Projects Recommended to the Society for the Encouragement of Arts, Manufactures, and Commerce, by the INSPECTOR, proposed F.R.S. Proposed MEMBER of the SOCIETY for the Encouragement of ARTS, &c.*, (London, 1761), p. 5. D. P. Miller "The 'Hardwicke circle': the Whig supremacy and its demise in the 18th-century Royal Society," *Notes and Record of the Royal Society,* 1998, **52**, pp. 73-91 at p. 79; for Hill's role in the Royal Society's reforms, see pp. 83-4. For Hill more generally, see George Rousseau, *The Notorious Sir John Hill: The Man Destroyed by Ambition in the Era of Celebrity*, (New York, 2012).
[18] Hill, *Some Projects*, 2-3.

impartiality, and its members' role as patron of projectors' schemes. Writing to Adam Smith to attack the view that projectors should not be crushed by government, Jeremy Bentham referred on two occasions to the example of the Society of Arts. Bentham attacked Smith's argument that projectors should be suppressed by government. Bentham argued that the "very professed and capital object" of "that popular institution" the Society of Arts, was the "propagating of that obnoxious breed".[19] "But," he concluded "if it be right to crush the acting malefactors, it would be downright inconsistency not to crush, at the same time, or rather not to begin with crushing, these their hirers and abettors?"[20] Then, in a later letter, Bentham described the Society's committees as "ready trained in the conduct of enquiries", a model of public probity.[21] If public oversight of projectors were required, Bentham wrote, then "the members or representatives of this democratic body would be as likely, I take it, to discharge such a trust with fidelity and skill, as any aristocracy that could be substituted in their room."[22] So for Bentham the Society were simultaneously patrons of specific schemes, and public overseers: because he sought a relaxation of the usury laws, this meant that it could serve as a prominent example of how projection might appear in public without appearing like the corrupting influence of private interest run rampant, and requiring to be crushed. Bentham did not think that oversight would be required, but the example of the Society was meant to render it harmless.

By contrast, Tobias Smollett's 1771 novel *Humphry Clinker* hinted at both the Society's promise and its limitations. As part of the novel's action, the narrator and his uncle both become members and assist the members' "deliberations, which were conducted with equal spirit and sagacity"; but Smollett also allowed his characters to warn that the Society would "certainly be productive of great advantages to the public, if, from its democratic form, it does not degenerate into cabal and corruption".[23] This was not an abstract problem. In practice, the mixture of ranks caused some of its more eminent members considerable discomfort. Thus Thomas Hollis noted that an "ingenious

[19] Jeremy Bentham, *Defence of Usury,* in John Bowring ed. *The Works of Jeremy Bentham,* Vol. 3, (Edinburgh, 1843), p. 29.
[20] *Ibid.*
[21] *Ibid.*
[22] *Ibid.*
[23] Tobias Smollett, *The Expedition of Humphry Clinker*, (London, 1824), 153; for Smollett's overall attitude to the Society, see George S. Rousseau, "'No Boasted Academy of Christendom': Smollett and the Society of Arts", *Journal of the Royal Society of Arts*, 2007, **121**: 468-75.

artist" named Kirby had served with him on the Committee of Fine Arts. Hollis found his behaviour "ill-humoured and petulant to me", and "disregarded & despised it wholly having the testimony of my own Mind for the integrity & disinterestedness of my procedure in this affair."[24] Hollis himself was capable of giving offence as well, recommending Dr Johnson as an ideal candidate to draw up an advertisement for the Society as "a kindness"; Johnson noted that he "slipt away, and escaped it."[25] The French traveller M. Grosley noted with apparent distaste the presence of a "lusty hatter" on the committee of Agriculture, who "signalized himself by long and vehement speeches, the aim of which was to contest facts, and require to have them provd."[26] Thus a mixed membership composed of a relatively broad public brought pressures as the possibility of harmony.

For the Society more generally, the tensions which individual members flirted and skirted with in their pursuit of impartiality became most problematic when it tried to become involved directly in market concerns. The problem came to a head during the 1760s, and it is notable that in reports after that decade the Society seems much more sedate. It therefore makes sense to see a transition in how the Society's public role was understood during that decade, which was also the period when the Society's membership was greatest, and its revenues at their highest.

In fact, part of the problem was that the Society was flush with cash; in 1763 alone it raised £4,614.[27] The *Lloyd's Evening Post* noted in 1764 that the Society had "large sums of money undisposed of, whoever would propose proper subjects for useful premiums, would do great service to the Community."[28] This meant it became attractive to projectors. To support such schemes, the Society's members needed to encourage individual private interests, which might be identified with projectors. In the process, however, they risked the accusation that they were acting partially, rather than in a properly public interest. The difficulties recalled standard problems about the position of natural philosophy with respect to market activities, and deployment of rhetorical claims to be "disinterested philosophers working for the public good" as a way to avoid "being

[24] Thomas Hollis, *Diary,* 4 November 1761, quoted in John Abbott, "Thomas Hollis", in Abbott and Allan, eds. *Virtuoso Tribe,* 51.
[25] Quoted in Derek Hudson and Kenneth Luckhurst, *The Royal Society of Arts 1754-1954,* (London, 1954), p. 29.
[26] Pierre Jean Grosley, *A Tour to London, or new observations on England and its inhabitants,* vol. 1, (Dublin, 1772), 165.
[27] Hudson and Luckhurst, *Royal Society of Arts,* p. 11.
[28] *Lloyd's Evening Post* (London, England), January 2, 1764 - January 4, 1764; Issue 1011.

identified with the rapacious and fraudulent among the projectors." [29]

Faced with such issues, the Society passed certain measures to demonstrate its public probity. Thus in May 1764 it resolved that none of its members would be entitled to receive a pecuniary Premium or Bounty. This was reported with a sneer in the Lloyd's Advertiser, which intimated that the measure had been directed specifically against Robert Dossie, the Yorkshire-born apothecary, chemical populariser and friend of Samuel Johnson. Dossie had been heavily involved with many of the Society's projects, both winning premiums and conducting tests on the Society's behalf. Dossie had publicised and improved processes for producing vitriolic acid. [30]In 1760, he had stood unsuccessfully to become the Society's secretary, and attached his name both to his own publications and those of the Society. He was also the named editor of its *Memoirs of Agriculture* from 1768.[31] Dossie's authorship made him a prominent and enviable target for accusations of partiality, and his chemical procedures were attacked. But more problematically for the Society's goals of publicising industrial processes, the involvement of Dossie and other members of the committee of chemistry in adjudicating awards seemed to indicate a desire to profit at their expense.

The need to deal with the particular interests of projectors put the Society's inclusive, public, ethos under considerable strain, and led to accusations that it was acting partially. Avid encouragement of individual projects could also lead external observers to argue that its concerns were, in fact, provincial – rather than properly national in outlook. Thomas Bentley, who was in the midst of promoting the Grand Trunk Canal, wrote to Erasmus Darwin in 1765, noting that he was keen to make an application to the Society, because "their taking Notice of it may produce some good Books & raise a warm Spirit of Improvements". Bentley also noted that "[d]oubtless this ought to be made a national Object: – And it is astonishing the Society have not attended to it

[29] *Ibid.,* p. 185.
[30] FW Gibbs, "Robert Dossie (1717-1777) and the Society of Arts", *Annals of Science,* 1951 **7**: 149-172, at 152.
[31] *Ibid.,* 152

before now! But they have been too much immersed in the little Scheme of bringing Fish to London. A National Institution ought to attend, chiefly, to Objects of general & public Utility."[32]

6. The Society of Arts and Fish

Before the Society's involvement, fish-supply to London had been a concern for both Parliament and the "National Society of Fisheries" during the 1740s and 50s; Parliament even founded its own unsuccessful fish-market at Bishopsgate.[33] Thus the Society's scheme followed on from considerable existing concern. It was proposed by Captain John Blake, who was described as a "naval man… a speculator in the encouragement of seamen", in November 1761.[34] Appearing at a committee concerned with the possibility of offering a premium for catching turbots, Blake claimed "that machines might be contrived, capable of carrying one thousand weight of fish, and at the same time so light, that they might be drawn by a pair of horses; and convey the above weight of fish without weather or jolting, to London, from the sea-coasts of the kingdom".[35]

At first the scheme attracted considerable support within the Society, and was very favourably reported in the press. The *St James's Chronicle* called the scheme a "[d]esign worthy of this truly useful and excellent Society, and which in all Probability will, by their Means, be rendered effectual, after having baffled all the Efforts of the Legislature itself".[36] It was always more than a merely commercial venture. Temporary encouragement was meant to prove the viability of alternative forms of supply to the capital, and prevent fishmongers from acting monopolistically – hoarding fish away from the capital to keep their prices high. In the process, the 'real' market which the Society sought to encourage was meant to emerge, materialising, the Society's harmonious, philanthropic, and nationalistic public. The scheme would serve all ranks of society: "even the very

[32] Thomas Bentley to Erasmus Darwin, 9 November 1765, Wedgwood Museum, Josiah Wedgwood & Sons Ltd. Barlaston, Stoke-on Trent, quoted in Robert E. Schofield, "The Society of Arts and the Lunar Society of Birmingham", *Royal Society of Arts Journal,* 1959, **107**: 507-514, at 512.
[33] Bob Harris, "Patriotic commerce and national revival: the Free British Fishery Society and British politics, c. 1749-58," *The English historical review*, 1999, **114**: 285-313.
[34] Walter M. Stern, "Studies In the Society's History and Archives LXXXII, John Blake (1713-1790)," *Journal of the Royal Society of Arts*, 1971, **119**: 116-19.
[35] Quoted in Anon, "Fish monopoly, Society of Arts' attempt to break it down, 1761," *Society of Arts Journal*, 1883, **31**: 979.
[36] *St. James's Chronicle or the British Evening Post* (London, England), October 29, 1761 - October 31, 1761; Issue 100.

Inferior, as well as the Middling Part of the Inhabitants, may enjoy their Share of those Bounties of Providence, which at present seem to be confined to the Great and Opulent."[37] Encouragement of Blake's scheme was meant to remove the fishmongers' power to do harm, and allow for consumption of fish by a much wider group.[38]

Initially, Blake proposed a subscription fund, somewhat like a joint-stock company, in which each member would contribute twenty guineas; he was over-ruled, and the decision made to pay for the encouragement from the Society's funds directly. The scheme had already taken on a certain momentum of its own. It excited happy patriotic speeches at the Society.[39] In February 1762, Blake was provided with additional funds by Parliament, through a bill introduced by Charles Whitworth, another vice-president of the Society.[40] There was a snug fit between the public agenda of the Society and the long-standing goals of the legislature.

Such direct involvement in a market enterprise was a novelty for the Society. Initially some members showed a little wariness about the scheme, but even those who argued against it did not disagree with the general goal. Thus the eccentric vegetarian radical Thomas Hollis, who was opposed to the scheme, wrote in his diary when the Society's support was first mooted: "[t]he proposition carried with a high hand; yet voted against it heartily; not because the Idea of encouraging the Fishery for supplying the town more effectively with fish is not a right one but because the scheme *as tendered* was crude & big with great novelties & inconvenience to the Society."[41] As more questions about the scheme arose, commentators strove to demonstrate that they were not swayed by any partial interest.

The anonymous author of the letters which were published as *Brief Detail of the Home Fishery* in 1763 claimed that he was "not acquainted with any fishmonger" and had not "conversed with any

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[37] *St James's Chronicle or the British Evening Post* (London, England), November 3, 1761 - November 5, 1761; Issue 102.
[38] Cf. Walter M Stern, "Fish Supplies for London in the 1760s: an Experiment in Overland Transport" parts 1-2, in *RSA Journal,* 1970, **118**: 356-365, and 430-435, which notes the market failure of the scheme.
[39] *St. James's Chronicle or the British Evening Post,* (London, England), October 29, 1761 - October 31, 1761; Issue 100.
[40] "A Bill [with the Amendments] for the better Supplying the Cities of London and Westminster with Fish, and to reduce the present exorbitant Price thereof; and to encourage Fishermen. 25 March, 1762," in *House of Commons Sessional Papers of the Eighteenth Century, 1715-1800*, Vol. 20, digitised at http://gateway.proquest.com/openurl?url_ver=Z39.88-2004&res_dat=xri:hcpp&rft_dat=xri:hcpp:rec:hcsp-000320, (accessed 14 Feb 2014).
[41] Hollis, *Diary,* 4 November 1761, Quoted in Abbott, "Thomas Hollis", p. 51.

one person who is partial to fishmongers", again trying to suggest that he was a disinterested observer, judging the case on its merits.[42] The idea of the scheme's public role provided the organising principle for arguments about it, from both sides. In the context of the factional and scurrilous 1760s, this emphasis on impartiality was a striking feature of these discussions at the Society. One report from January 1764 noted that a debate about the scheme "was agitated with great ingenuity and strength of argument on both sides", but that it was "carried on (considering so numerous an assembly) with great decorum".[43]

The debates concerned two central questions, with significant ramifications. First, how long would encouragement need to be continued? Was this ultimately an experimental, or deterrent effort, like planting madder or was it meant to be continued for a longer time? If so, would the Society have to pay for it? Those who spoke against continuing the scheme argued that the Society had merely intended to show "the practicability of bringing fish to London by land carriage"; those in favour claimed that it was of a more "extensive nature".[44] To withdraw support at this stage, they argued "would in fact be discountenancing this undertaking in its present promising state, when the assistance of a much higher aid, than that of the Society, is expected". It would also allow the fishmongers to "shew their resentment to the public", by putting the price of fish up again.[45]

The second question was about Blake's role. Given his central involvement in the scheme, was it really a public form of encouragement; or had he entered into direct competition with existing monopolists? In 1763, he had been accused of withholding some of the funds which had been allotted to him. Answering this charge, Blake tried to prove his impartiality by publishing his accounts, itemised down to individual criers, horses, stationery, and carriers on roads.[46] All of this was meant to prove that he was spending no more than was absolutely necessary, superintending the scheme without thought of profit. Blake also claimed, however that the fishmongers were trying, illegitimately, to drive him out of business. They were undercutting his prices, Blake claimed, and "if the public continue to leave the fish upon his hands, and are led away from his places of

[42] *Brief Detail on the Home Fishery,* p. iii
[43] *London Evening Post* (London, England), January 26, 1764 - January 28, 1764; Issue 5653.
[44] *Ibid.*
[45] *Ibid.*
[46] John Blake "To the PUBLIC", quoted in *Brief Detail of the Home Fishery,* 70-74.

sale by those who *it is apparent* are underselling themselves […] it is very necessary for the superintendant to pursue such measures as may secure his own property, as well as the trust reposed in him".[47] The inclusive market which Blake had projected had not come into existence, he claimed, because of the actions of his enemies. Blake promised to continue for three years, by which time the hundred fish carriages which had been made bespoke for the scheme would be "nearly worn out".[48] That would give him time to develop the more philanthropic component of the scheme, supplying markets "with ordinary fish, at about 4 pence per pound" which so far had been delayed by the combinations against him.[49]

All of this seemed far too close to direct interference with the market. Some of those who remained sympathetic to the scheme tried to salvage Blake's impartiality – and his honour – by appointing him the "public inspector of fish". [50] After all, "we now get our information so lamely and *partially* that we often argue on false foundations. An officer of this kind, well chosen, would be of great utility in this maritime nation."[51] Blake, however, clung onto his role, and continued to promise that soon it would be able to stand on its feet, without requiring any further support from the Society.

In January 1765, a group of fishmongers met with Blake, and offered to buy the carriages from him, hoping to continue the land carriage trade "not only for the good of the public, but in hopes of some emolument to ourselves."[52] This was a redefinition of the scheme's intention, away from its initial expansive public goal, which could combine philanthropy with a more plentiful supply.

The land carriage fish scheme was finally abandoned in July 1766, Blake still promising to show his accounts as proof of his probity. There was now some discussion about what right the Society had to demand to see his accounts. The question was delicate, and turned (once again) on different definitions of the public. Blake, a public man, had been supported by the Society; so what right did they have to accuse him in a public way? Would the Society "not act more consistently, after the several public marks of approbation they had given to Capt. Blake's conduct, to suffer him

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[47] *Ibid.,* 74.
[48] Blake, "To the PUBLIC", 69.
[49] Quoted in *Ibid.,* 69.
[50] *Brief Detail of the Home Fishery,* 114.
[51] *Ibid.,* 114.
[52] Reported in the *Gazeteer and New Daily Advertiser,* June 6 1765.

voluntarily to render his accounts, rather than call upon him in this public way to do so?" [53]

As recriminations about Blake continued to be exchanged, the tone of newspaper reports descended to outright mockery. One reporter wrote a mocking eulogy for the scheme:

> LAST Night the Society of Arts, who for several Weeks past have been unreasonably glutted, and even surfeited with Land carriage Fish, took a farewell Supper of that stale Commodity, upon their breaking up for the Summer Season. – The Question which this Fish Business has caused to be so agitated of late under various Motion, and every different Form, is in Substance this: 'Whether the Superintendant stands obliged to the Society for a Pack of old rotten Fish Machines?' […] ….Alas! for this respectable and benevolent Society, founded on Patriotism, and splitting on Fish Carriages.[54]

As in Hill's satire, the physical embodiments of the scheme served as a telling synecdoche for the inclusiveness which the Society projected, and the misfit between fish carriages and patriotism were meant to expose the pretensions of the Society's public ethos. How, these satires asked, could high public ideals be embodied in such corrupted goods? It had always required the claim that an impartial ethos could be reconciled with involvement in the marketplace, and the involvement of a wide group of supporters, to claim they could. With the demise of the fish scheme, this seemed to have collapsed.

5. The New Dispensation: Politeness and Respectability

After the 1760s, no reports of the Society were as ribald as those which surrounded the fish scheme. Sometimes individual candidates accused the Society of behaving badly, but there is little of the satirical sense of a noble institution brought low by the scheming of particular interests. Instead, and increasingly, press reports emphasised the Society's politeness and respectability.

This was not solely an internal matter of course: a number of significant shifts were occurring in

[53] *Lloyd's Evening Post* (London, England), January 8, 1766 - January 10, 1766; Issue 1327
[54] *St. James's Chronicle or the British Evening Post*, July 1, 1766 – July 3, 1766; Issue 832.

the outside world which suggested movement away from the expansive unwieldy nature of its early years. Increasingly, alternative institutions which shared certain concerns with the Society of Arts were available in London; these were much less rule-bound than the Society now appeared. Around the same time, the upper class throughout Britain had become more assertive and unified into a "new British elite promoting a new British agriculture", and embedded in a massively enlarged military and state bureaucracy, which operated within a "traditional framework of patronage and family connection."[55] In the repressive climate which emerged during the 1790s, moreover, a more expansive view of public involvement could seem suspect, even seditious. The sense of shadowy threat was embodied in the Seditious Meetings act of 1795, which placed limitations on public lectures; a subsequent act was published in 1817, and appears to have had some negative effects on voluntary societies concerned with science in London; the Society of Arts simply decided that it did not apply to them. [56] One cannot say for certain, but it seems unlikely that the boisterous organisation of the 1760s could not have made the same claim. No longer fashionable, and responding to these external trends, it is little surprise that the Society moved away from its most inclusive claims. The sense that something was missing was now captured by a complaint which appeared in the *Literary Gazette* in 1817: "the public is not enough associated with them, is made, at least if we may use the expression, the *sleeping partner,* furnishing sinews and capital in aid of the active and enterprising portion of the firm."[57] This encompasses the key shift in the emphasis of the Society's "public" during this period: it was increasingly represented as a relatively passive audience.

Alongside these external developments, the Society's membership collapsed at the end of its second decade. Where it had advertised in the press for suggestions about how to disburse its capital, its income now fell to a stable level. The exact reasons for this loss of members is as unclear as any shift in fashion; it seems likely that at least a few were put off by the argumentative tone of

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[55] David Cannadine, *Aspects of Aristocracy: Grandeur and Decline in Modern Britain* (New Haven; London, 1994), pp. 22-33*,* quotation at 22.
[56] Frank James, "Michael Faraday, The City Philosophical Society and The Society of Arts", *RSA Journal*, 1992, **140**: pp. 192-199. For the general effects of the acts see Paul Weindling, "Science and Sedition: How Effective Were the Acts Licensing Lectures and Meetings, 1795-1819?," *The British Journal for the History of Science*, 1981, **13**: 139-153, and Ian Inkster "Seditious Science: A Reply to Paul Weindling," *The British Journal for the History of Science*, **14**: 181-187.
[57] Anon, "Society of Arts" *Literary Gazette,* 1817, **1**: 55-6, at 55.

the Society's meetings, while others who were not actively involved simply allowed their memberships to lapse. In step with this, a very significant shift in the balance between honorific and pecuniary premiums was evident across all the Society's committees. In chemistry and manufactures, this meant that far fewer rewards were made overall; in Fine Art, it meant that the Society gave almost exclusively honorific rewards. Mechanics was the only category where absolute numbers of awards increased over this period, and here the balance was slightly less skewed in favour of honourific premiums. But overall, the shift was significantly in favour of medals instead of money, and from this followed an increase in the symbolic, rather than pecuniary value of rewards, which at least in principle meant a greater distance from the questions of corruption which had been so serious during the 1760s.

This was mirrored by an increasing emphasis on the need for people of high social status to become involved in the Society. From the beginning, the membership had been strikingly mixed, and for many members this appeared to be a source of significant strength. A press report of 1762 had boasted that "with great Pleasure we can assure the Public, that the Members of this most useful and laudable society are now increased to very near Two Thousand Five Hundred, of which Number are near Two Hundred Noblemen, Knights of the Bath, and Baronets."[58] But with the collapse in its membership, the Society came to seem less dynamic, and this blamed on a lack of eminent members. By the end of the 1780s Arthur Young was complaining that the Society "was not very fashionable. People of no account in life have been its active supporters", while "the men of great property have been more inclined to give them their ridicule than assistance".[59] Officers of the Society actively sought patronage; in 1785 Caleb Whitefoord asked a friend with connections to the Prince to "seize the earliest Opportunity of setting in a just & fair Light, the Society's Merits; and of soliciting his Royal Highness' Patronage."[60] This seemed promising, but was not pursued. The Society was shifting towards greater respectability, but not yet on a firm footing.

It was at the beginning of this period, in 1770, that the Society moved into its new building in

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[58] *St. James's Chronicle or the British Evening Post* (London, England), September 20, 1764 - September 22, 1764; Issue 554.
[59] Arthur Young, *Annals of Agriculture,* vol. 1, p. 64. Quoted in Max Louis Kent, *The British Enlightenment and the Spirit of the Industrial Revolution: The Society for the Encouragement of Arts, Manufactures and Commerce (1754-1815),* (Unpublished PhD Dissertation, University of California, 2007), p. 234.
[60] Hudson and Luckhurst, *Royal Society of Arts,* p. 26.

the Adelphi, and commissioned James Barry to paint the great series of images which appeared on its walls. Given the Society's straitened finances, this seems something of a paradox: how could it lavish expenditure on its own building, when it was unable to pay for premium awards? But the paradox is only apparent. In a study of the social spaces of the Society of Arts, Andrea Mackean argues that "[i]t was as a point of mediation between the general ideals of art and the particulars of commerce, between grand narratives of History and particular activities of individuals, where the Society of Arts, the Adam brothers, and James Barry self-consciously sought to position themselves and their works."[61] This was done, Mackean argues, through the ordering of the Society's building at the Adelphi, where the rooms in which the Committees made their judgments were separated from the Great Room, where the Society's public meetings were held, and which was framed by James Barry's paintings and the more public space of the repository at ground level:

> The tension between the polite and commercial is subsumed into an image of the polite enactment of philanthropic and disinterested support of commercial activities as separate from the actual inventions and improvements relegated downstairs to the Repository, or hung unused as ornaments on its walls. Yet, this segregated polite space was set in a narrative space – of the building, its hierarchy of rooms, and Barry's paintings, which located the polite arts in a spectrum with commerce.[62]

This is a good explanation of the tensions in the aesthetics of the spaces of the Society's buildings after the 1770s; what Mackean does not acknowledge, however, is that this careful ordering was a new development for the Society, following the turbulence of the previous decade.

Alongside the effects of the new building, the new image of the public was also the one which the Society's members and officers sought to promote at their public prize-givings. These commenced in 1787: Allan speculates that William Shipley may have been inspired to recommend that they become public in response to Barry's painting. Previously, "the general rule in the 1760s

[61] Andrea Mackean, "Making a Place for Ornament: The Social Spaces of the Society of Arts", in Susan Bennett, ed. *Cultivating the Human Faculties: James Barry (1741-1806) and the Society of Arts,* (Cranbury, NJ, 2008), 76-87, at 84.
[62] *Ibid.,* 85.

and 1770s was for winning candidates to be told that they could obtain their medals, pallets and money prizes on application to an officer of the Society", an affair which was much more private and paid less attention to the Society's own role in patronising the awards.[63] The prize-givings became the new primary public focus of the Society. We can get an impression of how they had changed from the raucous descriptions of the meetings given in the 1760s in the engraving in figure two. Here the Society's president, awarding the prizes, stands by a lectern while a large (and largely female) audience are assembled as onlookers. Several have their heads turned to each other, apparently in conversation: this is a public spectacle but does not completely command their attention in the way that a scientific demonstration or public lecture might. Along the front row of one of the benches sit a number of girls, recipients of premiums for fine arts. Some of the premium winners, returning to their seats, are in what looks to be quite intimate conversation – heads cocked, hand-in-hand - with some of the women; a table of worthies sits beside the platform of the Society's eminent president.

The prize-givings were fashionable events. Attracting larger audiences each year, they migrated from the Society's own rooms to Freemason's Hall, on to the Lyceum; then to the theatre on Drury Lane; and on to the Opera House.[64] By 1817 the audience was estimated to be around two thousand.[65] In 1816, attention to the prize-givings had been intensified by a widely-publicised contest between the Earl of Liverpool and the Duke of Sussex to become its president.[66] Press reports celebrated the stagey respectability of the prize-givings, with the members of the Society clasping "staffs of office, and red favours on their breasts".[67]

Press reports increasingly narrowed the view of the Society to the achievements of its more respectable members. Press reports of its activities focused almost exclusively on medals for tree-planting and land reclamation: even as more awards started to be given in mechanics, these were not widely reported. Press reports emphasised improving acts, particularly land reclamation.[68] The

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[63] D.G.C. Allan, "'Much Pomp and Ceremony': the Origins of the Society's Prize Distributions," *RSA Journal,* 1999, **140**: 179-181, at 179.
[64] Anon, "Society of Arts", *The Literary Chronicle and Weekly Review,* May 31, 1823, p. 350.
[65] Anon, "Society of Arts", *The Literary Gazette: A Weekly Journal of Literature, Science, and the Fine Arts*, July 26, 1817, p. 56.
[66] *Morning Chronicle,* February 13, 1816.
[67] *Morning Post*, May 30, 1822.
[68] *The Ipswich Journal* (Ipswich, England), Saturday, May 31, 1800; Issue 3514.

Society had always been patriotic in intent, but this was now in step with broader currents of nationalist celebration. In 1805, for example, a resolution was passed "for commemorating, in the Great Room of the Institution, the character and achievements of Lord Nelson."[69] The press also reported the Society's annual dinners, and the patriotic toasts which were drunk at them, which were drunk "with a feeling of enthusiasm which has never before been exceeded" and went to "the King, the Prince Regent, the Queen, the Society, the Ladies who were members of the Society, the Navy, the Army, the Plough, Loom, and Soil, the Artists of the United Empire, the Lord Mayor and City of London, the Royal Society, the Royal Academy, the Board of Agriculture, the Workington Agricultural Society, and the Dublin Society."[70]

[69] *Jackson's Oxford Journal* (Oxford, England), Saturday, November 30, 1805; Issue 2744.
[70] *The Morning Chronicle* (London, England), Wednesday, May 1, 1811; Issue 13097.

Figure one. Interior of the Society of Arts, on John Street, Adelphi; men and women sit around room as premiums are distributed; large paintings on walls; illustration to Phillips' 'Modern London'. 1804 Etching and engraving. © The Trustees of the British Museum

Somewhat incongruous in this company, the Workington Society was celebrated because of the presence of John Christian Curwen, Whig MP for Carlisle, and Workington president, who gave a speech about his own public-spirited achievements. Curwen was a colliery owner and estate improver. His experimental work was much agitated by the possibility of feeding horses with potatoes and tree plantation, and he claimed to have got his start in agricultural improvement through the Society of Arts.[71] The Society gave an opportunity for him to advertise his local improvements on a national scale.

At the prize-givings, the Society's secretary celebrated its achievements, and told a story about its contributions to British prosperity, emphasising how public-spirited it was, and aligning it with other worthy institutions. In 1817, he added that the Society's procedures protected it from accusations of acting out of "selfish and party purposes", or any other corruption. Reward was public recognition of merit, decided by the Society, not a matter of commercial exchange: "the difference between a silver and a gold medal does not depend on the relative commercial value of the materials out of which they are formed, but on the greater or less degree of merit of which the Society has chosen that it should be the representative."[72] According to this description, the Society was the arbiter of merit, able to adjudicate the value of particular material things, and the merits of those who produced them. This was the outcome of the long-term shift towards honourific prizes, and the movement away from direct involvement with market activities like the fish-scheme.

The Society was also a benevolent patron. On giving an award to John Roberts, from St Helen's, for a ventilating device, the Duke observed, "that the individual to whom this reward was adjudged was a man in indigent circumstances – a miner." And he continued that the award "proved that no condition of life was too humble to entitle the possessor of talent to public honour and reward, when that individual directed the energies of his mind to the public good. This was the grand connecting link between the various classes of which society was composed, which contributed at

[71] For Curwen, see Edward Hughes, *North country life in the eighteenth century,* Vol. 2, (Oxford, 1965).
[72] Arthur Aikin, "An Address at the Annual Distribution", *Transactions,* 1817, **34**, p. 213.

once to the security, the happiness, and the pride of this country."[73] There was, however, meant to be no doubt as to who was on top of the grand connecting link.

As a result of this presentation, the Society could be regarded as something of a closed shop. In 1824**,** the *Mechanics Magazine* published a letter from a member of the Society which encouraged contributions from a wider group: "[h]aving had occasion lately to see some operative weaver on the subject of improvement in silk machinery, I was surprised to find that a notion generally prevailed, that considerable interest is requisite to procure the admission of inventions to be submitted for the consideration of the Society of Arts."[74] The author assured "ingenious workmen in other trades" that "no interest or patronage whatever is necessary", and that they could just write to the Society's Secretary. In theory, this was true, but in practice the advantages of honourific reward were those of advancement, recognition – patronage.[75] Whether the Society could meaningfully supply this in the absence of some personal connections is dubious, given the smallness of its rewards. Years after his award, Roberts recalled what had brought him to London in the first place: "the cause of my leaving Cumberland was from a discovery called the "safety-hood," which Mr. Curwen wished me to take to London. He paid my expenses, and desired me to go to the Society of Arts with it."[76] Curwen's support led on to a further reward from George IV of £100, and Roberts' eventual establishment as an instrument maker in London.

The respectable prize-givings were not the Society's only activities during this period, though they were by far the most prominent. Historians have made much of the decision of Arthur Aikin, the Society's secretary, to introduce paper-readings at the Society, on the basis that this brought it closer to other literary-philosophical and scientific societies at which public lectures could be heard.[77] We have to note, however, that initially Aikin delivered the vast bulk of these lectures himself, and their subject-matter was entertaining and antiquarian. Over time, the Society did offer a space for lectures associated with more "modern" industries; this would culminate with the great

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[73] Quoted in *The Cottager's Monthly Visitor,* 1825, **5,** p. 336.
[74] A Member, "Society of Arts", *Mechanics Magazine*, 1824, **2**: 179.
[75] John Roberts, 10 July 1835, quoted in *Report from the Select Committee on Accidents in Mines* 34, (London, 1835), 252.
[76] *Ibid.,* 253.
[77] Arthur Aikin, *Arts and Manufactures Illustrated: with Historical and Literary Details, in Lectures at the Society of Arts, Manufactures, and Commerce,* (London, 1831).

series of lectures on the results of the Great Exhibition.[78] Some of the Society's members were also active in campaigning for reform of the patent laws, and at Committees in the House of Commons its awards were referred to – quite dismissively – as a possible alternative to patents, or a model for other ways of rewarding inventors. As we will see, a few unexpected premiums stirred other kinds of interest as well. I will discuss many of these in subsequent chapters; some of them were quite significant. In the context of the shift of the public role of the Society which I am tracing here, however, their piecemeal and private character is most notable. The sense of a connective, broad public, encouraged into being by the Society and sustained by its encouragements, was nowhere to be found. Or almost nowhere: increasingly, sympathetic accounts of the Society located its active achievements in its past. These discussions laid the foundations for the Society's respectable reputation, as it has been presented in official histories, neglecting the more ribald organisation of the early years.

7. Conclusion

This chapter has been about the different ideas of the public which the Society of Arts sought to embody and encourage, and the challenges which these conceptions faced. There were four overlapping views. From the Society's earliest years, when it was made up of a small group, emerged the picture of a public who could be encouraged into improvement through advertisements in the newspapers and the offer of rewards. The Society were anxious to solicit information from these outsiders about the projects which they hoped to support; one of the ways they did this was by proposing new members from a relatively wide range of social realms. As the Society's membership grew, and what had formerly been external contributors came to attend its meetings, its public ethos shifted towards a language of unification. Now the membership as a whole could be conceived as working on a common endeavour, improving the nation as a whole by encouraging schemes which would knit all true patriots together. By the beginning of the 1760s, the

[78] William Whewell et al., *Lectures on the Results of the Great Exhibition of 1851*, (London, 1851).

Society was flush with success, and rich enough that it could countenance direct pecuniary support of a number of different schemes. This however, put pressure on the claim that it could act impartially, leading to reports and satires which represented the partiality of individual projects and members – even as they continued to pay homage to the Society's honourable and respectable goals. Measures were passed to try to prove the Society's probity, and in noisy debates its members sought to claim that their schemes were operating on behalf of a wide public, rather than being focused solely on private profit. These efforts could not expunge the taint of factional interest, and amid accusations of cronyism the Society's fashionability and membership declined around the end of the 1760s. When its members re-established it, they did so on the basis of a staging of polite respectability, where the public was conceived as an approving audience for the Society's acts of patronage.

These shifts in the Society's public character were primarily of emphasis, rather than absolute transformations to its ethos. I have emphasised the changes partly because they would have appeared decisive to someone who read about the Society primarily in the newspapers (this view may be shaped by their changing reporting conventions as well). Even in its later period of respectability, the Society received contributions from Spitalfields silk weavers, and provided a base for the members of the City Philosophical Society; whatever Smollett may have claimed, the earlier period was only relatively democratic and open, and relations of patronage were still very significant. Nevertheless, a significant change in the Society's overall horizons is detectable, related to its own constitution as well as developments in the political and associational climate outside. In particular, its historians have not noted the factional and oppositional character of its public meetings during the 1760s. The tendency to present the Society as a neutral encourager of worthy and patriotic projects which I noted in the previous chapter certainly accords with one aspect of how its members wanted to regard it, but misses these much more contentious questions about what it meant to be "public", through configurations of openness-through-publication, impartiality, and expansive national ideals.

The Society's public ethos was repeatedly criticised by reference to its involvement with material things. This critique was offered most strikingly in the Sign-Painters' Exhibition and John Hill's

satire, but it also pervaded public reports of the Society during its most tumultuous phase. These arguments had the force they did because the Society's public was abstraction, but rather sought material embodiment. Proof of the success of the Society's schemes was offered not through the development of literary styles, but in samples, models and projects which could be examined and shown. In the eyes of the critics, this was a supremely problematic part of the Society's claim to impartiality. It was also the foundation of all the Society's rewards, and the earnest efforts of its committees. These are the subject of chapter three.

Chapter Three: Rationales of Reward

1. **Introduction**
2. **Comparable Institutions**
3. **Individual Committees**
4. **Conclusion**

1. Introduction

In the previous chapter, I analysed the shifts in the Society's overall public ethos, emphasising the different ideals which it embodied at various times, and how it stepped away from direct involvement with market-based projects after the 1760s. As an overall picture of what it meant to participate within the Society, however, these questions of ethos need to be qualified by the activities of the Society's individual committees. Each of these offered rewards in its own way, and offered a different model of public participation within the Society.

Before we can understand the premiums given by each committee, moreover, we need to understand the different rationales with which they were offered. Those historians who have sought to assess the Society's premium awards have tended to compare them to patents for invention, usually unfavourably.[1] Some of these points of comparison are both anachronistic and contextually misleading: contemporaries understood the premiums not solely by comparison with patents, but also in comparison with government bounties and drawbacks; we can also usefully compare them to the rewards offered by other economic and learned societies. All were, to a greater or lesser extent, entangled in local circumstances, and sought to reward a wider constituency than just original inventors. Appreciating the range of rewards for encouragement should also challenge our view of how eighteenth-century patents worked because – as Christine Macleod has emphasised – they too were caught up in local factors and went for schemes and projects which could not be defined in terms of inventive novelty. I give an overview of these different institutions, and examine its implications for how we think about the premiums, in section two.

[1] Christine Macleod, *Inventing the Industrial Revolution,* (Cambridge, 1988), 194.

Section three then gives an overview of the rewards given by each of the Society's Committees. In each case, we can draw a contrast between the practices of the early society and what happened later on; this can be associated with a shift away from pecuniary and towards honourific rewards, as well as questions of emphasis which were distinct to each Committee. The transition did not occur as a matter of policy, and occurred at different paces in the different committees – but some shift is detectable in all of them. Thus in the Society's early days, manufactures, chemistry and mechanics were all fairly active and faced the same sorts of questions about whether they should reward novelties or diffusions of existing practice; while by 1800 mechanics had risen to give many of the Society's rewards, and the other committees had fallen almost into abeyance (although they evidenced occasional additional bursts of activity later on). Each committee, I will argue, showed a different balance between the attempt to diffuse existing achievements and reward novel or experimental practice; in each case, what premium candidates thought they were doing in approaching the Society of Arts, and the opportunities which its premiums promised, were different as well.

Section four then offers some concluding remarks about how the different policies of the committees contributed overall to the role of the public at the Society of Arts, asking how they qualify the picture of the Society's ethos which was offered in the previous chapter, and setting the scene for chapter four, which is about the place of exemplary experiments and anecdotal achievements within the Society.

2. Comparable Institutions

The comparison between the premiums of the Society of Arts and patents is misleading because it suggests that the premiums were intended to reward novel inventions. While some of the premium offers took this form, most did not; and very few of the submissions to the Society of Arts fit with our standard idea of what patents protect either.

During the eighteenth century the British government paid out immense sums in drawbacks, bounties and premiums to support particular industries. This was sometimes to support standard crops such as corn (for which the British government paid £6 million before 1766); and sometimes for relatively more speculative enterprises such as whaling (supported with £2 million between 1733

and 1860).[2]

The Society worked in a world of lobbying, drawbacks, and tariffs. D. G. C. Allan has identified a number of areas where the Society's members and officers lobbied parliament or provided evidence for parliamentary committees. Thus M. Bourbillon de Bounneuil hoped in 1790 that he could get a "drawback from duty on salt he used for manufacture of mineral alkali near Liverpool", and was instructed to send a quantity of alkali to the Society; but failed to submit a sufficient quantity.[3] In 1791 the Society supported an increase in the duty on imported goat skins, after lobbying from a merchant member.

As well as those paid in the mainland kingdom, considerable sums were spent on encouraging colonial enterprises, particularly in North America and Ireland. For example, between 1737 and 1828 the Irish Linen Board received £20,600 a year.[4] In 1796, the Board produced a "Spinning Wheel Entitlement List", which gave details of individuals to whom spinning wheels and looms had been given in exchange for their agreeing to cultivate a certain acreage of flax – those who planted one acre were given four spinning wheels; those who planted five acres were given a loom. More than sixty thousand people were rewarded in this way.[5]

Although these sums were orders of magnitude greater than those offered by the Society, the Society's early members, when it was flush with funds and keen on pecuniary reward, appear to have imagined their support as acting on the same lines as those given by government: but it was a very different matter to support schemes in London than it was in Dublin. The Linen Board was far more systematic in building up a particular local industry, and this reflected a very definite local ideology about the industries which were to be cultivated in the wake of the Wool Acts which limited Irish wool exportation in favour of the English. The Dublin Society was very closely aligned with these projects: in James Livesey's words, it "pursued many of the activities we normally

[2] Julian Hoppit, "Bounties, the economy and the state in Britain, 1689-1800" in Perry Gauci, ed., *Regulating the British Economy, 1660–1850*, (Farnham, 2011), pps. 139-160.
[3] D.G.C. Allan, , "Studies in Society's Archives XX,, The Society of Arts and the Committee of the Privy Council for Trade, 1786-1815," *RSA Journal, 1961,* **109**: 806-9, at 806.
[4] John Sproule, ed., *The Irish Industrial Exhibition of 1853: A Detailed Catalogue of its contents,* (Dublin, 1854), 288.
[5] Henry D. Gribbon "The Irish Linen Board, 1711-1828," in *The Warp of Ulster's Past: Interdisciplinary Perspectives on the Irish Linen Industry* (New York, 1997), 77-87.

associate with states and was the principal agent of economic development in the country."[6] The far more scattergun approach of the Society of Arts was rather more divided between the display of experimental possibility, the demonstration that an industry might be viable, and the diffusion of best-practice techniques than this consolidated approach to building up an industry in a particular place.

Nevertheless, contemporaries sometimes aligned the Society of Arts with these kinds of government support. For Thomas Mortimer, in his 1772 book *Elements of Commerce*:

> When we look into the present state of our mechanic arts and manufactures, we find the effect of bounties has been wonderful indeed! Especially in the linen and silk manufactures. The bare mentioning of the present flourishing situation of the linen manufactures in IRELAND and SCOTLAND, and of the mechanic and polite arts in ENGLAND, since the institution of the Society for the Encouragement of Arts, Manufactures, and Commerce, is sufficient to remind us of the utility of bounties.[7]

In this passage, Mortimer slides back and forth between the support which the government had given to the linen industry and the apparent effects of the Society on the fine and mechanic arts. Respecting the North American colonies, the *London Evening Post* reported in 1760 that "an Act of Assembly has lately passed, offering Premiums, in addition to those of the Society [of Arts]; which, under the Sanction of the Legislature, cannot well fail of co-operating with great Success".[8] In all these cases, the premiums were associated with these government bounties, rather than with patents.

Other provincial improving societies were more closely tied to defined and stable local needs and interests than the Society of Arts. For example, the Bath and West of England Society also gave pecuniary and honorific premiums. Those given between 1767 and 1798 are summarised in table

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[6] James Livesey, "The Dublin Society in eighteenth-century Irish political thought," *The Historical Journal,* 2004, **47**: 615-640, at 616.

[7] Thomas Mortimer, *The elements of commerce, politics and finances, in three treatises on those important subjects. Designed as a supplement to the education of British youth, after they quit the public universities or private academies,* (London, 1772), 38.

[8] *London Evening Post*, June 21 1760, Issue 5092.

3.1. The table is intended to illustrate the Bath and West's concerns; the sums given out overall were negligible but give a way of ranking the Society's priority. By far the largest group, in the number of awards given and the amount paid out overall, was for "faithful service": these went to named people, for periods of domestic or agricultural service between 20 and 65 years. The second largest group was for premiums paid to people who had managed to raise large families without seeking assistance from the parish, while the third went for the use – either routine or experimental – of ploughs, drill-machines, and other agricultural instruments. After this come categories which are much more similar to those of the Society of Arts: for machines, and crops, manure, and estate improvement. But the two largest categories are striking because of the way in which they are embedded within paternalistic aspects of the local "moral economy", connected with ideas about administration of the poor law and the importance of population but also going to named individuals. The third category went both to aristocratic propagandists who caused experimental ploughs to be used on their properties, and to their ploughmen. The overall focus of these premiums is a contribution to the agriculture of a particular place, judged in terms of performance

Category	**Amount Awarded**	**Number of Awards Given**	**Honorary Awards**
Faithful Service	£353 17s	117	
Raising a family without parochial assistance	£125 11s	38	
Performance of ploughing, drilling, harvesting	£127 13s 9d	33	5
Crops	£218 2s	30	2
Manufactures	£52 18s	13	1
Machines	£66 3s	11	
Livestock	£99 5s	11	4
Miscellaneous	£40 15s	9	2
Manure	£22 17s	6	
Estate Improvement	£13 13s	3	1
Essays and accounts of experiments	3 3	2	1

and faithful service (and sometimes – as in ploughing – through competitions.)

Table 3.1, Premiums Given by Bath and West of England Society, 1767-1792

(Source: *Letters and Papers on Agriculture, Planting, &c.* vol. 1).

Finally, we can make the comparison between premiums and patents for invention. The Society often stood self-consciously in opposition to patents. In later years, the Society's policy towards patents softened, and a number of its members were actively involved in patent reform.[9] However, the comparison between premiums and eighteenth-century patents runs deeper than this suggests, because of the ambivalent connections for both patents and premiums with the affordances of particular locations.

Patents are stranger and more historically contingent instruments than their advocates are often inclined to recognise. In the standard view, patents distinguish between an idea, which was made public, and its instantiation in material tokens (which the patent protects).[10] By this view to invent something is to have an idea which was separable from a particular material form. In the mid-eighteenth century, however, patents were still in the process of shifting from their earlier form, which was much more closely linked to the exploitation of particular sites. As Christine Macleod notes, seventeenth century patents were "equally concerned with subcontracting government business, authorization of potentially controversial activity as with protecting invention"; this meant that, for example, a "new diving bell or suit was often no more than window-dressing to reassure investors and to provide the basis for a patent whose real value (if any) lay in the exclusive share of the sea bed it assigned".[11] Even by the mid-eighteenth century, "special licenses were granted under cover of a patent for invention for a variety of enterprises which, although new or relatively so, were not technical inventions—for example, banking and insurance, lotteries, navigational aids,

[9] James Harrison, *Encouraging Innovation in the Eighteenth and Nineteenth Centuries: The Society of Arts and Patents 1754-1904*, (Gunnislake, 2006).
[10] See Greg Radick and Christine MacLeod, eds., "Owning and Disowning Invention: Intellectual Property and Identity in the Technosciences in Britain, 1870-1930," *Studies in History and Philosophy of Science,* 2013, **44**: 188-300.
[11] MacLeod, *Inventing the industrial revolution,* 81.

whaling and fishing licenses."[12] As we saw in the previous chapter, it was quite often the case for inventions of public significance which were rewarded by the Committee of Mechanics that it was difficult to separate organisational innovations from strictly technical ones. The small number of patents which were debated in parliament show a similar pattern, with intense wrangling about administrative questions being conducted under the question of mechanical improvement. In 1755, for example, Parliament was petitioned by Richard Lyddell concerning his "new invented ballast machine or vessels" for the preservation of the Tyne river and Harbour. Expert witnesses from Trinity House declared that they had never "seen any thing of the like Kind in England".[13] But discussion of how the machine should be used turned into wrangling to make sure that the ballast would be unloaded sufficiently far out to sea: "that an Officer, to be appointed by the Corporation of Newcastle, shall be on board each of these Machines – That he shall have the Care of the Ports, and the Openings for letting out the Ballast. That he shall be paid by Mr. Lyddell and that the Ballast shall be dropped in Forty Fathom, if thought necessary, under a Penalty; and that he shall be limited to Fourteen pence per ton."[14] Despite its claimed novelty, the machine was not separable from its structures of oversight or the way it was meant to be used.

What these comparisons should suggest is that premiums partook of aspects of all the other institutions for encouragement of improvement and invention without being quite the same as any of them. Many early premiums were paid on the basis of diffusing useful techniques among a wide public, the same rationale as government bounties, though on a much smaller scale. The rewards of the Society were less tied to particular localities than were those of other economic and improving societies, but were akin to them; like patents, their connection to individual locations was often ambiguous. On this basis, then, we can explore the activities of the Society's various committees.

3. Individual Committees

[12] *Ibid.,* 82.
[13] "Eleventh Parliament of Great Britain: second session (14 November 1754 - 25 April 1755)" in *Journal of the House of Commons,* 1802, **27**: 238.
[14] *Ibid.*

I now want to turn the awards given by each of the Society's committees. Differences in ethos and personnel in each committee meant that they all had slightly different approaches, but we can see some common patterns across them all. In general, a focus on pecuniary awards for diffusing achievements in the Society's early years gave way to honourific awards. Sometimes this shift was very dramatic. In other committees, it was more gradual.

By far the largest number of premiums was given by the Committee for Fine Arts. The amounts which were given by this committee are summarised in table 3.2. The change was very dramatic between the Society's earlier period and later years: in its first decade it awarded £4,401 in 466 pecuniary awards; in the decade from 1805, by contrast, it paid out just £215 and gave 329 honourific awards. Many of these were for imitations, and is likely to have contributed to the social tone of the Society's prize-givings, not least because this was the only category to reward women and girls very extensively. (They are very prominent in figure one, for example).

It may be argued that fine arts were unlike the Society's other activities, because the nature of an artistic production is different than an invention or experiment. On the other hand, the "mechanical" and "polite" arts were not so readily separable during the eighteenth century. The Society maintained sporadic interest in design suitable for manufactures, and occasional premiums were given for drawings of machinery and the like. As Andrea Puetz writes "its premiums for the 'polite arts' had originally been conceived and publicised as a key strategy in its broader concern for the improvement of commerce and of the national manufactures": thus awards were meant to raise awareness of design, and to encourage the acquisition of drawing skills[15]. Awards for design, particularly for weavers, were extended through the 1760s; awards for design were abandoned altogether in 1779. These awards are perhaps notable chiefly because they exemplify – in the field of fine art – the difficulty of relating the knowledge associated with individual trades and the Society's more general concerns:

> It therefore appears that the children and youths without direct experience of the silk industry […] depended for models on somewhat outdated patterns and were

[15] Anne Puetz, "The Society and the 'Polite Arts' 1754-1778, 'best drawings', 'high' art and designs for the Manufactories", in Susan Bennett, ed, *Cultivating the Human Faculties, James Barry (1741-1806) and the Society of Arts,* (Cranbury, NJ, 2008), 26-42, at 26.

> also not entirely *au fait* with some of the essential aspects of the design process. It is perhaps in response to such problems that an anonymous "Mercer" wrote to the "polite arts" committee in 1757, urging the Society to employ a master weaver to attend the adjudication of the designs, "for no one Else can be a Proper Judge whether their designs can be worked or not" and emphasizing the "intricate" nature of designing for this industry.[16]

Overall, the Committee's goals swung back and forth: in 1758, it began to support high art, such as oil paintings and sculptures; these tailed off at the end of the 1760s, alongside the decline in the Society's other pecuniary awards. This left the Society in a somewhat paradoxical position: when it gave out most money, it was most in the position to support art which was, in some senses, meant to be above the marketplace; it thus avoided many of the questions about direct involvement with industry which bedevilled the other committees.

Table 3.2: Summary of Polite Arts Awards

	Pecuniary Awards	**Value of pecuniary awards (£)**	**Honorific Awards**
1755-1764	466	£4,401	7
1765-1774	193	£2,953	89
1775-1784	43	£634	132
1785-1794	6	£153	98
1795-1804	2	£100	22
1805-1814	12	£215	329
1815-1824	5	£70	480
1825-1834	2	£25	271
1835-1844	2	£15	122
Total	731	£8,566	1,550

[16] *Ibid.,* 37.

The Committee of Mechanics was the great exception within the Society, in that almost all its activity occurred after the 1760s (716 out of 810 awards, of which 551 were given after 1800). While the overall number of awards increased, however, this was due almost exclusively to an increase in small pecuniary and honourific prizes. Despite the small number of awards given early on, £2,418 was paid between 1755 and 1769, compared with £4,919 in the whole later period, £3,023 of which was paid between 1800 and 1841. Looking at the size of the awards, as well, two prizes of £100 each were given in 1800 and 1802 for the discovery of a quarry of English millstones; eight awards of £40 and five awards of £50 each were made; all the rest were for between £2 and £30. By contrast, in the earlier period, 13 awards of £50 each were given, and five of a hundred pounds or more. The contrast in numbers is much more striking when we compare the honourific awards – in its early first fifteen years, the Society gave out 4 gold and 10 silver medals in mechanics, compared with 113 gold and 346 silver later on.

The low value of the Society's rewards was notorious for contemporary commentators, as well as for historians. When questioned by a Parliamentary Select Committee in 1835, J. C. Robertson said that "I apprehend that were the entire number of inventions which have been rewarded by this society compared with the number carried into actual practice, the disproportion would be found enormous; and this I attribute principally to the smallness and inadequacy of their premiums."[17] However, this does not explain why candidates approached the Society at all, which is what I will attempt to do here.

The awards given before 1800 can be placed in five main categories, which are summarised in table one. The immediately striking features of this list are that the largest number of awards was given for "fishing" – all of these were for the operation of the improved gun harpoon, which the Society hoped to introduce. Rather than rewarding invention alone, then, they were meant to support the operation of a novel device and encourage its further uptake. Similarly, among the awards given for mills, by far the greatest amount of money – £310 in total – was given to James Stansfield for his operation of a sawmill. There was no suggestion that this was technically novel, but the Society intended to prove that it was viable. Thus at least some mechanical premiums were

[17] J.C. Robertson, ""Minutes of Evidence before Select Committee on Arts and Manufactures", in *Selection of Reports and Papers of the House of Commons* Vol. 37, (London, 1836), 124.

associated with more than mere novelty, but also the direct encouragement of the adoption of given machines – which made them somewhat more akin to government bounties than to patents. I have traced the location of 572 of the awards; of these, 370 went to inventors based in London; the next largest contingent came from Yorkshire, with 13 awards. Clearly, the London contributions skew the data to some degree: many of the domestic inventions, instruments, and tools came from inventors who were based in the capital.

The picture after 1800 is very different, though not in the ways which we might expect. On the face of it, it would seem plausible to associate the increased number of the Society's awards with the "wave of gadgets" which T. S. Ashton associated with the Industrial Revolution, and which subsequent historians have cautiously endorsed.[18] Even if (given the small scale of its rewards) we might not expect the Society to support transformative new inventions, we might well expect to see numerous microinventions by which the new machinery was made practically workable. Enough rewards were given that we get some glimpses of these things, but the vast bulk of the Society's rewards were not of this kind.

Instead, the three largest categories of invention were given to naval inventors, those intended for domestic use, tools, and instruments. The number of naval inventions was much greater than those of any other class. The Society's formal offers of premiums never made any mention of premiums for naval purposes; and yet, year after year, this was what candidates offered, and what prizes were given for.

What were the likely reasons for this? I think the most credible explanation is that inventors came to the Society because they sought to publicise local successful and workable schemes. We do need to distinguish between the different categories which were rewarded, because premium candidates came to the Society for rather different reasons. There is evidence that the reason for the great prevalence of naval inventions was that this was an area where significant patronage was required, for which patenting would have been entirely inappropriate. Moreover, there was significant philanthropic interest throughout the kingdom in some kinds of naval inventions. As a

[18] Alessandro Nuvolari, "Collective invention during the British Industrial Revolution: the case of the Cornish pumping engine," *Cambridge Journal of Economics*, 2004, **28**: 347-363; Joel Mokyr, "Demand vs. supply in the industrial revolution," *The Journal of Economic History,* 1977, **37:** 981-1008.

typical example, Thomas Grant's adaptation of a barrel which could act as a life-preserver was supported by the Alderman, Mayor, Recorder, and Justice of Portsmouth, all of whom had observed a trial "whereby ten men were at the same time kept floating with their heads considerably above the water in a strong current at ebb tide, through Bidegord Bridge."[19] Humble (and faintly ludicrous) as it was, Grant's invention had received some local patronage – publicity through the Society was intended to attract more. This was a pattern within inventions of this kind. John Peat's temporary rudder came with an anecdotal letter of support from a passenger whom it had rescued, from the Master-attendant of the Barbados Naval Yard, and three Royal Navy captains. Grant Preston's binnacle and lamp had been tried out on board "thirteen or fourteen voyages between London and Leith on board the Caledonia."[20] J. Park, the junior master attendant of Portsmouth Yard, invented a mooring block – meant to prevent the need for the large amount of ballast which was dumped into the harbour to keep in place the claw anchor by which ships were moored in place; he reported that "trials were made under the inspection of several experienced and distinguished naval officers."[21]

The model in this respect was not patented inventions but projects which attracted significant national support. For example, Henry Greathead's life-boats, which the Society rewarded in 1802, were initially supported by the gentlemen and ship-owners of the South and North Shields; his claim to a premium was accompanied by testimonials from the Duke of Northumberland, who had initially funded the boat in Scarborough, as well as the elder brethren of Trinity House. In 1802 a parliamentary Committee which was considering the merits of Greathead's lifeboats noted that:

> Trinity House, the Society of Arts and Manufactures, and the Underwriters at Lloyd's, had not only pronounced the invention to be of the most important use, but that this testimony of the latter description of Gentlemen has been further evinced by a gratification to the inventor of one hundred guineas, and a subscription of £2000 for encouraging the construction of life-boats.[22]

[19] Thomas Grant, "Life Preserver", *Transactions,* 1819, **35**: 63-71 at 63.
[20] Grant Preston, "Ship's Binnacle and Lamp", *Transactions,* 1813, **31**: 188-194, at 191.
[21] J. Park "No. VI, Mooring Block", *Transactions,* 1819, **36***:* 83-94, at 93.
[22] Anon, "House of Commons, Wednesday May 26", *The Parliamentary Register,* 1802*,* **26**: 532-536, at 533.

Thus the Society was one among a number of organisations which could offer patronage in mechanics – over and above what a patent would allow. Candidates were aware of this, and often resorted to the Society when other channels had failed. Admiral Molyneux Shuldham's new method for ballasting small vessels, rewarded in 1819, had already been rejected by the admiralty when he submitted them: he hoped "by honouring me with some mark of their approbation" the Society might "be the means of drawing thereto the attention of scientific men, which may cause it to be put to further trial."[23] I do not think this desire can account for every naval invention, but the desire to advance the claims of particular improvements within the naval hierarchy suggests, I think, why it might have been appealing to naval inventors. Overall then, the Mechanics committee did not coherently reward novel mechanical inventions associated with industry. Instead it gave prizes to a fairly wide variety of schemes and contraptions, mainly to inventors from the capital and connected with immediate utility, or with the navy.

Table 3.3: Main Types of Mechanics Awards before 1800

Type	**Number**
Fishing	51
Mills	36
Domestic (building and locks)	26
Carriages	19
Tool	18
Crane	18
Naval	17
Instruments	17

[23] Molyneux Shuldham, "New Method of Ballasting Vessels," *Transactions,* 1819, **36***:* 126-132, at 126.

Agricultural	17
Clock making	10

Table 3.4: Main Types of Mechanics Awards after 1800

Type	**Number**
Naval	98
Domestic	66
Tools	60
Instrument	59
Clock making	50
Medical	31
Safety	25
Agricultural	21
Steam engine components	15
Carriages	12

Table 3.4 London Inventions

Type	**Number**
Domestic	53
Instrument	52
Tool	46
Naval	37

Clock making	33
Medical	22
Agricultural	16
Safety	15
Other	12
Luxury	10
Crane	9
Carriages	8
Mill	8
Gun	7
Fire	6
Music	6
Steam engines	6
Textiles	6

The Society's awards for manufactures fall into two main phases. Up until 1778, all but one were pecuniary; 132 of the 245 rewards were given during this period, the majority of which (118) had been made by the end of the 1760s. That the number did not (as in the case of fine arts) drop off at once suggests that the committee adopted a similar policy as revenues decreased during the 1770s, but with more straitened resources. In the early period, the committee was fairly consistently interested in supporting certain projects: thus in 1759, four awards of between 10 and 20 pounds were made for the production of paper from silk rags, while in 1758 and 1759, three awards were given for the imitation of Turkish carpets in English materials. While in the case of paper-making historians have not credited these awards with any direct success, they do point towards a consistent ethos, based upon the imitation of foreign goods, and meant to encourage working manufacturers. As Maxine Berg writes,

> [p]remiums given by the Society of Arts and patents continually stressed the connections between imitation and new products. The Society offered a premium for artificial flowers to displace those imported from France and Italy, arguing that

> the flowers could be made "in other substances, obtainable in any quantity' […] The Society offered many premiums for varnishes to imitate the Chinese, Venetian, and French lacquers, […] The Society prided itself on the part played by its premiums for a native varnish to displace imports of Japanese and French lacquerware.[24]

Alongside the focus on luxury, some rewards were given for productions within workhouses, particularly spinning worsted.[25] Manufactures was thus not solely associated with the encouragement of luxuries, but intended to be part of a more philanthropic ethos as well.

After 1778, awards were given on a much more piecemeal basis, and the focus on improved products has largely disappeared. During the 1780s, the committee gave almost no pecuniary awards at all, instead rewarding samples of paper intended for marbling and copper-printing, and which was made from raw vegetables, English silk, a success in spinning wool very fine, and a "pocket memorandum book for the use of blind persons". A few pecuniary awards were made during the 1790s, for improvements to spinning wheels and improvements to looms and shuttles, techniques of weaving fishing nets, and a new treatise about employing poor people in workhouses. We thus see a slow trickle of continuing concern for the Society's earliest goals in manufacturing – particularly in paper – and an occasional resurgence of the idea that the Society should be philanthropically encouraging workhouse manufactures. This continued to be the pattern throughout the early nineteenth century: of the eighty-five rewards which were given between 1800 and 1837, 37 were for the production of straw hats in imitation of Italian ones – several of these went to schools and workhouses, while 15 were for silk-weaving. The remainder consisted mainly of samples: such as a silver medal which was given in 1809 "to the patrons and committee of the flag association", for "a matchless specimen of double brocade-weaving, in a flag now executing in Spitalfields"[26]; and for the production of wool from Merino sheep. In other words, it seems likely that weavers occasionally approached the Society, while other trades mainly stayed away, and there was certainly no concerted effort (as there had been in the early days) to support given industries –

[24] Maxine Berg, *Luxury and Pleasure in Eighteenth-century Britain*, (Oxford, 2007), 106.
[25] I discuss these rewards in chapter four.
[26] Thomas Atkins, "Specimen of Double Brocade Weaving", *Transactions*, 1809, **27**: 113-117, at 115.

with the exception of straw hats.

Thereafter most awards in this class continued to be pecuniary, though their value was extremely low – between £2 and £50, with most at the lower end of that scale. During the 1760s, by contrast, several single inventions had been paid £100 each. Overall, the value of pecuniary awards between 1754 and 1778 was £2,690, while in the much longer later period it was just £790. The activity of the manufacturing class thus suffered particularly from the Society's general shift away from pecuniary rewards, because (unlike in mechanics) new kinds of candidates did not make the Society their own – with the partial exception of silk weavers – while small rewards continued to be paid on the basis of the development and diffusion of practice, but were of much less value than in the Society's early years.

Awards given in the class of agriculture numbered 650 overall. They clustered around planting trees, introducing novel crops, and agricultural machines: both the inclusions and exclusions from this class are striking. In particular, I want to focus on a common tension which ran through the Society's rewards in this class: were the awards meant to be for experiments, treatises about the best method of culture, and exemplars (making them somewhat more like patents), or were they for the diffusion of crops and practices which simply needed a small amount of additional encouragement to be introduced on a wider scale? This ambiguity ran throughout the Society's awards in this class, and in agricultural writing more generally prompted significant questions about how experimental knowledge could be generalised.[27] It has also shaped attempts to evaluate the Society's contributions to agriculture historically. Thus Trueman Wood tries to resolve the tension:

> The lists were prepared with great care, and modified from year to year, though we find the same offer repeated time after time, sometimes over a long period, even though large amounts had already been paid away among successful competitors, for it is to be remembered that the premiums were not, as a rule, in the nature of

[27] I return to this question in chapter four.

> prizes to be taken once for all, but rather as grants-in-aid, to be repeated as long as there seemed to be any need for such assistance.[28]

In his actual analysis, however, Trueman Wood refers primarily to the Society's more experimental awards.

As noted above, the Society's interest in agriculture was different than that shown both by other agricultural societies, and at agricultural fairs. While the Society undertook occasional trials of ploughs, it did not have the face-to-face opportunities for direct social display. Instead contributors reported achievements from their own locations – often landed estates or farms on which experiments were conducted – which often did not have samples which could be shown off. This is reflected in omissions from this class: during a period when animals were bred to prodigious sizes, only a total of 20 awards directly concerned animals: they included cures for foot-rot, a "method of bringing cattle to early maturity, so as to furnish good beef in much less time than heretofore known"; a method of "hatching, rearing and fattening poultry."[29]

One reason people competed for agricultural premiums was to publicise their improving efforts. As at the agricultural fairs, these often had an aspect of "glittering patronage", as the press reports which I quoted in the previous chapter indicated. Alongside the encouragement of the large-scale achievements of landowners, however, awards were often given for achievements on a much more modest scale; according to the Society's inclusive ethos, improvement was not only the preserve of the great. Thus 59 awards were given for land improvement, between 1786 and 1824. These included "improving waste moor land, boggy land, peat moss, draining land, and gaining land from the sea through drainage and embankment. Some of the awards were for very small plots: in 1812, Major Bryan Heasledon improved just 21 acres of boggy land in Clapham, Yorkshire (he received another award for another 177 acres the following year); in 1788 Henry Bate Dudley gained 45 acres in Essex. There were 213 awards for plantations of trees, again of hugely different acreages.[30]

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[28] Henry Trueman Wood, "The Royal Society of Arts. V. – The Society and Agriculture. (1754-1830)", *Journal of the Royal Society of Arts,* 1909, **59**: 1108-1118, at 1108.
[29] John Christian Curwen, "Feeding of Cattle," *Transactions*, 1817, **34**: 48-64; Hannah D'Oyley "New Method of Rearing Poultry to Advantage," *Transactions,* 1807, **25**: 24-9.
[30] I discuss these in detail in chapter eight.

Meanwhile, 220 were for reports of the growth of crops – these included accounts of methods of cultivation as well as certificates of having successfully grown a given acreage. One of the Society's long-standing aspirations was for the growth of alternative crops, for which pecuniary rewards were paid. With only one exception, these produced extremely limited responses. Five awards went between 1765 and 1767 for the cultivation of burnet; ten for acreages of hemp of between 15 and 37 acres. The one exception to this general rule was madder, for which 86 premiums were given, and awards of between £5 and £145 pounds. All of these awards were pecuniary, and the small scale of each individual award indicates. Cultivators of "True Rhubarb" received twenty-four awards between 1769 and 1804**;** while during the early nineteenth century, three awards were given for opium. Summarising the Society's role in encouraging the planting of rhubarb, C.M. Foust notes the pre-existing "rhubarb mania" which attracted the Society's interest, and argues that its awards helped to "sustain and authenticate the excitement for Rheum Palmatum", noting that "[w]e know of no large cultivators who did not communicate with the Society or covet its prizes."[31] Beyond just growing the plant, its commercial establishment required significant experimental work (which was also conducted beyond the Society itself) to prove that the English rhubarb was of the same quality as its Turkish forms.

Alongside the crops for alternative husbandry, a number of awards were given for crops which were more conventionally associated with improved agriculture. In this spirit, six were given for lucerne plantations of between 12 and 16 acres, and one for an account of the most profitable means of its culture. Nine were given for the collection of grass seeds in 1766 and 1767, in line with a program suggested by Benjamin Stillingfleet, which I discuss in chapter seven. The focus of these encouragements was often on alternative sources of feed for cattle. Six awards were given for potatoes, which focused primarily on their use as cattle feed. Five went for varieties of spring wheat, between 1761 and 1807. Beween 1766 and 1822, 14 awards went for turnips, including comparative experiments on their growth, and novel techniques of preservation which would allow their use as cattle feed. The "turnip rooted cabbage" – the swede - took twelve awards between 1767 and 1789: the Society managed to reward two separate people for its introduction (John

[31] Clifford Foust, "Studies in the Society's History and Archives: The Society of Arts and Rhubarb," *RSA Journal* , 1988, **136**: 434-437, at 437.

Reynolds in 1775 and John Ross, professor of Oriental Languages in King's College, Aberdeen, in 1789).

Alongside the premiums which the Society distributed for introductions of novel crops, it also acted as a clearing-house for the distribution of seeds. Thus, in 1786, Samuel More received seeds of "root of scarcity", later known as mangle-wurzle; the Quaker philanthropist John Cokely Lettsom received seeds and translated a French treatise about it.[32] Thereafter it appeared on the Society's premium lists for another thirty years, without producing any effect.

Between 1766 and 1808, 20 awards went to descriptions of comparative cultures of wheat, or experiments which were intended to decide between the drill and broad-cast methods of husbandry. On the basis of these reports, Robert Dossie argued that "Jethro Tull only started the notion [of drill husbandry] The practice was very little pursued till the Society awakened the public attention to it by their premiums. "[33] Certainly, as we will see in the next chapter, the Society was part of a wave of offering written communication about drill husbandry; these, however, were strikingly inconclusive.

Finally, a range of miscellaneous awards show other paths which the rewards in this category could have taken. There were 41 for bee hives, collection of wax, or more effective management of bees.

A few isolated examples were connected with gardening, and the botanical transfer of plants. In 1771 Thomas Green communicated a method of destroying red spiders in gardens and hot houses. A few experiments on manures were reported: In 1779 "Aaron Arable" from Boston, Lincolnshire received an award for his "communication concerning the advantages of urine and the liquor of dunghills used as manure"; in 1799 John Middleton undertook "various experiments on different kinds of manure".[34] The reverend Edmund Cartwright was rewarded in 1818 for his comparative experiments upon manures; William Withers received a reward for his experiments on the effect of manures on young plantations, in 1827. Even Trueman Wood judges these reports as of low

[32] Trueman Wood, "Society of Arts and Agriculture", 1110.
[33] Robert Dossie, ed., *Memoirs of Agriculture,* 1772, **3**, p. 87, quoted in Harrison, *Encouraging Innovation in*, p. 17
[34] Aaron Arable, "Communication concerning the Advantage of Urine and the Liquor of Dunghills, used as Manure", *Transactions,* 1784, **2**: 47-54; John Middleton, "Observations on Different Kinds of Manure", *Transactions*, 1799, **17**: 231-239

quality, writing that "[a] good deal of information was supplied to the Society from time to time, and published in the *Transactions* , but it does not appear that the exhaustive series of experiments laid down by the Society were ever carried out in their entirety."[35] Experimental reports were received piecemeal, and invited many questions about how representative they were, and whether they could demonstrate anything conclusively. I will return to the implications of this in chapter four.

Overall, then the agricultural rewards reveal a remarkably consistent series of priorities as well as a significant ambiguity. The Society sought to encourage the new crops and novel practices associated with the improved agriculture of the eighteenth century; it encouraged enclosure and land reclamation, and rewarded experimental accounts of plantations of trees and ways of boiling potatoes. At the same time, it did not offer a clear distinction between its more experimental interests and its commitment to the diffusion of existing practices.

The class of chemistry garnered 128 awards. The number was never very great, even during the Society's heyday: only 34 rewards were given between 1755 and 1769, though these were quite lavishly rewarded – with £1,390 paid out, and six rewards of between £100 and £200. As with manufactures, most (25) of these were concerned with material substitutions: verdigris or cobalt; or turkey red made in England; or producing earthen retorts from and crucibles from English materials. This was chemistry in its most quotidian form, concerned with substitution, tests and raw materials rather than any more elaborate chemical philosophy. Between 1770 and 1800, 25 rewards were given, partly for the same purposes, and partly for a miscellany which included other instruments, sunflower oils, and generating yeast.

Then between 1800 and 1837, 70 rewards were made, including 18 gold medals, and 34 silver ones, and a total of £535 paid out overall. From this we might expect a similar pattern to mechanics, with candidates from identifiable trades submitting their achievements for reasons of their own. In fact there was very little of this, though a few chemical lecturers and demonstrators received awards for oxy-hydrogen blowpipes and safety chambers for them. John Roberts

[35] Trueman Wood, "Society of Arts and Agriculture," p. 1112.

(mentioned in the previous chapter) took £50 and a silver medal. The chemistry committee was no longer actively involved in the Society's broader substitutive projects (only three of the awards were for this purpose and they were all decidedly eccentric, such as Thomas Willis' 1801 premium for the substitution of bluebells for gum Arabic).[36] Overall, it is very difficult to see any general trends in the chemical awards of the later period, though occasionally they touched on public concerns concerns – thus Samuel Bentham was given a reward for preserving fresh water on long voyages.[37] The largest reward of this period was given to James Ryan in 1817 for his method of ventilating coal mines. Ryan was soon complaining that the Society was not doing enough to support the establishment of his scheme, despite his proof that it was considerably safer than Humphry Davy's safety lamps.[38]

Given the committee's focus upon immediate utility, even relatively novel instruments and processes were described primarily in terms of expediting existing practice. In 1825, William Sturgeon took an award for his "improved electro-magnetic apparatus", receiving a silver medal and twenty-five guineas; this is remembered as the first invention of the electromagnet. The note attached to Sturgeon's invention was extremely apologetic, noting that apart from the smallness of its battery, it was identical to apparatus used by "Ampere, Sir H. Davy, Mr. Barlow, Mr. Faraday and others"; its value was that it was more portable than Marsh's (which the Society had rewarded the year before), and therefore "better fitted than that for the use of the lecturer."[39] In other words, Sturgeon was being rewarded for the convenience of his apparatus, rather than its novelty. Sturgeon wrote to the Society's secretary from Woolwich, where he was working at the Royal Military Academy, alongside a number of other luminaries including Peter Barlow and Olinthus Gregory. [40] The letters in support of Sturgeon's apparatus noted its convenience, and cheapness, and suitability for experiment, rather than its originality. As it was offered to the Society, then, Sturgeon's electro-magnet was meant less for original researches than for the easier replication of

[36] Thomas Willis, "Preparation of the Bulbs of Hyacinthus Non Scriptus," *Transactions,* 1802*,* **20***:* 201-208.
[37] Samuel Bentham, "Method of Preserving Fresh Water on Long Voyages, " *Transactions*, 1801, **19**: 191.
[38] James Ryan, "Method of Ventilating Coal-Mines", *Transactions,* 1817, **34***:* 94-121, at 118.
[39] William Sturgeon, "No. III: Improved Electro-Magnetic Apparatus", *Transactions,* 1825, **43-44**: 37-52, at p. 37.
[40] William Gee, "Sturgeon, William (1783–1850)", Rev. Frank A. J. L. James, *Oxford Dictionary of National Biography*, Oxford University Press, 2004 http://www.oxforddnb.com/view/article/26748, (accessed 26 Jan 2014).

what had already been done.

There was also some alignment between the committee of chemistry and the Society's attempts to encourage colonial projects. This was on the initiative of individual members. Thus in 1760, Dossie moved that the Committee on Chemistry should "take into consideration the planting of curing Rhubarb in the British Dominions, and to settle the manner of an Advertisement for the same if judged necessary."[41] Then, in his capacity as chairman of chemistry, Dossie sought testimony from Miller and Collinson, and called for trials to be made of British varieties, and for seeds to be sent to North America.[42]

Overall, then, the rewards of the chemistry committee present something of a puzzle, more striking for how few of them there were, and for what they did not reward, rather than what they did. This is all the more surprising, given the calibre of working chemists who were intimately involved with the Society: Robert Dossie and William Lewis in its early days, while the chemical lecturer Arthur Aikin served as secretary, and Michael Faraday was chairman of the committee of chemistry. There are three reasons for the committee's apparent inactivity.

The first is the recalcitrance of chemical manufacturers in sharing their processes with the Society, and the controversies in which the chemistry committee became embroiled with Falconbridge and Redmond. Moreover, the Society was more active in this respect than its premiums indicate. At the Board of Trade, the Society's premiums were occasionally used as evidence of the potential viability of English industries, if supported by tariffs. Thus in 1780, when the Commissioners were discussing the possibility of introducing a tariff on verdigris, which John William Anderson from a works at Newnham in Gloucester had petitioned for, the evidence included "[a]n account of premiums given by the Society for the encouragement of arts, manufactures and commerce: Certificates of the goodness of the English verdigrease; And a chemical proof of the comparative purity of the English and foreign verdigrease."[43]

Second, the chemical committee never had a clear view of how useful improvements might be

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[41] FW Gibbs, "Robert Dossie (1717-1777) and the Society of Arts", *Annals of Science,* **7**: 149-172, quotation at 169.
[42] *Ibid.*
[43] "Journal, April 1780: Vol, 87"', *Journals of the Board of Trade and Plantations, Vol. 14: January 1776 - May 1782* (1938), pp. 300-307. < http://www.british-history.ac.uk/report.aspx?compid=77804> (accessed 16 March 2012).

diffused more broadly. Some awards were given for improvements which had been introduced in individual locations – but even had many more examples been submitted, the committee's focus upon novelty would probably have excluded them. Thus, a long-extended premium was offered for the destruction of smoke from chimneys. Only two awards were made: in 1791 to William Pitt from Pendeford near Wolverhampton and in 1823 to George Chapman from Whitby.[44] Pitt described how "my situation amidst the smoke of those great works put me upon the idea hinted at in the 153rd premium of the Eighth Volume of the Society's Transactions; namely, that of destroying smoke, in order to prevent annoyance to the neighbourhood"; the smoke was condensed into "tar, pitch, and varnish." He noted that there were already "three considerable works on the banks of the canal in this county for converting the smoke of pit-coal into the above articles" – their wider employment would require further integration into the ways coal was employed in steam engines.[45] Researching the possibilities of this, he visited tar-works, noting the intelligence and helpfulness of their foremen, and the possibilities for the industry through improved efficiencies. At Wilkinson's works at Bradley, for instance, one hundred tons of coal were consumed a day, about one fifth of which was "actually employed in making Tar," while the remaining "smoke of eighty tons per day, flies away". [46] Despite his assiduous research, however, Chapman's process was worked and witnessed in Whitby, but apparently not transferred elsewhere. Elijah Galloway's 1836 *History and progress of the Steam Engine* mentions it among a raft of other measures for equivalent purposes, most of which were patented, and only a few of which were ever transferred from their original location of use.[47] The Register of Arts noted that

> [n]otwithstanding the premium offered by the Society of Arts in the successive volumes of their Transactions for a long series of years, it does not appear to have been productive of any feasible plans being communicated to the Society, for the consumption of smoke; which may be accounted for by the reward being probably

[44] William Pitt, "On converting the Smoke arising from steam-engines, &c. into Tar", *Transactions,* 1791, **9**: 131-140, at 131; George Chapman, "No. IV: Plan for Consuming the Smoke of Steam-Boilers, &c", *Transactions,* 1823, **41**: 31-39.
[45] Pitt, "On converting"*,* 138.
[46] *Ibid.*
[47] Elijah Galloway, Luke Herbert, *History and progress of the steam engine: with a practical investigation of its structure and application* (London, 1836), 805.

> considered, inadequate to the value of the discovery. We are strengthened in this opinion by observing, that the authors of every crude scheme which had the least degree of originality in it, taking out patents for them.[48]

Again, this suggested that smoke abatement was primarily a technical requirement, in need of a "feasible plan"; the experience of legislation through the nineteenth century indicated that there was no significant technical difficulty, though there was usually considerable resistance from manufacturers to the introduction of such measures.

The Committee of Colonies and Trade granted a total of 123 awards. These showed the most dramatic shift of all the Society's committees. Almost all the awards which were given before 1775 went to the American colonies – the only exceptions were two awards for silk cocoons produced in Minorca, and, in 1773, an award for the foundation of a botanical garden on the island of St. Vincent. In these early years, the Society's association with the colonies was understood by its members and correspondents as affording an opportunity to encourage planters to try new crops, move away from slavery, and adopt new forms of sociability. In Such cases, as suggested above, the Society's premiums were meant to supplement the efforts of the legislature – going beyond them by encouraging risk taking. From Carolina, Alexander Garden lamented that planters were characterised by a caution which amounted to cowardice, a "fatal rock on which most of our Improvers Split, for if One bad Season, or one bad Market Disappointment, they have neither Courage or Resolution to continue."[49] The Society's rewards were meant to temper such cowardice, and to offer alternative social orders of production. Thus Henry Baker wrote to Garden about the prospect of cultivating vines in North America:

> As for cultivating this Vine no other Labour is imposed on the Negroes than what is agreeable to the Laws of Humanity. Poor sandy and dry Land ought to be employed for this purpose, and it is probable more assiduity will be given to it,

[48] Anon, "On Furnaces Consuming their Own Smoke", *Register of Arts, and Other Patent Inventions,* 1829, **3**: 136-140, 151-153, 165-168, at 166.
[49] Alexander Garden to the Society of Arts, April 20th, 1755, transcribed in Joseph I. Waring, ed., "Correspondence between Alexander Garden, M. D., and the Royal Society of Arts", *The South Carolina Historical Magazine*, 1963, **64**: 16-22 at 19.

> because the Work is easy and the Emolument great; hence likewise People from other parts may flock to you; for who can doubt of an increase of inhabitants in that Country where the Laws espouse the cause of Liberty and where Trade increases private fortunes.[50]

A meliorist attitude towards slavery was – if not common – certainly powerfully represented in the early Society. Its vice-president Joshua Steele went in 1780 to plantations in Barbados, and established a sister organisation (which conducted correspondence with London), which meant to reform conditions and focus on the "improvement" of poor whites on the island.[51]

As we saw above, some observers aligned the Society's awards with bounties offered by government, and concerted (though unsuccessful) efforts were made to introduce the culture of silk to Georgia; 11 went for potash manufactured in America, and 10 for silk. Some £2,805 was paid out overall. As with the other categories, many of these awards were for small-scale, exemplary efforts: awards went in 1758 for a solitary effort to raise logwood, in 1772, for groundnut oil from Georgia; in 1766 for sago powder made from "dried sweet potatoes, and vermicelli noodles from soy beans grown in Georgia". Itemising these rewards, Joyce Chaplin adds that

> South Carolina's William Bullen requested in 1770 that the colony's agent lobby in the society's offices on behalf of Christopher Sherb, who was planting vines and making wine. Without assistance, Bull explained "this poor adventurer" had little chance of winning a premium from the society and would then be forced to abandon his meritorious scheme. [52]

Thus, in relation to America, the Society could pose as a bastion of improvement and metropolitan connection.

Following the declaration of Independence in 1776, the geographical focus of the premiums changed – as, to a significant extent, did their goals. Where they had been intended for planters

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[50] Baker to Garden, n.d., quoted in *ibid.,* 21.
[51] See David Lambert, *White Creole Culture, Politics and Identity During the Age of Abolition,* (Cambridge, 2005), chapter two.
[52] Joyce Chaplin, *An Anxious Pursuit: Agricultural Innovation and Modernity in the Lower South, 1730-1815,* (Chapel Hill, 1993), 138-9.

directly, they were now honourific rewards for imperial enterprises. This shift meant that the Society's rewards went, mainly, to colonial officials. Unsurprisingly, then, of the 69 rewards which were given between 1776 and 1840, 36 were gold medals and 20 silver ones; only £290 was paid out in this period overall. A number of awards went for accounts of botanical transfers – particularly in the West Indies and Calcutta, where William Roxburgh sent several communications from the Botanical Gardens. In 1798, Alexander Anderson was rewarded for re-establishing the botanical garden in St Vincent. For Roxburgh, the Society was one part of the larger learned empire with which he communicated. By 1839, a medal was given to the chairman of the East India Company for tea produced in Assam. The Society was celebrating what its members took to be a great colonial enterprise; there was no suggestion that its interest had any direct effect on these activities.

The exceptions to the general shift towards rewarding activities which were already happening was a brief attempt to support the cultivation of hemp in Canada, for which eight awards were made between 1804 and 1806. Somewhat perplexingly, exportation of British cured herrings in imitation of the Dutch were also rewarded in this class, and in fact received the largest pecuniary rewards of this period, with £50 paid to J. F. Denovan in Fifeshire in 1819, and the same amount to the same candidate in 1823.

Overall, then, the rewards in Colonies and Trade shifted from the idea that the Society itself could be the direct means of promoting new colonial industries with improved productive practices, to a clearinghouse for botanical information submitted from the colonies, to retrospective support for imperial adventures. This had obvious institutional reasons, reflecting the different colonial ethos in North America, India and the West Indies (the Society would never have countenanced paying premiums directly to Indian cultivators, for example). It had a perhaps surprising additional effect: the Society's meliorist involvement in America was one which allowed for at least some direct contact with planters, and the belief that their practice could be reformed by means of the Society's encouragements. This put the Society in step with rewards given by Government, and also meant that quite a number of American improvers who had common goals corresponded with London; the Society was also a model for Steele's organisation. The disappearance of this point of contact was perhaps the most decisive loss which the Society's broad

public ever suffered; later on, when individuals like Roxburgh and Anderson who happened to communicate with the Society died, they were not replaced.

4. Conclusion

Overall, then, we can see that each of the Committees functioned in a slightly different way. In the early years, the premiums were close to government bounties, intending to diffuse good practice; they also had an exemplary aspect, proving what could be done if people were willing to take risks. This was particularly true in agriculture, in the madder plantations; in mechanics, with the reward paid to Stansfield's crane, and all the premiums for improved harpoons; and in Colonies and Trade, with the Society's various efforts to support particular "adventurers".

With the general shift away from reasonably high-valued pecuniary awards which occurred within all the Committees (though at slightly different paces), honourific rewards were much more heavily emphasised. This means that the comparison with patents, as an inducing reward for original invention and monopoly right for its exploitation, is quite misleading because in many areas, candidates in Mechanics were using the Society as a way to gain direct patronage for their inventions or projects; in this capacity, the Society acted alongside a number of other institutions and patrons. In agriculture, improvers used their premiums to draw attention to their local achievements; for naval inventors the Society was among a number of institutions which could grant rewards and lead to the purchase of inventions by the Navy: this was a far greater prize than a patent might represent.

Finally, and following from this, the rewards were personalised: they were intended to show that improvements – including minor ones – were worthy of recognition, and could be associated with particular individuals. At the same time, there was relatively little of the direct face-to-face contact and emphasis on local service which characterised the awards of the Bath and West of England Society. The Society of Arts was far less settled in a particular locality than that, even though the submissions which accompanied premiums described rich local achievements.

How might this alter our view of the Society's public, as this was described in the previous

chapter? First, it should be a reminder that candidates for premiums were resourceful, and had many sources of patronage other than the Society. In many cases they were using it for their own reasons, to publicise and gain credit for their own local achievements. It was quite rare that a single project seized the imagination of the Society, or attracted a significant number of entries over time: the exception to this was some of its colonial projects, and the enthusiasm for straw hats (which I will discuss in detail in chapter seven).

Second, it should be a reminder that despite the claims of its early members, the Society's rewards usually had a very slight effect on the world outside. Instead, they responded to fashions from the world beyond the Society's rooms – whether for planting trees or rhubarb, or for lifeboat schemes, or improved fire escapes. Historians of scientific rewards sometimes write as though natural philosophers and scientists respond directly to the systems of inducement and encouragement, and opportunities for advancement, which different rationales of reward represent. While this may be true at some times and in some places, it was generally not the case at the Society of Arts. Rather, the rewards allowed the Society's members and eminent officers to play the role of patrons of the nation, by indicating their concern with significant schemes. This was not without effect in all cases (as Roberts' case from the previous chapter, and many other premium winners who will be described hereafter should suggest); however, it would be misleading to suggest that the Society's premiums very often led, directly, to anything by themselves. Instead they represented a (sometimes quite respectable, but often small) part of a much wider public world of projects and improvements.

One of the tensions which has played through my description of each one of the committees is that between exemplary but experimental achievement and the diffusion of existing practice. This was, I would suggest, the central issue which the premiums actually raised. How they did so is the subject of the next chapter.

Chapter Four: Anecdotes and Experiments

1. **Introduction**
2. **Exemplary Experiments**
3. **Silk and other Experimental Materials**
4. **Conclusion**

1. Introduction

We have seen the variety of the Society of Arts' premium awards, as well as a paradox which ran through them about whether they were intended to encourage exemplary practice, or the diffusion of known techniques through a wider area. This chapter departs from this observation, by relating it to general problems in eighteenth century knowledge. The Society's members were far from unique, during the eighteenth century, in wrestling with questions of the relation between singular achievements and their relation to existing practice.

I want to use this chapter to critique some of the arguments about agricultural improvement which I reviewed in chapter one. As I noted there, a key point in these arguments is about the effect of the conversion of farms into cash values, which led to a loss of emphasis on local place. I agree that this was certainly the rationale and rhetoric of agricultural improvement for organisations like the Society, and that similar ideals can be seen in the Society's other areas of concern. In practice, however, agricultural experiments usually could not enable the forms of control and surveillance for which improvers longed in their written works, because questions kept arising about how far their conclusions could be generalised and how far they were connected to contingencies of time, place, and local connection. This led to problems which improvers recognised, and led them to adopt different strategies – creating richly detailed local surveys and drawing on extremely personalised, anecdotal accounts. So if we are focusing on improvement as experimental practice, rather than as a strategy of legitimation, we need to examine the effects of these other ways of reporting and knowing.

In section two, I describe how the tension between the two played out in the Society's rewards

for agriculture, and the partial solution which Arthur Young discovered for this problem by conducting regionally detailed surveys of existing practice. I then then discuss the broader interest in surveying during the eighteenth century, through the rise of what Joanna Innes has termed the "sciences of wealth and happiness". Members of the Society of Arts were intimately involved in these attempts to gather information which was simultaneously richly detailed, and reasonably comprehensive in its scope. Surveys could not do away with singular instances, however, and for an organisation like the Society, local acquaintance and personal knowledge might seem to trump larger aggregations of data. I suggest that we should understand such reports as anecdotes, a mode of writing emphasising particularities in ways which disrupt more systemic accounts.

The attempt to connect anecdotal, local reports with ideals of wider practice and publicity was not confined to social policy, however; rather, it extended throughout the Society's activities. Taking the example of letters submitted to the Society on the subject of cultivating silkworms in England, and the production of silk from garden spiders, section three analyses how the Society's contributors attempted to make extremely rich, local, and domestic reports into public knowledge. While this did not produce the industry to which they aspired, their reports continued to circulate as natural historical curiosities, or proofs of alternative possibilities. Such anecdotal achievements thus had a strange double aspect: they were "failures", but they were also exemplary, in that they proved what might be done. In conclusion, section five discusses the implications of these exemplars and anecdotes for the idea and role of the public at the Society of Arts; it also sets the scene for the Society's involvement in projects of particular aspects of natural philosophy, which are the subject of subsequent chapters.

2. Exemplary Experiments

When the Society first debated whether to offer premiums for agricultural improvement, Trueman Wood claims that William Shipley offered a puzzling objection: "that all the awards would

be taken in those districts of the country in which the greatest progress had been made."[1] While it may seem strange that the Society's founder objected to rewarding the best practice in agriculture, he had recognised a problem which wound through the Society's premium awards. Were premiums meant to go to exemplary achievements in privileged locations by skilled cultivators, or to encourage a wide diffusion among a broader group? The two goals did not need to be contradictory, but in practice there was some conflict between them. The main object of the Society's agricultural attentions during the 1750s was the cultivation of madder. To this end, it paid out more than £1,400, to 87 separate claimants. Madder was not exactly an experimental crop, having offered a form of alternative husbandry from the medieval period.[2] At the same time, gentlemanly contributors to the Society wanted to claim special privilege for its cultivation. John Arbuthnot claimed that it was difficult for men of means to compete with "men who attend to the lowest minutiae of the business, and live as much by frugality as agriculture"; gentlemen should prefer the culture of "such rich vegetables, as would yield a profit considerable enough to pay for an accurate expensive culture", a style of farming which would take much less trouble and fatigue than the common practice.[3] What remained ambiguous was how far the cultivation of madder should be disseminated more widely, and how far it could remain the preserve of gentlemen. The Dutch price was said to have grown exorbitant during the 1750s, and parliament agreed to remove tithes on the crop, in an act of 1758. Arbuthnot came before parliament to describe how the English crop had superior properties compared to imported varieties. [4]

In describing the ultimate effect of the Society's awards for madder cultivation, Robert Dossie again emphasised their exemplary character:

> the Dutch have been deterred by them from the raising the price of this commodity, so necessary to us, to a still greater height. For the States themselves, sensible of the strong reasons for keeping this article out of our hands, have

[1] Henry Trueman Wood, "The Royal Society of Arts. V.—The Society and Agriculture. (1754-1830)", *Journal of the Royal Society of Arts,* 1909**, 59:** 1108-1118, at 1108. I have not traced the original source for this claim, which Trueman Wood does not provide.
[2] Joan Thirsk, *Alternative Agriculture: A History, from the Black Death to the Present Day,* (Oxford, 1997), 104-118.
[3] Arthur Young, *The Farmer's Tour Through the East of England,* (London, 1771), 264. Arbuthnot's own practices of cultivation were learned in Holland. See *Ibid.,* 265-6
[4] *House of Commons Journal*, 1765-6, **30:** 171.

> checked, as far as they could, by the strictest prohibitions, the depraving it, when sent to our market, by adulteration.[5]

In this view, English madder was not straightforwardly a marketable commodity, but rather an example about what could be achieved, if the need arose. This was quite typical in the Society's awards: the premium for osiers was offered in 1794, for example, because they had become scarce in England, and their price had risen, due to the "want of importation of the rods from France, from whence many used to be bought."[6] When this temporary disruption ceased, the price of English osiers collapsed. Dossie argued, of the failure to encourage another alternative crop, "since the advance of the rate of labour, and the price of manure, the farmer can employ his land and stock more profitably in the culture of corn, or other articles, than of hemp."[7] The same logic obtained for straw hats, timber supplies for the Royal Navy, the production of potash and salt-peter, and dyes and fibres made from English and colonial materials. It meant that the Society was – oddly for an institution concerned with commerce – usually fairly remote from actual manufacturing or productive practice, but rather concerned with possible alternatives, exemplary instances, experimental demonstrations of what could be done – and would be done more generally, if circumstances changed.

The exemplary nature of many of the premiums is related to their status as experimental accounts. Arthur Young wrote admiringly that Arbuthnot "had no guides to follow, but such as led him much astray: he found no directions in books, but such as lost him considerable sums of money. Under these disadvantages, with that universally acting one, the want of experience, it is astonishing, that the crops here minuted should turn out profitable on the whole."[8] Eighteenth-century agricultural writing sought to demonstrate the value of different forms of culture by being presented in the form of financial accounts. But this raised very significant questions about the replicability of any particular culture – in different climates, locations, and market conditions. These problems were widely recognised, and improvers developed sophisticated ways to talk about these

[5] Robert Dossie, *"*Of the Improvements in Agriculture," *Memoirs of Agriculture,* 1768, **1** : 36-88, at 45-6.
[6] Anon, "Preface", *Transactions*, 1793, **11** : i-xii, at xii.
[7] Dossie, "Of the Improvements", 53.
[8] Young, *Farmer's Tour,* 325.

problems of the locality of singular experiments. In particular, Arthur Young's view on the nature of agricultural experimentation shifted quite dramatically over time. Late in his life he recalled how

> soon after the period of His Majesty's accession Sir Digby Legard in Yorkshire, Mr. Coville in Cambridgeshire, Mr Reynolds in Kent, Mr Billing in Norfolk, with a few other persons, communicated to the Society of Arts some valuable experiments. These were published by Mr. Dossie in 1768: previous to which date, it is now difficult to conceive how little was publicly understood of all that is most important in the improved practice of Agriculture.[9]

This associated improvement directly with named experimentalists. Young's own practice, however, had come to focus increasingly on surveys of existing practice rather than primarily on experiments, which he had come to consider problematic.

The early editions of Young's *Annals of Agriculture* record numerous singular experiments: but even where accounts were given to show the profitability of a particular method, particularities of soil and situation. Young recognised this even when he continued to report singular experiments. An observation of 1771, for example, noted that "this experiment is absolutely decisive; comparisons are drawn up between the old and new husbandry, from the various culture of different fields; but unless a perfect similarity respecting soil, time &c. be observed, no conclusions can be drawn from them."[10] Although agricultural experiments might be presented in rhetorically convincing reports, it was rarely possible to isolate the contribution of weather, soil, crop quality and particular styles of farming. A correspondent to the Bath and West of England Society claimed that "the farmers could not, or at least would not, see the difference between a crop failing through *improper management,* and through a natural unfitness of soil or climate, which would in all cases operate against it."[11] Already by 1770, Young had come to accept that the singular experiment was problematic: "it is impossible from single experiments, or from a great number in different lands,

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[9] Arthur Young, *On the husbandry of three celebrated British farmers, Messrs. Bakewell, Arbuthnot, and Ducket*, (London, 1811), pp. 29-30, quoted in Pamela Horne, "The Contribution of the Propagandist to Eighteenth-Century Agricultural Improvement." *The Historical Journal*, 1982, **25:** 313-329.
[10] Arthur Young, *A Course of Experimental Agriculture,* (London, 1770), 174.
[11] A Gentleman in Dorsetshire, "Culture of Madder Recommended," in Bath and West of England Society, eds., *Letters and Papers on Agriculture, Planting, &c,* 1783, **2**: 133-135, at 133.

separately considered, to deduce a satisfactory proof of the superiority of any method."[12] The hope was of course that they could be effectively aggregated. William Marshall thundered about the possibility of complete control: "to make an Authentic Experiment, an identity of Place, Time, Element and Process must be strictly observed in every particular…Nor can the Experiment be authentic, if the Process be in any instance left to an Agent; it must be performed by the immediate hand or under the immediate Eye of the Experimentalist."[13] As a practice this could be regarded as akin to what Arbuthnot was claiming on behalf of his precise, accurate, culture of madder; but as we have seen at the Society the boundary between experiment and standard cultivation was continually blurred. In this context, the demands of the experimentalists was for a practically impossible degree of precision, which would struggle to be diffused into common practice (because replicability of any such carefully observed results could not be guaranteed). Others in the Society's circle emphasised the common theme of the demands of repeated experiments. Echoing the common refrain of the need for experimental proof, Sir Digby Legard wrote in 1763 that "I would reject the most plausible theory if unconfirmed by experiments" and added that "even experiments themselves, if they are not executed with care, often varied in different soils, situation and circumstances, and repeated several years, are too apt to mislead". At the same time, Legard claimed that "[a]fter ten years' constant and very extensive practice, after the experience of a great variety of soils and seasons, I can recommend the drill and horse-hoeing culture as founded on reason and truth"; but such reason was founded on *experience*, rather than *experiment*, and from Young's perspective at least this rendered them suspect. For this reason, Young's communications with the Society stressed the extreme inconclusiveness of field trials, writing to Samuel Moore that "I hope… that you are endued with a good stock of philosophic patience to see the triumphs of drill ploughs and horse-hoes. I perceive however that you so far agree with me that the point *is not yet ascertained.*"[14]

Although they were intended to prove the value of precise observation and control, then,

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[12] Young, *A Course*, xi, quoted in Liam Brunt, "The advent of the sample survey in the social sciences," *Journal of the Royal Statistical Society: Series D (The Statistician)*, 2001, **50**: 179-189, at 181.
[13] Quoted in Simon Schaffer, "The earth's fertility as a social fact in early modern Britain," Roy Porter and Mikuláš Teich, eds., *Nature and society in historical context,* (Cambridge, 1997), 124-47, at 142.
[14] Quoted in Derek Hudson and Kenneth Luckhurst, *The Royal Society of Arts, 1754-1954* (London, 1954), 75.

agricultural experiments introduced difficulties which could not easily be resolved. Liam Brunt argues that this was the reason that Young adopted the surveying techniques of his farmer's tours, which were subsequently adopted by the Board of Agriculture.[15]

In adopting surveying techniques, Young was part of a more general trend, in which the Society of Arts was also involved more widely. Joanna Innes has termed these projects the "sciences of wealth and happiness", which included the County surveys of the Board of Agriculture, the immense compilation of information about local poor-law administration of Frederick Eden's *The State of the Poor* in 1798, and the statistical surveys of Scotland compiled by Sir John Sinclair in 1791 and 1792.. These were unlike both the standardising statistical data of the nineteenth century and seventeenth century's political arithmetic's emphasis on state power in the emphasis which they placed on particularities of practice, combined with a broad geographical sweep. During its first two decades a few statistical works were published with dedications to the Society – notably Adam Anderson's *Historical and Chronological Deduction of the Origin of Commerce* of 1764. As Innes puts it:

> within this evolving matrix – of official and unofficial information-gathering and interpretation both building upon and refining previously established lines of enquiry – new forms of investigation began to take shape. Richly detailed, locally focused, and combining verbal description with quantification, these sought to contribute to an understanding of national trends and processes through the close study of local instances – but at the same time to illuminate *variation* in experience, and the ways in which such variation was shaped by particular constellations of circumstance. This way of modeling the nation – as a concatenation of local communities which, aggregated, constituted the nation, but which were at the same time each particular, presenting their inhabitants with their own special mix of peril and opportunity – provided a rich and interesting basis for understanding the many forms of fit and misfit that might exist between national power and

[15] Brunt, "The advent of the sample survey".

wealth and individual happiness.[16]

Despite their power in combining particular descriptive richness with broad geographical scope, however, surveys had a complex relation with achievements which were more experimental, particular, or personal. To appreciate this difficulty, it is worth recalling what historians have told us about different styles of reporting factual and experimental information, and how these shifted in their typical form between the seventeenth and eighteenth centuries. Lorraine Daston gives a stark but suggestive formulation:

> the prototypical scientific fact mutated between circa 1660 and 1730, from a singular and striking event that could be replicated only with great difficulty, if at all, to a large and uniform class of events that could be produced at will. The texture of description of nature changed accordingly, from long accounts bristling with particulars to concise reports made deliberately bland by summary, repetition, and omission of details.[17]

By the later eighteenth century, Daston writes, "[l]ocal specificity had officially disappeared from nature along with all other forms of diversity and variability."[18] Eighteenth-century singular agricultural experiments were not committed to recording the wonders and the variety of properties which Daston expounds: equally, however, they remained caught up in local circumstance. Moreover, it remained unclear how many local particular circumstances they needed to specify in order to communicate their embeddedness in a certain soil and situation. This meant that even though they arose from a view of nature as regular, they could be exceedingly particular, describing a singular course of events, subject to variations in weather and prices, availability of labour, qualities of seed and the other whims of providence.

Disparagingly, one might describe such reports as anecdotal. But the anecdote had its own particular salience within eighteenth-century factual reporting. Again, this didn't meant that nature

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[16] Joanna Innes, *Inferior Politics: Social Problems and Social Policies in Eighteenth Century Britain*, (Oxford, 2009), 143.
[17] Lorraine Daston, "Description by omission: Nature enlightened and obscured," in John B. Bender and Michael Marrinan, eds. *Regimes of description: In the archive of the eighteenth century,* (Stanford, 2005), 11-24, at 13.
[18] *Ibid.,* 23.

itself might be disordered by wonders, but rather that mundane singular instances, full of particular detail, might have significance. As it was first used in English, "anecdote" was closely associated with "secret histories", revelations of the private dealings of public men; over the course of the eighteenth century, it came to take on a significance which was at once more concrete and more quietly subversive.[19] Andrea Loselle suggests that anecdotes' "singularity and sometimes their very inanity or offensiveness – the grounds on which they are more frequently dismissed than responsibly refuted – tell us more about the whole than do the histories and treatises that eschew their evidence."[20] Anecdotes suggest the atypical and exemplary; they indicate how things *can be* in a particular situation, the obstinate facts which refute all systematics rather than a survey of general practice. As such, they are at once miniaturist and capacious: small in scope but with no formally specified closure about the range of details – of labour, materiality, social background – which they might include.

Part of this stemmed from the way that anecdotes personalised things, making it unclear which details should be included. On the most absurd level, *The Monthly Review* thought that Robert Dossie had erred in his first compilation of the Society's work by "swelling it out with a quantity of *superfluous* matter, loosely printed."[21] These inclusions were problematic precisely because they blurred the boundary between public matter and private gift: "probably most readers may think that the *card of compliments* […] attending a present of '*a bit of butter'* made from the milk of cows fed upon his turnip-rooted cabbage might have been omitted, without much loss; – especially as the Society's opinion of the said butter is not added."[22] Dossie, however, had no clear criteria for which particulars should be included; whether social niceties and compliments to the Society were relevant and worthy of publication. This uncertainty as to which details to include captures in miniature the anecdotal quality of many of the premiums which the Society received.

I realise that it is slightly perverse to characterise the 'anecdote' as a genre of factual writing. I do

[19] "anecdote, n.". OED Online. December 2013. Oxford University Press. http://www.oed.com/view/Entry/7367?rskey=XriHAM&result=1&isAdvanced=false (accessed January 29, 2014).
[20] Andrea Loselle, "Introduction", in *SubStance* 2009, **38**(1): 3-4, at 4. Cp, Paul Fleming. "The perfect story: Anecdote and exemplarity in Linnaeus and Blumenberg," *Thesis Eleven*, 2011, **104**: 72-86, and Jack Stillgoe and Alfred Moore "Experts and Anecdotes: The Role of 'Anecdotal Evidence' in Public Scientific Controversies," *Science, Technology & Human Values*, 2009, **34:** 654-677.
[21] Anon, "Dossie's Memoirs of Agriculture, etc", *The Monthly Review,* 1769, **40**: 149-153, at 153.
[22] *Ibid.*

not mean to suggest that it was consciously adopted. Instead, the reason to employ such a term is to draw attention to the combination of the local, particularist nature of achievements which were embodied in the premium awards, with the ambiguous question of which details should be included, and their tendency to remain based on personal judgments. Where systematic writing could be very precise about what did and did not count, factually, anecdotal reports were much more open. Would further specification and detailing allow a given achievement to be recreated? How many of the private details of production, cultivation and management had to be noted for an achievement to be successfully transferred? And how would the knowledge which was produced in this way continue to circulate? In the next section, I want to exemplify these problems through a remarkable series of letters which the Society received in the early 1780s, concerning the possibility of rearing silkworms in England.

3. Silk and other Experimental Materials

Efforts had been made to introduce silkworms to England from the time of James I (who was emulating the French success); success had always been held to depend on the availability of mulberry trees – a nineteenth century source referred to the efforts of "King James, Mr Walter Aston, Mr John Appleton, the British Silk Company, Miss Rhodes, Mrs Williams, Mrs Allen, Mademoiselle Coge, and others," efforts it called "highly laudable, because if it could be made a profitable employment for country persons, much good might result therefrom".[23] It then summarised the variety of approaches which had been adopted: "some had warm buildings constructed purposely for the reception of the silk-worms: others devoted unremitted personal attention to their little charge; but none obtained very promising results."[24]

What was striking about the letters submitted to the Society of Arts was the way in which particular, domestic, circumstances were entwined with the narration of silkworm culture – and the openness about the question of which details were relevant to the report. In the most remarkable of

[23] Anon, "Useful Insects and their Products", *The Journal of Agriculture,* 1851, **4**: 57.
[24] *Ibid.*

the letters, two almost entirely contradictory visions of silk-worm culture were imagined: one, from Ann Williams of Gravesend, offered an intensification of benevolent domestic management; the other, from Henrietta Rhodes, of Bridgnorth Hall, envisioned establishing a proto-manufactory on a larger scale.

Gender was a significant part in this, in that silk-worms were kept as pets by young women, and discussions of their cultivation were inflected with the question of how they were moved from highly intimate to more visible spaces. According to G. Swayne, who also wrote to the Society with general observations about the worms:

> the eggs of silk-worms have, in this country, been generally consigned to the care of young people, and chiefly those of the female sex. They have been preserved in bureaus, and chests of drawers, in rooms where fires have been constantly kept during the winter season. In the spring, as soon as the influence of the sun began to be powerful, the eagerness of youthful curiosity, has caused them to be removed to windows, where the sun exerted its full power: and in this situation they have been generally forced into existence, within a few hours, in a season, when the temperature of the air was unfit for them, and when their proper food could not be procured.[25]

Ann Williams kept her "innocent reptile" in a "woman's large hat box"; she fed them four times a day; cleaned them regularly; watched them with tender sympathy. She referred to them repeatedly as "my little family".[26] This was pragmatic management as well as solicitous care:

> [i]n a Morning they are always upon the leaves. I take them out gently upon them, and when the box is cleaned, I lay them in, on the same leaves, with fresh ones over them (with the dew on, if I can get them) and the fibre side of the leaves up: when they are all on the upper leaves, I

[25] G. Swayne, "Letter in Manufactures," *Transactions*, 1787, **5**: 141-180, at 156. On connections between bureaus and privacy more generally, see Amanda Vickery, *Behind Closed Doors: At Home in Georgian England*, (New Haven and London, 2009).
[26] Ann Williams, "Letters in Manufactures", *Transactions*, 1784, **2***:* 153-171, at 154.

> remove the old ones; by this method a quantity of silk is saved, for, from the moment they are hatched, they move themselves by a silken web; the silk continually issuing from their mouths, if they crawl to any distance.[27]

As such she did "not approve of the method used here of striking them with a feather off the leaves to which they strongly adhere, as every time that practice is used, they not only lose a quantity of silk, but are visibly in pain […] by these means, and keeping them dirty, they [other cultivators] do not rear one tenth part of what they hatch, or bring them to any size, though at the appointed time they will spin, but the silk is not worth mentioning."[28] The minute scale of her observation was mirrored by her attitude towards the silkworms' production. For Williams, nothing was waste: the scrags of silk which could not easily be wound were for making silk flowers; even the worms' dung could be used as a styptic for wounds and tried as a fertiliser.[29] Williams also attempted to substitute the silkworms food of mulberry leaves with lettuce, cowslips, and a number of other locally available plants. The size of the tiny creatures seemed to keep shifting, like her close eye upon them had a magnifying effect. She described them "rearing like sphinxes"; when the worms appeared to thrive she said that "I joke and tell all whom curiosity induces to see my little family they shall be big as bulls and cows."[30] Fattened bulls and cows were the subjects of agricultural shows, public scrutiny: the growth of the worms, their greedy avid feeding on lettuce and blackberry leaves, suggested that observations could have application to a world beyond Williams' hatbox. She promised to communicate further investigation, in terms which contrasted her own present obscurity with the potential public future of the industry:

> and now, my good Sir, to be serious, the immortal honour which your Society have bestowed on me, calls forth every grateful sentiment of my heart; and your illustrious body may depend nothing shall be wanting in me to fling a light on what may be of service to thousands after death has drawn a veil over my face, and

[27] *Ibid.,* 158.
[28] *Ibid.,* 160.
[29] *Ibid.,* 167.
[30] *Ibid.,* 170.

> covered me with the dark mantle of the grave. Exulting thought! That my poor endeavours may one day prove beneficial to my Country![31]

If such passages appeared in a novel of this period, or in personal letters, we would not hesitate to read the negotiations of intimacy and public-facing privateness as a way of defining a position imaginatively. That was what Williams was doing as well, her practical ideas about the properties of the silk intertwined with the idea of the uses to which intimate management could be put.

Henrietta Rhodes was in a different situation. She was unmarried and living at Bridgenorth Hall; her silkworm letters were one of a number of attempts to find a public position for herself. She subsequently wrote a novel about Italy which was noted for its striking inaccuracy, as well as a number of books of verse.[32] Her description of her own way of rearing the worms, published in 1784, emphasised how it could be combined with other activities. She reported to the Society that "they had no other attendant than myself", and neither her "amusements nor other avocations" were interrupted by their care.[33] Kept outside, they were undisturbed by music, and little injured by the cold except when they were young. One night, though, there was a thunderstorm, and Rhodes came down in the morning to find the pans in which she had kept them filled with a pale golden liquid, and all of the animals dead.[34] She believed they must have been struck by lightning, as thunder by itself could not have had so dramatic an effect.

Soon, however, she found them more difficult to manage than she had expected, and felt her pity roused: "as they grew larger, they became so extremely voracious, that I felt the most mortifying apprehensions lest a famine should ensue; and my compassion for the industrious little animals who depended on me solely for their daily food and support, was so abundantly excited, that the preservation of their lives became an interesting object independent of the advantages I had proposed to myself."[35] She sought mulberry trees nearby, some ten miles away, and "the kindness of many friends enabled me to send every day." This indulged negligence gave grounds to

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[31] *Ibid.,* 171.
[32] Anon, "Obituary: Henrietta Rhodes", in *the Annual Biography and Obituary for the Year 1818,* vol. 2*,* (London: Longman, 1818), 385
[33] Henrietta Rhodes "Letter in Manufactures", *Transactions,* 1768, **4**: 147-170, at 153.
[34] *Ibid.,* 152.
[35] *Ibid.,* 150.

criticize Williams' approach to the worms (which she had read in the Society's *Transactions*), in an account which wove her own mischance into their natural history:

> Mrs Williams thinks that the Silk Worm wastes its silk by being moved incautiously, but a power of throwing out a fine thread in its very early state, is enjoyed also by various other insects, and was given, no doubt, by providence to prevent the extinction of the whole species, by violent rain or wind; by this thread they still hang suspended and resist a torrent of water unless lightning snap the web, together with their lives.[36]

Rhodes continued her experiments through 1787, when she wrote to the Bath and West of England Society. She had now decided that rearing silkworms was good for her health: "In the summer in which I fed upwards of 30,000 in one room, nobody was the worse for attending them; and yet I frequently spent whole days with them, as did many of those friends who were kindly attentive to assist me in the care of them."[37]

Rhodes' letters were widely republished, and continued to be referenced well into the nineteenth century, and her conclusions were usually claimed to have disproved Williams' approach.[38] They offered results which kept being rediscovered. As late as 1838, a subscriber to the North American *Silk Grower and Farmer's Manual* noticed an obituary he had found in the *Gentleman's Magazine,* of Nathaniel Rhodes, which describe him as the "father of the celebrated lady of that name". According to the obituary, Rhodes was "well known in the Republic of Letters, by her valuable Observations on the Economy and Management of Silk-worms, which […] procured her the applause of those learned but cynic critics, the Monthly reviewers."[39] He wondered whether "the work so highly spoken of is known amongst us?"[40] Peter Nouaille from Greatness in Kent and Mr. Bertizen published pamphlets on their silk-worm culture, in support of Rhodes' claims: they noted

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[36] *Ibid.,* 168.
[37] Henrietta Rhodes, "On the Healthiness of Managing Silk Worms", in *Letters and Papers on Agriculture, Planting, &c. Selected from the Correspondence of the Bath and West of England Society for the Encouragement of Agriculture, Arts, Manufactures and Commerce,* 1792, **4**: 319-322, at 320.
[38] Republication of Rhodes' letters: e.g. *The Scots Mechanics' Magazine,* 1825, **12**: 95; *The English Review, or an Abstract of English and Foreign Literature,* 1789, **12**: 271.
[39] A Subscriber, "For the Silk Grower", *The Silk Grower and Farmer's Manual,* 1838, **1:** 229.
[40] *Ibid.*

that Britain's climate was in fact propitious for silkworms, as "heat is in general much more destructive of this insect than cold, and can be warded off with much greater difficulty – Thunder is peculiarly destructive to them. And as thunder is much more rare in Britain, than in warmer regions, it would, of course, be a much less hazardous article here, than in the countries where silk has usually been hitherto produced."[41] Informed of Rhodes' conclusions, General Mordaunt attempted to rear silk-worms on lettuce inside a greenhouse: "they prospered as well as any worms could do, few or none of them died; and they afford as fine cocoons as if they had been fed upon mulberry leaves."[42] The *Encyclopedia Britannica* noted that "[a]s far as one experiment can go, this affords a very exhilarating prospect in many points of view."[43] For James Anderson, musing on "Rearing Silk-Worms in Scotland", "if this branch of rural economy could be introduced into this country, it could be carried on under the direction of a class of persons admirably well qualified for that business, and it would afford to them a beneficial employment." They were

> businesses that cannot be properly performed but by females. The delicacy, the cleanliness necessary, and the lightness of the work, shew, that it ought to be appropriated to them. Now, there are many widow ladies in Scotland, who have got a very genteel education, that have but a very moderate income to live upon; these ladies and their daughters, are in want of some employment that would produce a reasonable return of profit to help them to live, which was at the same time so light, as not to subject the body to greater exertions than could be easily born, and so genteel, as not to degrade the person to the rank of servants who engaged in it.[44]

Rhodes' experiments provided occasions for further inquiry, and proved that respectability and worm culture were not mutually exclusive.

Nineteenth century entomological works, such as Captain Thomas Brown's 1832 *Book of Butterflies, Sphinxes, and Moths,* and a range of literary miscellanies which plagiarised it, incorporated

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[41] James Anderson, "Rearing of Silk Worms in Scotland", *The Bee: Or Literary Weekly Intelligencer,* 1791, **2**: 237-239, at 237.
[42] Reported in *Encyclopedia Britannica,* vol. 17, part 2, (Edinburgh, 1797), 482.
[43] *Encyclopedia Britannica,* fourth edition, vol. 19, (Edinburgh, 1810), 360
[44] Anderson, "Rearing of Silk Worms", 238.

extremely long extracts from Rhodes' experiments and attempted to renew discussion about growing mulberry trees in Britain. Within these books, however, Rhodes' experiments were contextualised internationally, set alongside efforts to introduce the industry into the Brabant region of Hungary (Brown thought the "Hungarian character" was particularly poorly suited to cultivation).[45] John Murray published a pamphlet on the culture of silkworms in 1826, and reported his own experiences touring in Italy.[46] Henry William Dewhurst, in his 1839 *Treatise on the Natural History and Management of the Phalaena* censured Ann Williams' conclusions: "[i]t is proper, that I should observe, that these experiments of Mrs. Williams are not confirmed by those of any other persons; but on the contrary, that Miss Henrietta Rhodes was unsuccessful in her endeavours to repeat them, and succeeded only in reconciling her silkworms to the use of lettuce and spinach."[47]

The silkworm experiments, as unprepossessing as they were, thus continued to circulate as factual knowledge about the properties of these animals, as a shining instance of what could be done, more than sixty years after they were completed. This was presumably because they were readily obtainable in the Society of Arts' *Transactions* and in earlier works which republished them. Discussion of the introduction of the industry was always about both its commercial viability, and the moral economy of how production might be performed (should it be by respectable ladies?), as well as the logistical difficulties which food substitution or the production of enough mulberry leaves posed. Anecdotal curiosities abounded among the Society's rewards for manufactures, hovering on the line between experimental industry and natural history. In 1833, Daniel Bolt was given a premium for the thread he had wound from a green garden spider: the premium report noted the earlier interest of the French Academy of Sciences in spider silk, and the judgment that Reaumur had passed that it could never be viable. Bolt's spider, which he attached to a "small reel with the steam-engine of the factory in which he is occupied, and putting it in motion, at the rate of 150 feet per minute, found that the spider would thus continue to afford an unbroken thread during from three to five minutes."[48] It produced more silk than a common spider, but still less and

[45] Thomas Brown, *The Book of Butterflies, Sphinxes and Moths,* Vol. 2, (London, 1832), 178.
[46] John Murray, "Culture of the Silk-Worm", excerpted in *The Mechanics Magazine*, 1826, **5**: 328.
[47] Henry William Dewhurst, *A Familiar Treatise on the Natural History and Management of the Phalaena,* (London, 1839), 71-2.
[48] Daniel Bolt, "Silk from Spiders", *Transactions*, 1838, **48**: 234-236, at 235.

weaker than a silkworm's. Moreover "spiders are not so easily confined as silk-worms, and whenever two come in contact, a battle ensues, which ends in the destruction of the weaker one."[49] It was therefore necessary to confine them in cells; Bolt had constructed an apparatus which "although very ingenious and well adapted to carry on a course of experiments with a hundred or two, would manifestly be wholly inapplicable to any purposes of commercial utility." The report concluded that Bolt had "made some interesting additions to the history of the garden spider, and has obtained the silk in its natural state; exhibiting all its peculiar lustre: his method, likewise, of winding the silk directly from the animal is, to say the least of it, effectual and ingenious."[50]

These singular material achievements were typical of the kinds of scheme recommended to the Society of Arts in their mingling of particular circumstances, moral idea, and experimental ardour. They were also typical because, despite their local interest and curiosity, they did not lead immediately to any productive industry.

4. Conclusion

This chapter began with the observation that the Society spoke of diffusing good existing practices, and that this goal was in tension with the experimental, local nature of many of the achievements which candidates for premiums described. In the case of agriculture, this tension was recognised and partially resolved by large-scale surveys, which meant to contain information about common existing practice and valuable achievements. The kinds of activity which the Society supported, however, often meant to emphasise possibilities – showing what could be done if risks were taken, or alternative approaches tried. In communications of these subjects, premium candidates were intensely localist, even personal; the question of how such practices could be generalised was a considerable problem for the Society, and a significant constraint on the effects of the premiums. In cases like the silkworm letters, local achievements continued to circulate as puzzling facts of natural history, even though they did not directly lead to any new industries.

What did all this entail for the public of the Society of Arts? The local achievement which so

[49] *Ibid.,* 236.
[50] *Ibid.*

many of the premiums represented contributed to the sense that the Society was gathering knowledge from all corners of the kingdom and its colonies, open to improvements whatever their source. It also meant that the Society was not a controlling, privileged, centre – the other side of the rich particularity and local detail of the premiums was the scattered junk-shop ethos of which its critics so often complained.

Chapter Five: Simple Machines

1. Introduction

The Mechanics committee of the Society of Arts rewarded an enormous variety of machines: from life-boats and prosthetic limbs to fulling mills and expanding rings. This places us in the now-familiar position of trying to glean some coherence from an immense miscellany. In this chapter, I want to suggest that it is possible to find some common themes and aspirations among all these many things, and to suggest that we can appraise their significance according to the term of praise which, more than any other, the Committee offered: that a given machine was "simple". Unpacking the senses of this term, I want to suggest, tells us interesting things about what the Society was trying to achieve, as well as about the public culture of mechanics in eighteenth-century Britain.

Historians have described the pervasiveness of public lectures and public mechanical demonstrations testify to a wide interest in machines, whose spectacle was sometimes remote from direct application.[1] In Larry Stewart's words "modernity, and enlightenment, once placed great faith in the machine".[2] But was this faith directed towards the future – or did it dwell in the already existing culture of familiar machines? And what does Stewart's rhetorical appeal to the singular "machine" actually tell us about the variety of tools and processes, which were in use?

[1] See, in particular, Alan Morton, "Lectures on Natural Philosophy in London, 1750–1765: S. C. T. Demainbray (1710–1782) and the 'Inattention' of his countrymen," *The British journal for the history of science*, 1990, **23**: 411-434; Alan Morton, "Concepts of power: natural philosophy and the uses of machines in mid-eighteenth-century London," *British journal for the history of science*, 1995, **28**: 63-78.
[2] Larry Stewart, "A Meaning for Machines: Modernity, Utility, and the Eighteenth-Century British Public," *The Journal of Modern History*, 1998, **70**: 259-294, at 294.

Talk of the singular machine has a long pedigree, and is associated with a narrative of technological development which comes with triumph and foreboding.[3] However, as Maxine Berg notes, during the eighteenth century there was no "machinery question", that is, no well-defined set of national priorities or formal language for discussing the overall economic and social effects of machinery; this would emerge with the development of political economy during the 1820s.[4] A wealth of eighteenth-century sources testifies to the informal, disunified sense which attached to the term "machine" during this period. The poem which opened the Gentleman's Magazine for January 1746 promised to describe "machines, which mathesis with care/applies to fire, and earth, and air".[5] With no hint of parody, the three machines were: a candlestick holder, an anthill cutter or harrow, and a ventilator.

In assessing the meaning of machines, then, much depends on which machines we are talking about, and how we make sense of their different roles. Faced with the mechanical variety at the Society of Arts, however, we are in the familiar position of facing an immense number of particular machines which seem intended for many different purposes. Does "simplicity" offer a clue for identifying common elements between them? It certainly seems like it should be able to, being associated with powerful ideas from theoretical mechanics and significant questions raised by the division of labour. It would, however, be a mistake to suggest that the Society's machines can be considered according to a single, simplifying horizon: discourses of mechanics during the eighteenth century entertained at least four partially overlapping senses of what simplicity entailed, which had different kinds of significance and did not cohere into any singular sense. I review these senses in section two. Section three then analyses the Society's rewards for tools and what I call "local machines": that is, devices which had been found successful in particular locations, and which premium candidates hoped to bring to wider notice. Such machines were rarely valued for their novelty as such, but rather were strongly associated with their utility in particular locations and for certain tasks. In such situations, "simplicity" was meant to imply that they could be widely adopted elsewhere as well. The proof of their value, at the Society, was that they had been shown to

[3] For an iconic example, see Humphrey Jennings, *Pandaemonium: The Coming of the Machine As Seen by Contemporary Observers, 1660-1885,* (London, 1987).
[4] Maxine Berg, *The Machinery Question and the Making of Political Economy 1815-1848,* (Cambridge, 1982), 1.
[5] "Britannicus", "To Sylvanus Urban", *The Gentleman's Magazine,* 1746, **16**, N.P.

work: the question of who could make such judgments, with respect to the tools of individual trades, was one which greatly exercised the Committee of Mechanics.

Section four then pursues the Society's efforts to conduct trials of machines. Despite the involvement of mechanics, attempts to develop comparative measures for mechanical performance, and the employment of a language of mechanical analysis in terms of the simple machines, the machines which were brought to the Society remained entangled with local and social factors, which could not be abstracted away. I exemplify this through the Society's trials of handmills, at which the lecturer James Ferguson was an unsuccessful candidate; and the long-running efforts to define improved wheel-carriages and ploughs. Not only could the Society not find ways to abstract such machines from their immediate surroundings; mechanical lecturers who spoke about them had to contend with the difficulties of interpreting real-world systems of human and animal labour which could not easily be reduced by analysis. These difficulties account for the way in which mechanical projectors stated their claims at the Society, making a mockery of mere mechanical analysis and emphasising the momentum of projects which had attracted local patronage elsewhere, and which could be presented rhetorically as concrete, and genuine. I exemplify this with the example of the projector Daniel Bourn, who confronted the Society in the early 1760s with the merits of his wagons.

Finally, section five sums up the various views of machines and their simplicities which have been presented here, and asks how this made for a public culture of mechanics at the Society of Arts.

2. An Ethos of Simplicity

Five partially overlapping senses of mechanical simplicity can be detected in eighteenth-century discussions of mechanics and manufactures. I want to give an overview of these, because they point to the plurality of ideas about simplicity which were available during this period, and the difficulty of assimilating simplicity to any single ideal. By seeing the different, partially contradictory things

which simplicity could mean, we can start to understand how such an immense variety of machines could be prized in such terms at the Society.

They were, first, analytical mechanics, which emphasised the decomposition of machines into the Galilean simple machines. The analytic sense of mechanical simplicity first appeared in an English-language work in John Harris' 1704 book *Lexicon Technicum;* by mid-century textbooks routinely touted the virtues of simple machines or mechanical powers as a way to diminish friction by the reduction of moving parts.[6] Typical statements of this view included, for example, William Hooper's statement that "[i]n all machines, simplicity is their primary excellence, as they are thereby less liable to friction and impediment; the disorder of any one part of a machine frequently obstructing the operation of the whole."[7] Something of the significance of this view, as well as the problems which it came to pose, can be seen in the efforts of nineteenth century engineers to redefine simplicity to focus on the direct employment of natural powers. Already in 1814, Robertson Buchanan was explicit about the new form of mechanical simplicity: it was not merely a matter of "few moving parts".[8] Even "if the parts of a machine be few, they are perhaps more easily taken in by the eye at one view, which may make them more easily comprehended by the mind, and in that sense be more simple," this was not what machinery required: rather "the kind of simplicity at which we ought to aim has more regard to the *manner of action* than to the number of moving parts."[9] Writing about steam engines in 1841 John Scott Russell attacked the "fallacy", that "simplicity of form and of outline are essential to simplicity of action", arguing instead for "durability, precision, and economy of operation."[10] Thus over the course of the early nineteenth century, attention had shifted from the earlier focus on reducing the number of parts.

Third, an ideal of simplicity as legibility, according to which simpler machines were those which could be taken in at a glance, as proof that the maker of machines was not sophisticating them;

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[6] John Harris, *Lexicon Technicum,* (London, 1704), N.P. entry "Machine". For the earlier tradition of thinking about simple machines, see Sophie Roux, "Cartesian Mechanics," in CR Palmerino and J.M.M.H. Thijssen, eds., *The Reception of Galilean Science of Motion in Early Modern Europe,* (Houten, 2004), pps. 25-66.
[7] William Hooper, *Rational recreations: in which the principles of numbers and natural philosophy are clearly and copiously elucidated, by a series of easy, entertaining, interesting experiments. Among which are all those commonly performed with the cards*, (London, 1774), 179.
[8] Robertson Buchanan, *Essay on the Shafts of Mills also an introductory account of the progress and improvement of millwork,* (London, 1814), 151.
[9] *Ibid.*
[10] John Scott Russell, *A Treatise on the Steam-Engine: From the 7Th Edition of the Encyclopedia Britannica,* (Edinburgh, 1842), 227.

simplicity could then be associated with a liberal wish to communicate improvements. As Diderot put it, "the more complex a machine is the less we are able to judge it."[11] . Describing to the Society the merits of his mechanism for raising carts when horses had fallen to the Society, Benjamin Smith wrote that "the invention is of itself so simple, and the operation so conspicuous at the first view, that the whole process may be easily comprehended and executed."[12] Such simplicity was associated with liberality, a willingness to share new machines without any obfuscation. John Clarke, of the Board of Agriculture, wrote in 1794 about an improving farmer from Hereford: "[t]he beautiful simplicity of the various machines, mostly of his own invention, used by this respectable and most intelligent farmer, are well worthy the inspection of the agriculturist in this district, who is desirous of arriving at eminence in his profession".[13]

Fourth, mechanical simplicity provided a horizon for the improvement of machines, by analogy with other forms of the construction of other philosophical systems. An article by "Ruricola" in the *Monthly Review* complained "that the original winnowing machines were infinitely less complex in their structure than those now in use, and were proportionably more convenient in using. This is perhaps the only instance of a new invention being more simple than it became afterwards."[14] Adam Smith, likewise, argued that "[t]he machines that are first invented to perform any particular movement are always the most complex, and succeeding artists generally discover that, with fewer wheels, with fewer principles of motion, than had originally been employed, the same effect may be more easily produced."[15] The sense that machines, once simplified, would necessarily be better connected with the others, but also had something of the aesthetic about it, akin to Thomas Kuhn's description of how scientific theories are evaluated: "the arguments, rarely made entirely explicit, that appeal to the individual's sense of the appropriate or the aesthetic-the new theory is said to 'neater,' 'more suitable,' or 'simpler' than the old […] the importance of aesthetic considerations

[11] Quoted in Otto Mayr, *Authority, Liberty and Automatic Machinery in Early Modern Europe*, (Baltimore, 1989), 80.
[12] Benjamin Smith, "Paper in Mechanics", *Transactions*, 1810, **28**: 215-219, at 216.
[13] John Clark, *General view of the agriculture of the county of Hereford: With observations on the means of its improvement,* (London, 1794), 65.
[14] Ruricola, "Review of James Sharpe, *Descriptions of some of the Utensils in Husbandry, Rolling-Carriages, Cart-Rollers, etc.*," in *The Monthly Review, or Literary Journal*, 1779, **60**: 17-19, at 17.
[15] Adam Smith, "History of Astronomy", in *Essays on philosophical subjects: to which is prefixed an Account of the life and writings of the Author*, (London and Edinburgh, 1795).

can sometimes be decisive."[16]

Fifth, and finally, mechanical simplicity might be associated with the subdivision and simplification of tasks, which might offer the possibility of subsequent mechanisation. John Pickstone describes this, as an anatomisation of tasks, and their subsequent mechanisation, wherein "the elements of the productive process had been separated, each had been developed as the sole work of one component, and these components had been assembled to form a productive mechanism which reflected and expanded the work once carried out by a skilled craftsman".[17] Again, however, early nineteenth century writers struggled to draw precise distinctions between the different aspects of a divided labour process; the work which went into such definitions indicated a sense that they had not been clearly distinguished before. John Farey, in his treatise on the steam engine, wanted the term "machine" to be confined to "such tools or instruments, as are employed to perform intricate or forcible operations, and in which the simple mechanical powers are conspicuous".[18] Machinery, meanwhile, was meant to be a "general term for all mechanical organs, which can be combined together so as to form the limbs or moving parts of machines".[19] According to Charles Babbage, for example, "the difference between a *Tool* and a *Machine* is not capable of very precise distinction […] A *tool* is usually more *simple* than a machine; it is generally used with the hand, whilst a machine is frequently moved by animal or steam power. The simpler *machines* are often merely one or more *tools* placed in a frame, and acted on by a moving power."[20] These attempts to define a series which stretched from tools to machine were quite typical of the works of this period, but they had to be made, even by authors who were the staunchest defenders of a systematic view of machinery, and as Babbage suggested they were often somewhat imprecise. Generally speaking, eighteenth-century works did not even attempt to offer a clear distinction between tools and machines, focusing instead upon their continuities. Rather than being treated as component parts of a larger whole, these simple machines could be celebrated for the connections which they established between different trades. Thus, rather than emphasising the reduction of

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[16] Thomas Kuhn, *Structure of Scientific Revolutions* (Chicago, 1962), 155
[17] John Pickstone, *Ways of Knowing*, (Manchester, 2000), 100.
[18] John Farey, *A treatise on the steam engine: Historical, practical, and descriptive*, Vol. 2, (London, 1827), 55.
[19] *Ibid.*
[20] Charles Babbage, *On the economy of machinery and manufactures*, (London, 1835), 12. For the ultimate fate of these series, see Donald Mackenzie, "Marx and the Machine," *Technology and Culture,* 1984, **25**: 473-502.

tools into ever-smaller processes, Smith celebrated the wide range of labours which they embodied:

> To say nothing of such complicated machines as the ship of the sailor, the mill of the fuller, or even the loom of the weaver, let us consider only what a variety of labour is requisite in order to form that very simple machine, the shears with which the shepherd clips the wool. The miner, the builder of the furnace for smelting the ore, the feller of the timber, the burner of the charcoal to be made use of in the smelting-house, the brick-maker, the brick-layers, the workmen who attend the furnace, the millwright, the forger, the smith, must all of them join the different arts in order to produce them.[21]

This overview should suggest two important things about eighteenth-century simple machines. First, tools were not separated from machines of other kinds; and second, discussions of machines might concern the wider complex of economic activity and interconnection involved in the production of even a simple machine such as shears.

3. Tools and Local Machines

While I am defining this view as characteristically eighteenth-century, it persisted in the mechanical rewards which the Society of Arts made during the nineteenth century. Despite the efforts of the writers on mechanics, there was not a sudden transformation in the kinds of "machines" which might be considered valuable in relation to specific trades: this was of course intensified by the practical focus of the Society's rewards on domestic machines, used in London. Thus, as we saw in chapter three, a large number of the devices rewarded by the Committee of Mechanics were closely connected with the building trade. In 1828, Andrew Smith's lever cramp for flooring was described as "simple and convenient apparatus", by means of which "a single

[21] Adam Smith, *An Inquiry into the Nature and Causes of the Wealth of Nations,* Vol. 1, (London and Edinburgh, 1776), 12-13.

workman may, unassisted, lay down a floor".[22] According to the trade press, Smith sold 2,000 of these cramps to builders in London, and went on to improve them further.[23] Most aspects of building were not to be mechanised, and in this context a high value for useful handtools made sense.

At the same time, however, canny manufacturers could not resist the allure of more charismatic machines. Here the claim was that machines intended for one purpose could be generalised beyond their original function. Thus in 1803 the Mechanics committee gave a premium to the London manufacturer George Walby, for his steam-hammer, which was intended for making steel trowels for brick laying.[24] Walby's apparatus was remarkably demonstrative, and on show in his Goswell Street premises; in his accompanying statement he argued that it might be used for other kinds of hammering. But it was the trowels, not the hammer, which were the true prize. Contemporary sources suggest that Walby was greatly admired in the trade; he was described some years later as "a conscientious workman, who was formerly an enchanted smith in the imagination of the London bricklayers, who paid 50 per cent more for the Goswell Street manufacture than for any shop trash."[25] But "[i]t is not to be supposed that all the trowels which he sold were indebted for their superiority to the operation of this machine; but as the symbol of a deserved celebrity, in this manufacture, a particular notice will be acceptable."[26] Walby's example suggests the difficulties of drawing clear distinctions between the significance of tools and machines in this context, as well as the symbolic associations which might enter into more complex machines.

Alongside the relatively prominent place which the Society gave to hand tools, many mechanics awards were recommended on the basis that they made existing work processes simpler, more reliable, or less painful. Here the emphasis was on contributions by workmen themselves, a point which the Society's publications occasionally made explicit. Thus, of one of the ventilating devices which the Society supported, it was noted that "J. Callaghan is himself a workman, and the Society

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[22] Anon, "Lever Cramp", *Transactions,* 1828, **46-47**: 105-109, at 105.
[23] Anon, "Smith's Improved Flooring-Cramp", *Mechanics' Magazine and Journal of Science, Arts, and Manufactures,* 1833, **18**: 338-9, at 338.
[24] George Walby, "Paper in Mechanics," *Transactions*, 1804, **22**: 335-341
[25] John Holland and Dionysius Lardner, *A Treatise on the Progressive Improvement and Present State of the manufacturers in Metal,* Volume 1, (London, 1831), 322.
[26] *Ibid.*

have rewarded him in hopes that his fellow-labourers may be induced to avail themselves of the invention of one of their own comrades, though they would probably neglect the very same contrivance, if offered to them from any other quarter".[27] While not all such improvements came from workmen, they did rely on personal experience and proof that machines worked. This neatly combined several senses of mechanical simplicity: such improvements might in a sense, "simplify" processes of labour by making it easier to perform them; they were also recommended on the basis that they would be cheap, reliable and easy to apply. Thus Robert Burt offered a means for a spinner to wind off a ball of thread, claiming that his mind had been "led to this invention by my wife's complaining the hemp cut her fingers in winding"; he noted with some pride that it had since "been constantly used by my wife."[28] In the same year John Antis, from Fulneck, near Leeds, received a premium for a method of causing the bobbin of a spinning wheel to move backwards and forwards. This had been tried "by a lady here, who sometimes spins for her diversion", and Antis noted that he had "made every thing as simple as possible; so that it might be in the poorest person's power to obtain it."[29]

Novelty was emphasised much less than immediate utility within particular locations. Mr. Rich's nail drawer was "both simple and ingenious; it is eminently serviceable in breaking up ships, and on other occasions, where large nails and spikes have been driven deeply into wood, from which they are to be extracted."[30] It was a crowbar, with the improvement of a ring in its end. There is little to suggest that it was original, but it had been employed in the Navy, and this was sufficient to recommend it. These were machines which could be reinvented in multiple locations.

In such circumstances, awards for mechanics were often less about rewarding novelty and more about recognising elegant solutions which had worked in particular locations. In 1837, £5 was paid to J. Bowen of Corkbegg in Ireland for his dredging machine, which had a philanthropic goal with respect to an ultra-marginal local industry. Local people collected sand which consisted of "comminuted shells" for use as manure – as a result they "encroached on private property, which occasioned a number of trivial but vexatious law suits; and these in their turn engendered various

[27] Anon, "Face-Guard for Smelters", *Transactions*, 1826, **45-6**, 152-3, at 152.
[28] Anon, "Paper in Manufactures", *Transactions*, 1793, **9**: 148-151, at 148.
[29] Anon, "Paper in Manufactures," *Transactions*, 1793, **9**: 152-157, at 153.
[30] Anon, "Paper in Mechanicks", *Transactions*, 1791, **7**: 156-7, at 156.

violent and riotous proceedings."[31] They then "betook themselves to the sandbanks, and here they have been accustomed to work during all kinds of weather that the human frame can bear, immersed up to the breast in water, and collecting the sand from the bottom by means of shovels, which they empty into boats along-side."[32] It was painful and destructive work; Bowen also thought the locals drank too much. His machine was meant to allow "three men, in about an hour and a half" to collect "from one to two tons of sand, in a rapid tideway, from any depth not exceeding five fathoms." It was reportedly adopted by two hundred sand boats – "it being found not only to save much bodily labour, but also to save time, by enabling the boats using it to complete their landing by half tide, and to run up the river with the remainder of the tide."[33] Clearly such a simple dredging machine had no great mechanical novelty, and Bowen was seeking a reward less with the goal of diffusing his technique to other locations, and more for recognition that he had successfully solved a problem within this one.

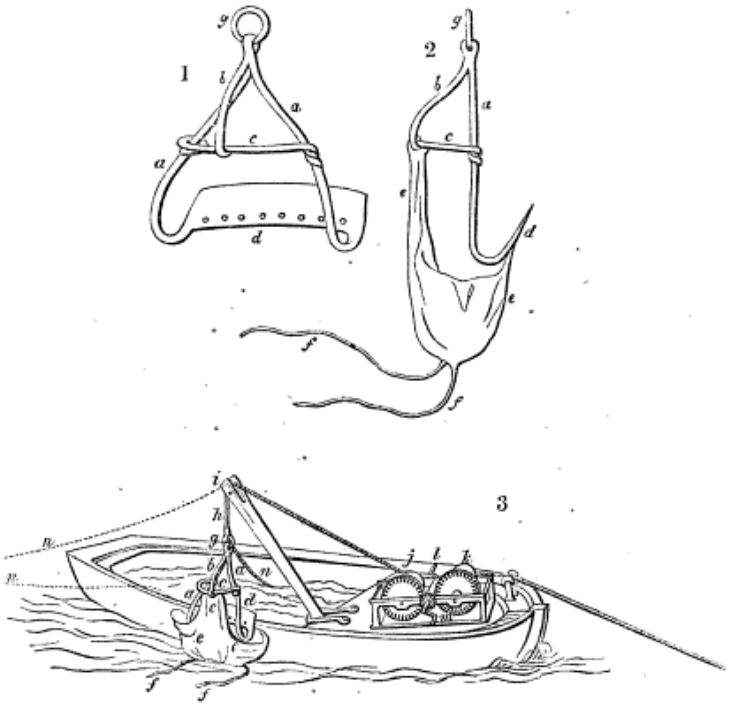

Figure one: Bowen's Sand-dredging machine. Transactions, 51.

Emphasis on the local utility of machines led, quite often, to the claim that those in London

[31] Anon, "Dredging Machine", *Transactions*, 1838, **51**: 24-27, at 25.
[32] *Ibid.*
[33] *Ibid.*

could not necessarily know what was useful in other regions. Thus in 1803 John Winterbottom, from Newbury, who had devised a road-flattening machine, asked that the committee would "before finally determining on the utility of this machine, condescend to make some inquiries in this part of the country, where it has been publicly tried", and recorded support from the Trustees of the London and Bath roads.[34]

From such local situations, it is often difficult to know whether a given invention really was a novelty, or was widely known elsewhere. Contributors recognised this and, occasionally, apologised for it. The way out of the embarrassment of the primitive nature of many such improvements was to emphasise that eminent people, workmen, as well as the inventor him or herself had found that it worked. Here simplicity had a part to play, both in acknowledging that an invention might not have been absolutely new, and in claiming that it had been found immediately useful. Richard Knight apologised for his method of blasting logs of wood, as "the simplicity of its construction and application is such as almost to preclude an idea of its originality; but as it has hitherto appeared entirely new to all my acquaintance, and as I do not know that any thing of the kind has ever before been presented to the Public."[35] What recommended the technique was partly the eminent men who had already employed it. Knight had constructed it initially for J. Lloyd, the MP for Flint, who had recommended it to Joseph Banks. Banks sent for Knight "and requested I would give him the necessary instructions for making one; but as I left that part of Derbyshire soon afterwards, I had not an opportunity of seeing it finished."[36]

For eminent members of the Society, inventions were closely connected with achievements on their own estates. Elizabeth Wyndham, the author and mistress of the Earl of Egmont at Petworth, wrote in 1796 to describe her improved lever, noting that, "I have sent you a Model of a mechanical invention of my own, which you will laugh at, as every body did at first, but I assure you, it has proved of great use, and the workmen all approve of it very much." [37] George Butler, esquire, opened his letter with a personal appeal to the Secretary: "[y]ou may possibly recollect my well at Downe in Kent, which is about three hundred and sixty feet deep; and is worked by two

[34] John Winterbottom, "Paper in Mechanicks", *Transactions*, 1803, **21**: 331-351, at 341.
[35] Richard Knight, "Paper in Mechanicks", *Transactions*, 1802, **20**: 247-257, at 248.
[36] *Ibid.,* 252.
[37] Elizabeth Wyndham, "Paper in Mechanicks", *Transactions*, 1796, **14**: 295-298, at 295.

buckets and a horse-wheel, each bucket holding a little less than a barrel."[38] Butler, therefore, had submitted an improved bucket, with iron hoops and a valve; these had been "worked four years without being out of condition."[39]

Those who relied on patronage from the great emphasised that simple inventions had been found to be valuable by their patrons, again emphasising personal connection. Sometimes such recommendations reached a high pitch of sentimental pathos: the reward was, it seemed, almost as much in recognition of this personal relationship as for the machine itself. In 1824, for example, Francis Watt received a reward for a screw wrench. His patron George Smart wrote a letter saying that Watt was

> not expected to live many days, and has sent it to me requesting my acceptance of it, in gratitude for some little attentions I have shown him formerly; conceiving it the best wrench that I have seen, if the Society should think it merits a reward, I shall have great pleasure in handing the same to the sick man, or his widow.[40]

Of course, humbler trades could hardly expect such eminent patronage. Nonetheless, the Society's members envisaged that machines would be diffused among improving workmen in much the same way as among its own worthy members – through personal recommendation and direct evidence that improvements worked. It is striking that almost none of the mechanics awards went for "machinery" in Farey's sense, as a more integrated system which brought together various machines; and that they were very rarely connected with the integrative and closely-watched modern factories. For example, the Society's awards to shoemakers all focused on individual bodies rather than on the environment within which they worked.

The five premiums which were given all went for apparatus which would allow shoemakers to work while standing, without pressing on the makers' stomach due to bracing the shoe during its construction. All were by working shoemakers. The letter recommending Thomas Parker, who worked in Blue Cross Street in Leicester Fields, noted that he "does all his work (which is in the

[38] George Butler, "Paper in Mechanicks", *Transactions*, 1794, **12**: 286-291, at 286.
[39] *Ibid.,* p. 287.
[40] George Smart "Screw-Wrench", *Transactions*, 1824, **42-3**: 121-123, at 121.

branch of boot-making) at the bench he offers for your inspection."[41] A. Stass, a shoemaker from Newport market, claimed in 1806 that his machine had been vouched for by "some of the first workmen in the trade" as well as by "physicians of the first abilities".[42] Thomas Holden grew corpulent through his sedentary trade and his doctor begged him "to relinquish it, or invent some method to do his work standing"; Holden complained that he had suffered "so much in my health, and from the piles, that I thought I must either give up my business, or lose my life".[43] His improvement was supported by a number of local cordwainers. In such cases, novelty in invention was hardly the point: these were inventions developed in the course of work, known best by those who performed it, and to be diffused among the networks of their trades.

From this perspective, the Society's awards depended greatly on their acquaintance with particular trades, or ability to consult with those who were involved with them. This was how the Committee of Mechanics sought to overcome the claim that judging machines would require specialist knowledge. In some areas, particularly timekeepers, the Society was proud of its ability to attract "practical men" to perform evaluations. As Arthur Aikin put it in 1819, any submission of this type

> [i]nsures to us the voluntary attendance of a greater or less proportion of those ingenious artists in this department who belong to the Society: some may attend from curiosity, some from the hope of obtaining useful information, some from a spirit of rivalry, some from a desire that the reputation of the Institution of which they form a part, may not be committed by rewarding what is worthless or well known, or by rejecting a valuable and original invention.[44]

The Society's minutes bear out this claim. On May 14th 1801, for example, Henry De La Fons' escapement came before the Committee. Mr Barwine, identified in the minutes as an "artist", claimed that he had seen a very similar escapement made by Mr Grant, who was also present at the committee. Grant produced his pocket time piece with a detached escapement, "possessing also the

[41] W. Heather, "Paper in Mechanics", *Transactions*, 1804, **23**: 285-287, at 286.
[42] A. Stass, "A Machine, to enable Shoemakers to make SHOES or BOOTS without suffering the pressure upon the Stomach usual in that Trade", *Transactions*, 1805, **24:** 111-113, at 112.
[43] Thomas Holden and Nicholas Turner, "Paper in Mechanicks", *Transactions*, 1804, **22**: 304-310, at 307.
[44] Arthur Aikin, "Address at the Annual Distribution", *Transactions*, 1819, **36**: 3-16, at 6.

same properties as the present escapement."[45] Despite these marks against De la Fons, the committee resolved to postpone consideration until another ten watchmakers could be invited to attend. On May 19 three – Jamieson, Littlewood Smith, and Leroux, all attended, "as artists". Jamieson claimed that he had seen "an experiment to this seven years ago", and "knew from practice that the spring is preferable to the Détente."[46] Littlewood opined that the Détente was better than the spring, and claimed De La Fons' escapement had "great merit in the locking"; Smith thought the design would "perform its work well if properly executed," though it was still "capable of some small matters of improvement."[47] Finally, Leroux claimed that "it has much merit and is in a state of invention that may lead to further improvements of Escapements."[48] This was enough for the Society: De La Fons was voted a bounty of thirty guineas, and told to leave a complete description with the Society, intended (a little hopefully, perhaps) "for the use of the public."[49]

Of course, this emphasis on personal factors and direct acquaintance with a trade could lead to problems if the Committee of Mechanics, or members of the Society, were not actually familiar with the tools which they sought to reward. The possibility of such credulity was captured in a joke in *The Evening Mail* in 1792: "A wag, some time ago, advertised a carriage to perform without horses, with only *one wheel,* and invited the *curious* in mechanics to see it. Many of the Members of the Society of Arts attended, and in the ardour of expectation they were shewn – *a wheelbarrow*."[50] An anonymous contributor to the *Mechanics Magazine* in 1825, wrote that "the Members of the Society of Arts are certainly very ignorant (with reverence be it spoken) of the tools that are used in an engineer's workshop. The Chuck, said, in your last Number, to be invented by E. Speer, Esq., is as common as chairs in a barber's shop."[51] In the magazine's next number, Speer responded, seeking to defend himself against the claim that he had been unoriginal, and tried to back up his claim by reference to the judgement of the committee:

[45] Min. Comm. (Mechanics), May 14th 1801.
[46] Min. Comm. (Mechanics), May 19th 1801.
[47] *Ibid.*
[48] *Ibid.*
[49] *Ibid.*
[50] *Evening Mail* (London, England), November 14, 1792 - November 16, 1792; Issue 582.
[51] J. Y., "Mr. Speer's Chuck", in *The Mechanic's Magazine,* 1825, **3**: 447.

> That I invented the chuck for my own use as an amateur turner, without the remotest idea derived from any but the brass chucks in common use, I can most positively aver. […] [S]ubsequent experience of its utility induced me to lay it before the Society of Arts, where its merits as an invention were discussed before two Committees, previous to my obtaining the medal with which the Society were pleased to honour me. Both these Committees were attended by many scientific and practical men, both engine, tool, and lathe makers, and persons professionally acquainted with turning in all its branches. Both our Chairmen of Mechanics were present, one of whom, you cannot but know, is an engineer of the first eminence. […] the claim to novelty was particularly discussed, and the evidence of several practical men taken as to that point.[52]

Printed in the *Mechanics Magazine,* alongside the jostling, active, periodically furious contributions of working mechanics from a wide variety of trades, Speer's appeal to the expertise of the committee of mechanics could not help but look a little ludicrous. They simply did not know what was commonly done.

Overall, then, the Society's mechanics committee allowed the tools associated with particular trades a relatively prominent place, emphasising the contributions of "practical artists". Alongside this, machines from both high- and low-ranking contributors to the Society were closely connected with particular localities, with evidence of their value being provided by claims that they had been immediately useful. This emphasis on the possibilities associated with common practice, and stress on connections with local areas, meant that claims to rationalise on the basis of theoretical mechanics did not play a dominant role in the Committee's decisions. While more formal attempts were made to try machines, and to describe improvements in terms of abstractions, these also collided with relationships of patronage, and the difficulty of abstracting from local particularities. What this entailed for mechanics at the Society is the subject of the next section.

[52] E. Speer, "Mr. Speer's Concentric Chuck", in *The Mechanic's Magazine,* 1825, **4**: 25.

4. Mechanical Analysis: Judging and Generalising Machines

A language of mechanical analysis was employed by some contributors to the Society of Arts; its Committee of Mechanics also made some attempts to trial machines and models comparatively. Moreover, some natural philosophers who are best known for their lecturing, particularly the astronomer and instrument-maker James Ferguson, and the inventor Richard Lovell Edgeworth, played an active part in the Society's competitions. In this capacity, however, they were much closer to the world of situated machines described in the previous question than to our standard picture of how natural philosophers could contribute to mechanics. This was both because of the range of different views which the Society aspired to entertain, and due to the difficulty of abstracting machines from particular material circumstances. I want to exemplify these challenges chiefly with reference to the Society's interest in the improvement of ploughs and wheel-carriages. I want to begin, though, with a telling example of the difficulties which mechanical lecturers faced in the Society, which is contained in a letter from James Ferguson to Alexander Irvine.

He had found himself at trials conducted of improved handmills, which were conducted at the Society in 1755, and gave an account of their shortcomings which – while it is certainly partial – points to the great difficulty of separating a mechanical trial from more contingent social and material factors. Ferguson described the Society of Arts as "a set of gentlemen" who had "entered into an agreement lately, to have hand-mills made and given in presents, that they might grind their own corn at home."[53] The prize was to be £50. Ferguson knew mill work "tolerably well", made a model, "and showed it to the gentlemen"; it was approved, and Ferguson was asked to construct a larger version.[54] Then, Ferguson claimed, a cabinet-maker named Gordon called on him, claiming that a country gentleman wanted a mill made on the basis of the model "if I would allow it to be copied."[55] Ferguson lent Gordon the mill "knowing thereby I should have an opportunity of seeing how such a mill would perform without being at the charge of making one."[56] The results were pleasing: "it was made, and performed so well, that a man of a very ordinary degree of strength

[53] Ferguson to Alexander Irvine, Jane 17th, 1758, quoted in Ebeneezer Henderson, *Life of James Ferguson F.R.S.: In A Brief Autobiographical Account, and further Extended Memoir,* (London, Edinburgh and Glasgow, 1767), at 227.
[54] *Ibid.*
[55] *Ibid.*
[56] *Ibid.*

could grind three-quarters of a bushel of wheat within an hour, and make as good flour as could be desired."[57] However, Gordon claimed he could improve the mill, intending to "lay it before the Society as his own; and if it would gain the premium, he would give me one half."[58] (As we saw above, a minor improvement to an existing model lay well within the Society's criteria for an improved machine). Gordon still had the model and "what he called an improvement was an additional part for boulting [sifting] the flour as the mill ground it."[59] According to Ferguson, this addition was disliked by the Society "because it would make such mills too expensive for them to give away": Gordon was a man who complicated machines. Ferguson asked Gordon to make the model into a full-scale mill, along the lines of the original plan, rather than making the addition. A fortnight later, Ferguson arrived at Gordon's house and saw the mill "which he said was made for a gentleman in the country, but had never been sent: and, indeed, I much question whether he ever had such a commission."[60] This mill had the boulting-work, but Ferguson thought that he could still exhibit it, informing the "gentlemen how much cheaper it could be made without that part."[61] Gordon refused; the Duke of Argyle "huffed him into it"; and "he, being the Duke's cabinetmaker, could not refuse."[62] But it emerged Gordon had made another mill, "and had raised the structure in so foolish a manner, that his mill required at least double the power to work it that mine did".[63]

At the trial, Ferguson reported "about twenty different sorts of mills brought into a great room".[64] One of them was designed by John Harrison, the celebrated inventor of accurate chronometers and long-term petitioner of the Board of Longitude. "Many trials were made, and it was long thought by most of the committee appointed for examining these mills, that the dispute would have been confined to Mr. Harrison's and mine."[65] Gordon was lurking about, his mill next to Ferguson's; he paid for a man to work them both. During the trial Harrison's mill was worked too hard, and broke. Ferguson reported that his own was rejected as a result of a trial made later in his absence "when it was judged to have failed all at once, because it hardly produced what

[57] *Ibid.*
[58] *Ibid.*
[59] *Ibid.*
[60] *Ibid.,* 228.
[61] *Ibid.*
[62] *Ibid.*
[63] *Ibid.*
[64] *Ibid.*
[65] *Ibid.*

deserved the name of flour; and I not know of any trial to have been on that day was unluckily absent."[66] Ferguson suspected roguery "and then upon dropping my hand upon the cog-wheel I could easily perceive that the upper mill-stone had been raised so high that the flour then ground by it must have been very bad indeed", because it was set too distantly from the lower stone.[67] He protested to the gentlemen of the committee "that the mill had been rejected upon a very unfair trial" – and that by resetting the stones properly close "it would still be found to make as good flour as ever."[68] The gentlemen, however, blamed him for being absent during the trial. Gordon's mill won the prize – but, Ferguson alleged, it "begins already to fail, and some parts of it are more than half worn out. And no great wonder; for in it the heavy stones of two feet diameter, and seven inches thick, are turned by a wheel with inclined teeth working in an endless screw, just as the fly of a common jack is turned. I leave you to judge what sort of a mechanical conjuror he is. Mine is turned by a cog-wheel and trundle".[69]

Although Ferguson resorted to a language of mechanical superiority, he had earlier been at Gordon's mercy, because the cabinet-maker was able to make working versions of the mill and he was not; Ferguson is also remarkably unclear as to how Gordon came to be attending his mill at the trial, and how he got the Duke of Argyll involved in the dispute between them. While extraneous to the working of the mill, all these details were parts of his experience of competing at the Society; his understanding of mechanics was unable to master them; and it was Gordon who took the prize, not him. While Ferguson's case was singular, it points to some general problems which theoretical mechanics faced at the Society.

Attempts to apply mechanical analysis to actual machines were submitted to what Simon Schaffer has termed "the puzzle of generalising from intimately manageable trials to full-size realities".[70] Experiments could be controlled, their inputs known, their parameters varied systematically, different measures sought. They were, in this sense, simplifications of much more elaborate systems of work; and the challenge for natural philosophers was to assert their authority

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[66] *Ibid.*
[67] *Ibid.*
[68] *Ibid.,* 229.
[69] *Ibid.*
[70] Simon Schaffer, "Fish and Ships: Models in the Age of Reason", in Soraya De Chadarevian and Nick Hopwood, eds. *Models: The Third Dimension of Science*, (Stanford, 2004), pps. 71-105, at 71.

against customary work patterns which had all too many reasons to resist them. One limitation to model trials might be that the principles on which they were based were insufficiently general. Basil Hartley has studied the trials of model ships which were conducted by the Society between 1758 and 1763, and concludes that "[t]he object of the trials was to improve the sailing qualities of warships by selecting the best performing models from which full-sized vessels could be designed."[71] The trials included apparatus to test ship resistance, which were based on John Smeaton's rigorous experiments on waterwheels; the models were also trialled in open water.[72] Despite their impressive experimental encumbrances, however, the designs of the ships were not derived mathematically and there was little systematic variation of their qualities. As a result, Harley argues, "[t]he empirical approach to the problem with no evidence of any mathematical or theoretical bases for the various hull forms tested, was a serious limitation" in the practical improvement of ship design.[73]

Alternatively, experimental models might be theoretically convincing, while still lacking the credibility to reform existing practice. Jane Wess has noted how mechanical lecturers contributed to discussions about the breadth of wheels which carts should possess, using model carts with interchangeable wheels upon inclined planes to show the advantage of wide wheels. She writes that "[a]lthough this argument was the simplest mathematically and could have been thought conclusive, it was revived with vigour several times during the period as other considerations became involved."[74] Experimental "legitimacy was not sufficient in itself to overcome commercial considerations, and the convergence of practice and philosophy […] was thwarted in this instance" – in other words, that proof by mechanical lecturers of the advantages of wide wheels was insufficient to trump the preference of coach makers for cheaper, narrow ones.[75] As we will see, however, the relation between theory and practice was much more involved than this allows, because mechanical theorists of wheels faced significant problems of scale. I am going to explore

[71] *Ibid.,* 52.
[72] For which see, Terry S. Reynolds, *Stronger than a hundred men: a history of the vertical water wheel*, (Baltimore, 2002); Jennifer Kairns Alexander, *The mantra of efficiency: from waterwheel to social control*, (Baltimore, 2008).
[73] *Ibid.*
[74] Jane Wess, "Lecture demonstrations and the real world: the case of cart-wheels." *The British Journal for the History of Science*, 1995, **28**: 79-90, at 83.
[75] Basil Harley, "The Society of Arts' Model Ship Trials 1758-1763: a study in the pre-history of ship model hydrodynamics", *RSA Journal*, 1991, **142**: 50-52.

these by looking at the attempts to offer analytic improvements for ploughs and wheel-carriages, which were a major goal for the Society in its early years. The difficulties of abstracting and simplifying the "mechanical part" of such machines from human and animal action is a powerful example of the challenges which mechanical analysts faced when confronted with the working machines of the eighteenth century; it is more than this, however, because such efforts provided subjects for mechanical lectures as well. Rather than mechanics acting as a simplifying legitimation, as Wess suggests, the lecturers had to grapple with the awkward complexities of the trotting, snorting, hauling world.

We can see this most clearly in the case of ploughs, and carriages. In both kinds of machine we see contributors to, and members of, the Society making significant attempts to find opportunities for mechanical analysis without being able to completely make trials tractable, or measures reliable. The Society offered a premium for "fixing the principles of the construction of a Plough" from 1765. Arthur Young strongly supported this idea, writing that "[f]or the length of time that the Plough has been known in the world, the true principles of it have hardly been thought on."[76] Young himself had asked John Arbuthnot to lay down "explicit rules for the instruction of wheel-wrights in building a common plough".[77] *The Gentleman's Magazine* contrasted these improved ploughs with "other instruments of this kind, formed at random", and praised their precision and simplicity: they were "constructed upon true mechanical principles, and so clearly described, that ordinary workmen of any nation may make them without applying for models."[78] Historians associate the eighteenth century with significant improvements to plough design, especially through the use of wrought iron and the employment of self-sharpening shears. [79]. Arbuthnot's goal went rather beyond this, however; he believed that a proper mechanical understanding would show the superiority of some kinds of plough construction over others; thus his essay would

[76] Arthur Young, *Farmer's Tour through the East of England*, vol. 2, (London, 1772), 522.
[77] *Ibid.,* 523.
[78] Anon, "Some Account of Mr. Arbuthnot's Husbandry", *Gentleman's and London Magazine*, 1772, 763-765, at 764.
[79] Kristine Bruland, "Industrialisation and Technological Change," in Roderick Floud and Paul Johnston, eds, *The Cambridge Economic History of Modern Britain*, Volume 1, (Cambridge, 2005) 128; Liam Brunt, "Mechanical Innovation in the industrial revolution: the case of plough design," *The Economic History Review*, 2003, **56**: 444-477.

> prove in what part of the plough the resistance is, from which the different lines of traction must tend to the horse's shoulders, in different operations and soils, and by explaining where the directions of the line of draught to the wheel plough differs from that of the swing plough, prove the superior advantage of the wheel plough, where the nature of soil will admit the use of it.[80]

The claim that wheel ploughs were invariably superior was a fairly short-lived fad, with improved lighter swing ploughs coming into fashion in the early nineteenth century. There were many soils for which wheel ploughs were simply unsuitable.[81] Overall, the preference for wheels and attempt to define ploughs away from the situations in which they would actually be employed suggests the challenges which Arbuthnot's simplifying and abstracting approach faced.

Because of the empirical difficulty of making sense of the horse's motion, however, evidence from the Society's trials served more to show the inadequacy of such measures. Olinthus Gregory's 1815 *Treatise of Mechanics* alluded to experiments conducted by Samuel More at the Society during the 1760s, within which More had "concluded, that a horse moving at the rate of three miles an hour can exert a force of 80 lbs"; but unfortunately "we are not sufficiently acquainted with the nature of the experiments and observations from which these deductions were made, to institute an accurate comparison of their results."[82] This was part of Gregory's generally dubious attitude towards horsepower as a measure.[83]

Experiments on ploughs using the dynamometer were described in the first edition of Young's *Annals of Agriculture.* Young described the machine as an invention of Samuel More's, "a spring, coiled within a cylindrical case, having a dial-plate marked with numbers like that of a clock, and so

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[80] John Arbuthnot, quoted in Young, *Farmer's Tour,* 523.
[81] Brunt, "Mechanical Innovation"*,* 448.
[82] Olinthus Gregory, *A Treatise of Mechanics: Theoretical, Practical, and Descriptive, Third Edition, Volume 2,* (London, 1815), 83.
[83] The opposition between "horsepower" and attempts to treat the motion of the horse in mechanical terms, as a major transition, was suggested in a passage of Marx's *Economic Manuscripts*: "With the simple application of animal power the principle of *voluntary movement* remains predominant; the purely mechanical action is concealed under the cover of voluntary movement, and therefore it does not emerge. But it is already entirely different with e.g. the mill, where the animals are led or whipped round in a circle with their eyes blindfolded. The movement here already appears as *unnatural,* and reduced to a regular mechanical course, the circle." Karl Marx, *Economic Manuscripts*,*1861-63,* most readily accessible at www.marxists.org/archive/marx/works/1861/economic/ch35.htm (accessed 11 March 2014).
[83] Arthur Young "On Plough Trials", *Annals of Agriculture*, 1784, **1**: 113-118, at 113.

contrived that a hand moves with the motion of the spring, and points to the numbers in proportion as the force is exerted", and noted approvingly that before its invention "it was exceedingly difficult to compare the draught of different ploughs, as there was no rule to judge by but the exertions of the horses as apparent to the eye; a very undecisive mode of ascertaining their force."[84] The reports of comparative plough trials which followed from this, however, made little reference to the different forces which were exerted, and even praised heavier over lighter ploughs. Overall, the trials seemed to prove that "[t]he weight of the plough is the least part of the horse's labour: the great object is, the resistance met with in the cohesion of the earth; lightness does nothing to overcome this; it is effected by just proportions only."[85] Such a conclusion demanded some way of analysing the different aspects of the horse's labour, not only a way of measuring the force which was exerted. For some observers, at least, the index was completely inadequate because it could not make sense of the different motions which went into the action of ploughing. Richard Lovell Edgeworth claimed that he was the inventor of the dynamometer, and wrote that "[i]n 1770 I presented to the Society of Arts, a scheme for a Splinter-bar furnished with a spring and an index, so as to point out the force employed by Horses. This was afterwards, in my absence, put in execution, and tried in ploughing, and was found not to succeed, because its vibratory unequal motions could not be summed up."[86] What was needed was a more sophisticated mechanical treatment of the horse. Again, mechanics sought to provide this, but it posed significant challenges.

One major source of these problems is indicated in figures two and three, which are taken from the submissions of the mechanical lecturer Adam Walker House of Commons Committee on the State of the Highways in the Kingdom in 1808. Walker described the limbs of horses as "a system of powerful levers, actuated by muscles of proportionate strength and wonderful contrivance!"[87] Thus, the animal could be analysed in terms of simple machines. At the same time, Walker was quite, that the horse in figure two was a child's toy horse, convenient for demonstrating

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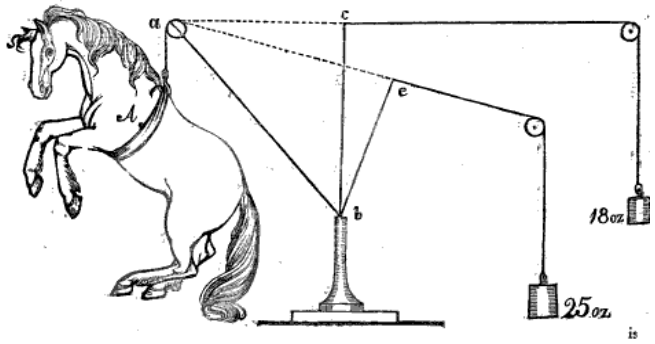
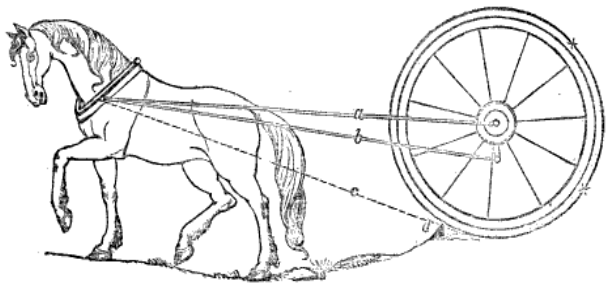
[84] *Ibid.*
[85] *Ibid.,* 117.
[86] Richard Lovell Edgeworth, "Appendix No. 5 to the Report of the Committee for the Improvement of Roads: Extract of a Second Letter from Mr. Edgeworth, Dated 1st May 1808", *The Belfast Monthly Magazine* **5**: 194-196, at 194.
[87] Adam Walker, "Of the General Principles on which the construction of Wheel Carriages ought to be founded," in the *First Report from the Committee on the Highways of the Kingdom*, published in the *Report from the Committee upon Expired and Expiring Laws, for the second to the fourth Parliament of the United Kingdom of Great Britain and Ireland* (48 Geo III), (London, 1808), 15-41, at 18.

the properties of a body with weight but no muscular force. The actual animal was more than an assemblage of mechanical powers – "he, individually, is a lever himself", continually "acting like a Theorist in Mechanics" in solving the problems of burden.[88]





Figures two and three: representing the horse as a system of mechanical. Source, Walker, "General Principles", pps. 20-21.

Adam was confident that the horse's motion could be simplified to provide true principles of carriage and plough construction. Such confidence had long been expressed by contributors to the Society, in occasionally contradictory and rather impressionistic terms. Certainly, and despite the claims of mechanics, they could not be reduced to smaller models. Joseph Jacob, a carriage-builder with close links to the Society, sought to analyse how "animal powers" produced draught (Jacob thought that standard mechanics of motion dealt only with "percussion", rather than the sustained carrying of draught). They could, he thought,

> be compared to a weight and pulley, moved forward in the same direction, and with the same velocity as the carriage itself; by which means the suspended weight

[88] *Ibid.,* 19.

> keeps constantly acting on the carriage with the whole force of its gravity, though it never actually descends.[89]

Relative to the measuring device, the animal was a mechanical anomaly, however, because in it "the powers of elasticity and gravity are united."[90] Optimal draught required the animal to be placed in a position where it could "affect a momentary exertion of his greatest muscular force" in getting the carriage moving, and then "facilitating the continuation of that motion when given, so that the constant exertion of the muscular force of the animal shall be as little as possible."[91] Effective continuation of movement was a matter of correctly employing an appropriate combination of the animal's weight and the "elastic force of its muscles":

> its centre of gravity rising and falling alternately, as it proceeds in the rectilinear direction of the motion of the carriage; such centre being reiterately raised up, and at the same time pushed forward, by the dilation of its muscles, acting against the ground in one direction, and against such centre of gravity in an opposite direction.[92]

In his mechanical lectures, James Ferguson traced the evolution of analysis of the line of traction – the angle at which the traces of the cart or plough should impinge of the shoulders of the animal -- through work by French analysts, who treated the question through analytic decomposition into simple machines. It had first been described, he wrote, by Camus in his *Traité des Forces Mouvantes*, which had tried to show that "it should be a horizontal line, or rather that it should always be parallel to the ground on which the carriage is moving, both because the horse can exert his greatest strength in this direction, and because the line of draught being perpendicular to the vertical spoke of the wheel, acts with the largest possible lever."[93] Subsequently, Couplet had attempted to incorporate the unevenness of roads, and Prony had given ways to compute ways to compensate

[89] Joseph Jacob, *Observations on the Structure and Draught of Wheel Carriages,* (London, 1773), 15.
[90] *Ibid.*
[91] *Ibid.,* 16.
[92] *Ibid.,* 17
[93] David Brewster, ed. *Ferguson's lectures on select subjects, in mechanics, with notes and an appendix*, vol. 2, (Edinburgh, London, 1805), 328.

for how horses stooped while they pulled hard.[94] Ferguson aligned his own view with that of the "ingenious mechanic" Henri Deparcieux, who had shown in 1760 that "animals draw by their weight, and not by the force of their muscles."[95] In quadrupeds, Ferguson argued, "the hinder feet are the fulcrum of the lever by which their weight acts against the load, and when the animal pulls hard, it depresses its chest, and thus increases the lever of its weight, and diminishes the lever by which the load resists its efforts".[96] This led Ferguson to prefer large horses, though they had less muscular power than small ones, for "the force of the muscles tends only to make the horse carry continually forward his centre of gravity; or, in other words, the weight of the animal produces the draught, and the play or force of its muscles serve to continue it."[97] David Brewster, editing Ferguson's lectures in 1808 had to refer to personal experience to back up this claim:

> When I first compared Deparcieux's theory with the manner in which horses appear to exert their strength, I was inclined to suspect its accuracy; but a circumstance occurred which removed every doubt from my mind. I observed a horse making continual efforts to raise a heavy load over an eminence. After many fruitless attempts, it raised its fore feet completely from the ground, pressed down its head and chest, and instantly surmounted the obstacle.[98]

Giving a mechanical account of the movement of horses was not an entirely intractable problem, but it was not easily settled. Richard Lovell Edgeworth, writing on the construction of roads and wheel carriages, noted that the Parliamentary committee on roads had devoted an unreasonable amount of time and attention to such questions, and tried to give an extremely detailed account of the varieties of motion involved in a horse's movement:

> When a horse moves forward, the centre of gravity of his body, and of his whole form, alternately rises and falls, so as to form an indented line in the air. This motion does not strike the eye, when we look in an ordinary manner at a horse,

[94] *Ibid.*
[95] *Ibid.,* 329.
[96] *Ibid.*
[97] *Ibid.*
[98] *Ibid.,* 335.

> when he moves slowly; but when a horse trots, this undulating motion is plainly seen. It is produced by the curves, described at every step by the body of the animal, on it's feet as centres. He cannot walk without first leaning his body forward; to support himself, he advances his legs successively, and is obliged to raise the centre of gravity of his body at every succeeding step, by a circular motion, described round each foot as it touches the ground; an experienced horse counteracts this motion by bending his legs. In drawing a heavy carriage, a horse usually walks; the motion therefore, which he communicates to the carriage, must be given by successive impulses.[99]

Edgeworth then gave his own account of the horse's movement, which emphasised both muscular force and weight but understood them in terms of an intermittent circular movement, "which may ultimately be considered to be the same as a continued draught, in a straight line parallel to the road on which he moves."[100] Edgeworth also described some (extremely expensive) experiments which had been conducted under his direction on the properties of carriages. The design of the experiments had been intended, as far as possible, to exclude the contribution of the horses.

Thus for both ploughs and carriages a language of mechanical abstraction and simplification, accompanied by measuring devices, was precariously balanced against the continued significance of local factors and animal contributions, neither of which could easily be scaled downs. This provides some background for the Society's ultimately very impressionistic approach to evaluating improvements in carriages and ploughs, and the ways in which mechanical analysis could be challenged by other contributors. This combined with the difficulty which the Society faced in separating machines from the patronage by which they were advanced, and the claims of projectors. I want to explore this through the case of Daniel Bourn, a projector of waggons.

A committee of gentlemen attempted to adjudge the qualities of an improved cart designed by the Bourn in April 1764. It was put up against "a common broad-wheel waggon", each loaded with

[99] Richard Lovell Edgeworth, *An Essay on the Construction of Roads and Carriages*, (London, 1813), 58.
[100] *Ibid.*

five tons of stones, and drawn by eight horses. The two went side by side, from "the New Road just by Pancras, to within a small distance of the Dog-House Bar".[101] On the way back, they were tried with four horses each: and "it appeared that the common broad-wheel waggon had greatly the advantage, and that the four horses in it did not seemingly work harder than the eight horses in the new-invented one."[102] Despite this fairly clear experimental failure, the report was positive, as the wagon had more in mind than this: its intention was "to roll the roads, and keep them from rutting".[103] The report added that it served as the "stage wagon from Leominster to London, and has been two journeys."[104] Not only was the trial impressionistic, based on the gentlemen's observations of the horses' fatigue, it was also looking for more than merely mechanical qualities which could belong to the wagon, which was also meant to beautify the road. Finally, the wagon's workability for a designated other task – as the stage coach – was mentioned, as if this proof counted for more than the mere experimental display.

Bourn wrote vehemently in defence of his schemes: his rhetoric invoked the questions of scale and material locality which, as we have seen, ran right through the Society's awards for mechanics. Bourn was furious at Jacobs' attempts to prove that his wagons did not have the merits which he claimed on their behalf by analysis which employed simple machines. Against such arguments, he affirmed the brute reality of his cart, and blurred the distinction which Jacob – and other analytical mechanics – had hoped to draw between the application of simple machines intended to demonstrate mechanical principles, and the actual material stuff of which his wheels were made. He was particularly outraged at Jacob's account of his line of draft (that is, of traction): wanting to know how his opponent could claim that "the tail-pole of a waggon is an 'imaginary line', and not a visible palpable substance", intimating that Jacob would not deny its reality were his pericranium "impelled against it, with a percussive force."[105] He denounced Jacobs' (quite conventional) analysis of the spokes of the wheel as "magic levers". And as part of the general exuberance of his pamphlet he attacked Jacob on, precisely, questions of scale, and how animals would interact with the small

[101] *Lloyd's Evening Post*, (London, England), April 13, 1764 - April 16, 1764; Issue 105.
[102] *Ibid.*
[103] *Ibid.*
[104] *Ibid.*
[105] Bourn, *Some Brief Remarks upon Mr. Jacob's Treatise on Wheel-Carriages, etc*, (London, 1773), 22.

wheels of his wagon: "did you think", he sneered, "the *little wheel* was to be drawn over this might stone by a *little horse* (or perhaps a cat) but the great wheel by a full-sized beast?" [106]

The success of Bourn's little wheels was meant to be proven by the momentum behind its campaign: Bourn's supporters, the locations where they had already been employed. He called Jacob the "mouth-piece and champion of the committee" and claimed to have found him "a very weak adversary, and unequal to the combat"; he asked the entire committee of the Society of Arts "singly, or the whole, jointly, to answer the arguments contained in my former treatise on wheel-carriages, and they may, if they please, employ Mr. Martin, or Mr. Ferguson [….] as assisting council to answer the said arguments."[107] This was, perhaps, a rhetorical misstep, but critical contemporaries did not treat the lecturers any more kindly than they did Bourn. According to *The Critical Review,* for example:

> [i]t will readily appear to the reader of these Brief remarks that Mr. Bourn is (in his own opinion) the only person living properly qualified to treat upon this important subject; for this reason we are apt to think that Mess. Martin and Ferguson, of Fleet-Street, have lately taken the liberty to display their knowledge, or rather want of it [….] concerning wheel-carriages.[108]

The tone of this review was mocking, and it is not clear that the mechanical lecturers came out of it with any more credit than Bourn. Despite their best efforts, they could not find a secure place from which to pronounce on the shape of carriages. Bourn was not speaking on behalf of empiricism against rational analysis; rather he had a speculative mechanics all his own, which was premised primarily on the magnificence of his wagons. He was a projector, and Jacob and the lecturers intended to dispense with him through all the techniques of proof and ridicule which mechanics could muster. Nevertheless Bourn was able to draw upon the astonishing difficulty of abstracting mechanics away from its materials:

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[106] *Ibid.,* 19.
[107] *Ibid., Brief Remarks,* 29.
[108] Anon, "Some brief Remarks upon Mr Jacob's Treatise on Wheel-Carriages, by Daniel Bourne", T*he Critical Review,* 1773, **36**: 399-400, at 400.

> consider with what vast gravitating pressure, these wheels are bound to the face of the road, and you will be at no loss to account for the difficulty of the traction. Here is some very fine even road, see! The chains are slack and one horse draws the whole load. Now tell me, reader, is it an accidental *stone?* Or is it *friction?* Or is it the *vis inertiae?* Is it such bugbear fooleries as these? Or is it not rather the nature and face of the road, that affect these mighty differences! which nothing but broad smooth faced rollers can cure or render smooth and firm.[109]

Such rolling was not quite the fate of all attempts to apply analytic mechanics at the Society of Arts, but it bespoke the rutted messiness, the impressionistic judgements and the wide range of properties from which inventions stirred.

Despite the peculiarities of his arguments, however, Bourn was not entirely an eccentric. Histories have occasionally cited him as an authority on the state of eighteenth-century roads, largely I suspect because of the unexpected vividness of his style.[110] In the more immediate horizon, Bourn's specific advocacy of wagons was picked up by James Sharp, an "ingenious ironmonger" from Leadenhall Street in London, who managed to get them into use on the Bath and Bristol wagons; Sharp also inserted advertisements in London newspapers "that the Public might view the carriages and their effects, while they were at work in the neighbourhood of Northampton and Stony Stratford."[111] Sharp acknowledged a debt to Bourn, presenting his own wagons as improvements on the earlier devices. The fact that his broad-wheeled invention had been tried in practice meant that the questions he raised continued to agitate parliamentary enquiries into the early nineteenth century, where his wagons were conflated with the origins of the movement for broad wheels more generally.[112] Despite the rhetorical extravagance of his pamphlets, Bourn clearly

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[109] Bourn, *Brief Remarks,* 20-21.
[110] For example, William Albert, *The Turnpike Road System in England 1663-1840*, 8; a quotation from Bourn supplies the epigraph to Dorian Gerhold's *Road Transport Before Railways: Russell's London Flying Waggons* (Cambridge, 1993).
[111] James Sharp, "Some Account of Rolling Carts and Waggons as they are now built by James Sharp, of Leadenhall-street, London" in *The Universal Magazine,* 1773, **53**: 149-151, quotation at 151.
[112] As, for example, in Walker, *General Principles,* p. 24. For the context of these reports, and their connection with broader state projects of gathering facts, see Jo Guldi, *Roads to Power: Britain Invents the Infrastructure State*

drew upon the difficulties which mechanics faced in finding an abstract, simplifying vantage from which to speak of these machines.

5. Conclusion

It would not be difficult to interpret the mechanical record of the Society of Arts as one of failure. Certainly, we do not find in its repository anything akin to the canonical machines of the industrial revolution, however that is interpreted, or even much suggestion of shifting organisations of labour.

While such a reading is tempting, however, the ambiguities and tensions which run through the ideal of mechanical simplicity which have been traced in this chapter offer a different interpretation. Simplicity meant a multitude of different things and sought to comprehend a huge range of tools and devices. This meant that, characteristically, the Society's adjudications on mechanical matters were caught between a wish to offer authoritative judgements and a wide range of local producers and users. This did not reflect a mechanical failure so much as a recognition of the enormous and shifting variety of tools and processes which characterised this period. Simplicity suggested both the improvement of existing techniques, and the possibility of employing natural principles directly; it is not hard to see why it was such a high term of praise. Where they could – as in the case of timekeepers – the Society made honest efforts to bring artists capable of adjudicating genuine improvements into the committees.

A great many other contributions, on the other hand, had to be judged in terms of local recommendations and personal patronage. In the eminent circles associated with the Society, this provided for rewards, sometimes philanthropic, for the tools and techniques of daily use, which were passed along by personal recommendation. They seem to have held similar beliefs about how tools intended for humbler trades, such as shoe-making and ventilation, might be diffused, favouring worker-inventors because they stood the best chance of getting their inventions adopted. This spirit of inclusivity in the midst of hierarchy accords with the complex and contradictory public ethos of the Society which I traced in chapter two. It also accounts for the local qualities

(Harvard, 2012), 47-103. Guldi notes that wheel engineering was meant to be a technical fix to improve roads "[w]ithout raising taxes or altering the balance of local and parliamentary power" (49).

associated with so many of the inventions which were submitted to the Society, for which the absolute novelty we might expect in the case of patents was of much less significance than immediate utility, and support from some eminent worthy.

Against the backdrop of varied local practice simplicity was meant to reduce construction to proper mechanical principles. Trials of ploughs and carriages conducted under the Society's auspices were intended to demonstrate best practice, and find reliable measures for improvements. Yet even these trials, and the writings of mechanics, could not altogether abstract from the creaturely and local conditions within which machines like ploughs and carriages were to be employed. Projectors like Bourn who approached the Society in its early years exploited the great difficulty of reducing inventions solely to mechanical measures; and attempts to reduce the construction of ploughs entirely to mechanical principles over-reached themselves, becoming inattentive to significant differences of soil and situation. Thus in relation to such machines, attempts to disembed practice had to be balanced against quite local considerations.

None of this was confined to the Society itself, of course. In discussing eighteenth-century "faith in the machine" as a future state of industrial transformation, historians overlook already-existing machines and techniques and the arduous attempts to reduce them to theory. This is a loss. Construction of carriages was the kind of question which preoccupied Parliamentary inquiries; tools like Walby's trowels and Benjamin Smith's lever-cramps were valued in the trades in which they were employed; even though they did not come into wide use, hand-mills were philanthropic tools of the kind of social harmony which the Society of Arts sought to promote. Despite the lack of successful novelties in the repository, then, there are good reasons to think that the Society's machines, with all of their simplicities, offer a meaningful picture of the varied culture of public mechanics during the eighteenth and into the early nineteenth century.

Chapter Six: Material Substitutions

1. **Introduction**
2. **Substitution and Natural Knowledge**
3. **Chemistry: Potash**
4. **Botany: *Toxicodendrons***
5. **Metallurgy: Iron From Black Sand**
6. **Conclusion**

1. Introduction

In December 1768, two stories appeared in London newspapers about attempts to present substitute materials at the Society of Arts. The first described how a "filamenous substance, to answer the purposes of hemp", taken from the stem of the Plantain, had been presented to the Society. While plantain was "cultivated in great quantities, for the sake of fruit," it had "not been applied to any material purposes, both in the East and West Indies; and it was hoped that if the plant were used for that purpose, this would "save a considerable part of the sums we pay to Russia for that commodity".[1] The second indulged in a whimsical satire about a gentleman presenting to the Society "a Method whereby he can make Snow from Salt at all Seasons of the Year"; his "factitious Snow" was "clear, but not near so white as that of a true gelid Nature, although some Degrees colder." It would be used by Noblemen, and the gentleman hoped "by a Course of Experiments, to discover a Method of making Crystal from Salt, having first extracted that Saltness which both makes it brittle, and causes it to melt away upon the Approach of the least Moisture."[2] Both stories, one about chemistry, one about botany, spoke about the possibilities of replacing materials with those from new locations, or ones which were made in new ways. And both spoke of how substitution might become possible on account of certain material properties. In this sense, they were quite typical of the aspirations of the Society of Arts.

[1] *Gazetteer and New Daily Advertiser* (London, England), 6 December, 1768; Issue 12406.
[2] *St. James's Chronicle or the British Evening Post* (London, England), 29 December, 1768.

As we saw in chapter three, substitutions of various sorts pervaded the Society's activities. Because these activities were divided among the Society's various committees, I do not intend to give an account of its overall policy and practice regarding substitution. Instead, I want to suggest that the substitutive projects which were brought to the Society indicated a specific kind of problem. First, given that materials were used and judged by so many people with different skills, how could their properties be understood using the materials and processes, and ways of knowing, which were at hand? This involves the wide public which was promoted by the Society of Arts, because it meant that natural philosophers might not have a particular privilege in defining the qualities of materials. Second, was it possible to say that two things, brought from or made in different locations, were practically equivalent to each other? This connects with the difficulties of disembedding practices, because it raises the question of how far local characteristics – which included techniques of production, aspects of climate, soil and situation, among many others – had to be recorded in the effort to transfer a process to a new place. Taken together, substitutive efforts challenged the privilege of spaces – like laboratories and botanical gardens – within which natural philosophers operated. Thus the writings of even those who were most committed to a view which asserted the prestige of natural philosophical ways of knowing were marked by the need to represent what was done in many different places, in many different ways, and had to face questions of local knowledge more directly. Although they did attempt to define privileged positions from which materials could be known, these had to engage directly with what was done outside, in a wider world.

Section two offers a general argument about the relation between substitution and natural knowledge during this period, emphasising both the rhetoric of decontextualisation and the persistence of provenance within writings on substitution. Natural philosophers tried to define "pure" forms of materials which could be sourced from anywhere; but their efforts were complicated by uncertainties about how highly valued materials (from particular places) came to possess given properties; how this value might be transferred; and the sense that materials were valuable precisely because of the range of properties which they combined.

Sections three, four, and five then offer specific examples of substitutive projects in which the

Society was involved: potash, *Toxicodendron* plants for black dyes, and making iron from black sand. Quality testing of potash has been regarded as evidence of the rise of a laboratory culture of precision measurement; in fact, it required tricky reverse-engineering and speculation about the likely contents of hearths on other continents. The practice of botany is often argued to require the erasure of local characteristics and human uses, but in the context of a dispute about dyes, these remained powerfully persistent argumentative tools. Finally, the attempts to make iron from sand indicate how radically different views of materials could coexist in a single attempt to work with them, which simultaneously sought to assert that iron should be defined primarily in terms of its functional characteristics and in terms of privileged locations where it might be found in pure forms. All of these projects belong to the Society's early period: they are intended to exemplify the promises of substitution, and the marks which it left upon chemical and botanical writings and practices. The Society's boldest period affords the most striking examples of this because it represents the time when these hopes were highest.

In conclusion, section six then analyses the questions raised by these efforts in terms of the wider argument of this thesis. Clearly substitution involved attempts to disembed practices, and sought the involvement of a wide public (or at least a public wider than just natural philosophers).

2. Substitution and Natural Knowledge

Material substitution has recurrently been a goal of economic policy, and natural knowledge has often been enlisted for its cause. In Cameralist and Mercantilist thought substitution was associated with economic natural history as a form of improvement, either by introducing new plants and forms of production, or by surveying local productive resources which could replace goods which had been imported.[3] While it could be a goal of overall policy, substitution might also be instigated by farmers and manufacturers and prompted by local shortages or raised prices of imported commodities: the unavailability of a given commodity because of a trade embargo or increased

[3] Lisbet Koerner, *Linnaeus: nature and nation.* (Harvard, 2009).

import tariffs, for example. In consequence, historians emphasise the "piecemeal" quality of policy which encouraged substitution, its attempt to offer a "political resolution of differences between varied competing industrial and commercial interests" by allowing for "bargaining among interest groups".[4] The substitutive effects of tariffs were not launched solely with the goal of replacing foreign imports, but also of nurturing indigenous industries in colonised territories, following the ban on exports of Irish woollen goods in 1699.[5]

Outside the realm of policy, substitutive activities were part of the day-to-day business of producers, trying to produce goods of different qualities and claim that theirs were as good as those from abroad. At times, such efforts could be characterised as fraud or adulteration, with illegitimate materials replacing their proper counterparts: the excise was involved in quality certification of imports, and this can be regarded as one way in which knowledge was enlisted in attempts at substitution, in its broadest sense.[6] As Maxine Berg has stressed, moreover, among manufacturers of luxuries, the attempt to imitate imported goods in locally available materials prompted a great deal of experimentation and product innovation.[7]

In this sense, then, substitution could involve experimentation of both formal and informal kinds, as well as natural knowledge which could identify whether given materials really were equivalent to each other. It might also encourage more direct experimental investigations into the properties of materials, whose goals would be defined by legislation about allowable substitutions. This contrast was drawn by the traveller, spy and colour theorist (and Society of Arts vice president) Edward Bancroft, who argued that in France, Colbert's distinctions between "*grand*" and "*petit*" teints meant that materials were restricted to certain groups of users: "the drugs to be employed in each branch being also particularly specified; and the dyers in each prohibited from using, or having in their possession, any of the drugs allotted to the other."[8] This would, Bancroft

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[4] David Ormond, *The Rise of Commercial Empires: England and the Netherlands in the Age of Mercantilism, 1650-1770,* (Cambridge, 2003), 142.
[5] See ibid., 169. For the overall effect of the tariffs on the English and Irish linen trades, see ibid.,167-174.
[6] Histories of purity testing focus particularly on the "scientific" standardisation of products which emerged during the nineteenth century. See, particularly, James Sumner, *Brewing Science, Technology and Print, 1700-1880,* (London, 2013), and Peter Atkins, *Liquid Materialities: A History of Milk, Science and the Law,* (Farnham, 2010).
[7] Maxine Berg, "From Imitation to Invention: Creating Commodities in Eighteenth-Century Britain," *The Economic History Review,* 2002, **55**: 1-30.
[8] Edward Bancroft, *Experimental Researches concerning the Philosophy of Permanent Colours; and the Best Means of Producing Them*, vol. 1 (London, 1794), xxxvi. For the background on French theories of dyes, see Susan

thought, have led to restrictions in the art's progress, had Colbert not also employed "eminent chemists", including Dufay, Hellot, Macquer, and Berthollet, "to superintend, officially, the practice of dyeing, in its several departments, and to cultivate those branches of chemical and other sciences, which were connected with the principles, or capable of amending the theory."[9]

Bancroft looked rather wistfully towards the clear demarcation, and high status for chemistry, which the French arrangements entailed. Where such legal prescriptions were not in place, however, works concerned with substitution had to contend with existing uses of materials. They addressed a world of already circulating materials and names, which could not easily be reduced to order. This was true for even the humblest commodities. In a letter addressed to the Royal Society in November 1748, for example, the Virginia doctor John Mitchell argued that "altho' Pot-ash is a thing daily used, and well known even to the Vulgar; yet, as the making it is a mechanic Art, practiced only by the Vulgar, and neglected and overlooked by the Learned, so we have had no satisfactory Account of it".[10] Any suggestion that learned practice could dominate the "mechanic Art" had to contend with the prevalence of existing uses. This extended to classification as well as their practical uses. As James Keir was to put it in his 1789 *Dictionary of Chemistry*:

> As these names Potash, Soda and Ammoniac have been so long familiar in commerce and different arts, that the united authority of all chemists in Europe, phlogistians and antiphlogistians, could not alter their popular meaning, a confusion seems unavoidable and frequent uncertainty whether the philosophical or popular language be meant.[11]

Giving recipes meant wrestling with the variety of popular meanings, and the goods sold under given names. Here analysis was much less about specifying the exact composition of materials, and more about describing what goods sold under given names could be expected to work. When

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Fairlie, "Dyestuffs in the eighteenth century." *The Economic History Review,* 1965, **17**: 488-510, and Sarah Lowengard, "Colour quality and production: testing colour in eighteenth-century France," *Journal of design history*, 2001, **14:** 91-103.

[9] Bancroft, *Experimental Researches,* p. xxxvi.

[10] John Mitchell, "An Account of the Preparation and Uses of the Various Kinds of Pot-Ash; by John Mitchell M.D. & F.R.S. Read Nov. 17 and 24. 1748," *Philosophical Transactions of the Royal Society of London*, 1748, **48**: 541–63.

[11] James Keir, *Dictionary of Chemistry,* (London, 1789), quoted in Maurice Crosland, *Historical Studies in the Language of Chemistry,* (London: Heineman, 1962), 202.

Robert Dossie gave instructions for making varnish, for work, he cautioned that "with respect to the gums animi and copal, under which names, a variety of sums brought from the East and West-Indies, as well as Africa, pass, there are very few parcels which will be found to dissolve in oil of turpentine."[12] In 1758, similarly, William Watson contributed an "Historical Memoir" on lichens to the *Philosophical Transactions*, which noted the taxonomic problems caused by the "lichens of the shops."[13] The nomenclatural complexity occasioned some detective work, for varieties of usnea described by European botanists did not "[a]ppear to be the true usnea of the Arabians, whatever title they may seem to have to it, either from their colour or smell." The substance commonly sold as usnea meanwhile, was the basis of a "fine perfumed powder": Watson thought that "other of the lichens had a great a share in the composition as the *usnea;* as the demand for that powder could not have been answered, if the makers had confined themselves to the usnea alone."[14] Thus what could have been understood as "adulteration" – the replacement of usnea with other varieties – was in this instance a pragmatic necessity, owing to the true stuff's scarcity. Likewise, several varieties of rhubarb were grown under the auspices of the Society in England in the 1750s, each "lauded as the true Rhubarb"; one variety had been imported at first in the early seventeenth century, while others appeared for the first time in the 1730s and 40s.[15]

As we will see below, making decisions about substitutions mobilised laboratory tests, botanical classification, and other ways of knowing. It is important to note, however, that this did not shut down the questions about whether two specimens, brought from different locations, were equivalent to each other.

Despite the difficulties of reconciling the variety of ways of knowing materials with clear assessments of their qualities, natural philosophical writers sought to define the aspects of materials which would be significant for their substitution: analysis might allow for the materially significant aspects of materials to be clearly defined. To this end, some works also employed a language of

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[12] Robert Dossie, *The Elaboratory Laid Open, or, the Secrets of Modern Chemistry and Pharmacy Revealed,* (London, 1758), 303.
[13] William Watson, "An Historical Memoir concerning a Genus of Plants called Lichen by Michelli, Haller and Linnaeus; and comprehended by Dillenius under the Terms Usnea, Coralloides, and Lichenoides: Tending principally to illustrate their several uses," *Philosophical Transactions of the Royal Society of London*, 1758, **50**: 652-687, at 655.
[14] *Ibid.,* 663.
[15] Clifford Foust, "The Society of Arts and Rhubarb," *RSA Journal*, 1988, **136**: 350-353, at 351.

purity, or analysis through purely functional characteristics. They sought to describe how materials which were considered distinct could be shown to be composed of the same properties. Thus, for example, the third chapter of Robert Dossie's book *The Elaboratory Laid Open* promised an "examination of the sameness of several substances, which make a part of the *materia medica* under different denominations, without any essential diversity: being necessary for the determining how far many substitutions are allowable."[16] The point of this was to rise above the particularities of different materials and show how they were composed of similar substances. So chemical analysis showed that "the supposed difference […] betwixt salts of several kinds of vegetables, as of wormwood, broom, or tartar, does not consist, really, in the salts themselves," but rather in their adulteration "from the admixture of some other substance".[17] The claim that chemistry could rise above individual material particularities took on programmatic qualities. In James Delbourgo's words, the preface of Bancroft's *Philosophy of Permanent Colours* sought to move "well beyond a Plinian account of the geographical provenance of materials," and instead to construct "a world-historical hierarchy that ranked chemical explanation of human achievement in colour, above ancient arts and indigenous empiricism."[18] The London cutler Henry Horne complained that a taxonomic list of different kinds of iron in *Chambers' Dictionary* had "very arbitrarily assigned names and characters to different sorts of iron, according to the different countries where they are produced; this he has done in such a manner, (though without any real judgment), as to give the world a very high opinion of the iron of one country, to the great disparagement of that produced in another."[19] In all these cases, functional characteristics were meant to show that geographical provenance was not, in itself, a sufficient arbiter of quality.

The desire to replace the association of material quality with provenance with either analysis in terms of functional characteristics or a definition of pure forms of substances was complicated by two factors. First, materials bundled together properties in numerous different ways: they might be

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[16] Dossie, *Elaboratory,* 66.
[17] *Ibid.*
[18] James Delbourgo, "Fugitive Colours: Shamans: Knowledge, Chemical Empire and Atlantic Revolutions," in Simon Schaffer, Lissa Roberts, Kapil Raj, and James Delbourgo, eds, *The Brokered World: Go-Betweens and Global Intelligence, 1770-1820*, (Sagamore Beach, MA, 2009), 315, 318. For Bancroft's defence of a theoretical chemistry, see 312-4.
[18] Bancroft, *Philosophy of Permanent Colours*, xxxvi.
[19] Quoted in Chris Evans, "Crucible Steel as an Enlightened Material", Paper presented at *Steel in Britain in the Age of Enlightenment,* University of Glamorgan, 7/8 December 2007.

more than the sum of their parts. Thus Mitchell thought that the great value of good Swedish potash was its impurity: good samples might contain a "metallic substance" which could be used as Prussian blue dye; some contained crystallized salts resembling sulphur and charcoal, which caused a degree of explosiveness when boiled. Such volatile potash was suitable for making a soap, "impregnated with their heating sulphurous quality".[20] Overall, wrote Mitchell, "the Combination of these [chemical] principles makes many Properties in Pot-ash, more than what results from them in a State of Separation."[21]

Second, functional analysis could not necessarily give an indication of how materials came to possess their properties, and hence how the best forms might be imitated. This was because it was unclear, *a priori,* which aspects of processes of production were materially necessary, and which were extraneous custom or ritual; some materials might also depend on qualities relating to climate, soil and situation in which they were produced. Mitchell believed that the Swedish potash came by its properties through its particular process of production, which involved a slow accumulation of wood in large heaps. In this process, he wrote, the green wood would "impregnate" the ashes with "acid saline Parts of the Wood or Tar", which would be lost in smoke if the pine were burned in the open air. Through this preparation, the ash would also contain "the resinous Parts and sulphurous Fumes of the Pine, that are hindered from exhaling by the Heap of the Mass." [22] However humble a commodity potash was, its production was skilled work, capturing a wide range of properties which belonged to the materials from which it was composed. By contrast, English potash was made without the benefit of "proper Vessels to extract the Salt of the Lye by Evaporation, or in want of Wood to reduce the Ashes to Pot-ash". Prepared over open fires, it was imbued with "Coal of the Straw […] and its Salt is not so strong, as our Workmen say, or so sharp and corrosive as the Salt of the foreign Pot ash, that is calcined in an open Fire."[23]

Because of these differences and uncertainties, it made sense to arrange potashes geographically. Lewis' 1753 book *The New Dispensatory,* for example, itemised potashes according to their origins, noting that "[t]he strongest is brought from Russia, in dark coloured very hard masses, which

[20] Mitchell, "An Account", 558.
[21] *Ibid.,* 553.
[22] *Ibid.*
[23] *Ibid.*

nevertheless soon deliquiate in the air."[24] Pearl ashes from Germany were "extracted from wood ashes by means of water, and afterwards reduced into a dry form by evaporation."[25] English ashes were "liable to great abuses from sundry admixtures." And so on. In the hands of other investigators, this arrangement became a basis for analysing the composition of potash as well. In this spirit, the Scottish chemist Francis Horne found that Swedish and Russian ashes appeared to be adulterated with lime. Horne wrote

> There would appear, by my experiments, a greater difference than this betwixt the Swedish ashes, if that is the true process, [i.e. the recipe which Home had used] and those I have examined. I had discovered the greatest part of the Muscovy ashes to be lime. I suspected it might enter into the composition of the Marcroft and Cashub; and have accordingly discovered it there. *Without the same grounds, none would ever have searched for it.* Whence then comes this lime? It must either enter into its composition, or arise from the materials managed according as the process directs.[26]

The persistent significance of provenance was a feature even of works which argued for a hierarchy with chemical analysis at the top. Despite Bancroft's rhetoric, the substance of his text related a wrestle with powders and beetles, and the adamantine whims of the East India Company, as he sought to discover which substitutions were allowable.

Overall then, this survey of writings concerned with substitution suggests three general conclusions. First, that attempts at substitution had to contend with existing uses, rather than assuming particular privilege for natural philosophy. This meant that discourses of adulteration, on the one hand, and pure substances on the other, were confounded by a range of different judgments and forms of knowledge. Second, despite this difficulty efforts to speak in terms of purity as a grounds for substitutability were made, which put functional characteristics for definitions in terms of provenance. Third, these attempts to abstract materials away from their local characteristics were complicated by the uncertainty about how materials came to possess their

[24] William Lewis, *The New Dispensatory,* (London, 1765), 115.
[25] *Ibid.*
[26] Francis Home, *Experiments on Bleaching,* (Edinburgh, 1756), 105.

properties, and the relation between this and local conditions or particular techniques of production. These factors shaped the chemical, botanical, and metallurgical attempts at substitution which came through the doors of the Society of Arts. Each of the following sections deals with one of these.

3. Potash

As we have seen, mid-eighteenth century learned discussions about the production of potash focused on the connections between its provenance and its properties, and sought to describe techniques by which high-quality production could be transferred to new locations. During the 1760s, the Society of Arts was directly involved in such attempts, by offering premiums for the production of potash in North America. Robert Dossie and William Lewis were also rewarded by the Society for techniques which they developed for assaying potash.

These rewards for assaying have been noted by a number of historians of science, who have understood them primarily as contributions towards the development of laboratory practice, acting as precedent for later titrimetric analysis of the purity of goods. Larry Stewart, for example, argues that they evince a transition from a chemistry based on 'spectacle'. This was part of a broader shift away from bodily, impressionistic knowledge of materials, and towards an emphasis on more precise measurement. Lewis' techniques for assaying the potash deployed two significant approaches: "first the measurement of the quantity of the acid not by vague volumetric measures such as drops or teaspoons, 'but by weight.'" Second, "Lewis assessed the saturation point by 'the change of colour produced in certain vegetable juices, or on paper stained with them'."[27] In the context of substitution, however, we might expect other considerations to come into play than what could be ascertained through the precise techniques which were available in Lewis' laboratory. Descriptions of potash had focused on scale; time; properties of different woods; and a wide variety of productive locations. How did Lewis' and Dossie's techniques contend with these factors?

To answer this question, we need to look in rather more detail at how potash was being

[27] Larry Stewart, "The Laboratory, the Workshop, and the Theatre of Experiment", in Bernadette Bensaude-Vincent and Christine Blonde, eds, *Science and Spectacle in the European Enlightenment* (Ashgate, 2008), pps. 11-20 at p. 25; cp Frederick G. Page, "The Birth of Titrimetry: William Lewis and the Analysis of American Potashes", *Bulletin for the History of Chemistry,* 2001, **26**: 66-72.

produced in the American colonies during this period. Despite its simplicity, its production remained a rather experimental affair. Thus Alexander Garden wrote to the Society in 1759, noting that in Carolina, knowledge of how to make potash was not widely available. In line with his general views of the improvement of the colonies, Garden described potash as a potential alternative to existing crops. In a subsequent letter, Garden noted that Thomas Stevens was visiting, and attempting to introduce his own process.[28] Stevens was a projector, who had gained reward from the Board of Trade in London in 1751, to introduce the production of potash on a large scale in the American colonies. Another attempt was made separately by a group from Liverpool and Manchester, who sought to employ waste tobacco plant stems (increasing profits by utilising waste materials, rather than shifting the patterns of production in the colonies as such).[29] This concern soon failed, and its works were purchased by Stevens, who added "a large furnace besides other buildings."[30] During 1756 he toured Boston, New York and Philadelphia, to promote potash manufacture according to his large-scale process. While it was not identical with the Swedish process which Mitchell had described, it operated on a similarly large scale.

Despite Stevens' visibility, however, the longer-term viability of potash production in America depended on much more domestic forms of manufacture. Roberts argues, for example, that it spread through the development of techniques "which simplified the manufacturing process and thereby reduced the cost of entry" considerably below that of Stephens' elaborate furnace.[31] Thus the industry reached its mature form once "individual farmers found ways of making potash with equipment in common use on colonial New England farms", particularly through use of kettles "the get to make sugar in".[32] Attention also shifted towards the collection of wood ashes, rather than the employment of other waste plants, or those specifically grown for the purpose.

Thus the Society's involvement in assaying potash occurred against a background of uncertainty and experimentation about the scale at which it ought to be produced, its raw materials, and the

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[28] Alexander Garden to the Society of Arts, April 20th, 1755, in Joseph I. Waring, ed., "Correspondence between Alexander Garden, M. D., and the Royal Society of Arts", *The South Carolina Historical Magazine*, 1963, **64:** 16-22, 86-94, at 18.
[29] Stevens' activities are described in William I Roberts III, "American Potash Manufacture Before the American Revolution", *Proceedings of the American Philosophical Society*, 1972, **116**: 383-395.
[30] *Ibid.,* 387.
[31] Letter of Joseph Locke, March 19, 1771, Wendel Family Papers, Massachusetts Historical Society, quoted in *Ibid.,* 392.
[32] Roberts, "American Potash Manufacture", 395.

equipment which effective production would require. Dossie appears to have recognised this, and positioned himself (somewhat opportunistically) as the author of a simplified technique. This he claimed, was a considerable advance on Stevens' approach, which had required so much heat that to "fuse the alkaline salt" also "fused the furnace likewise; and caused the destruction of an expensive apparatus."[33] Dossie also noted that he and the Society had been denied credit for the introduction of this procedure, due to its apparent similarities with Stevens' techniques. According to Dossie, however, such apparent similarities existed only because they had both drawn upon widespread existing methods:

> [t]he necessary vessels, and the manner of making the leys, did indeed appear similar in them: there being no novelty in either […] for the operation consisting only in mixing water with the ashes, and drawing it off after it is impregnated with the salt, is of so simple a nature as scarcely to admit of any variation, but that of adapting the magnitude of the vessels, or the convenience of their form, to the quantity of the ley required.[34]

Dossie's original addition – he claimed – was the introduction of a cauldron. Reports which had given priority to Stevens had "obtruded" this cauldron in the place of Stevens' furnace, even though no cauldron was mentioned in his process, and one "could have no possible office, or use in his method".[35] Of course Dossie's claims about the simplicity and invariance of potash production was true only for relatively small batches: it made no reference to the elaborate impregnations which Mitchell had documented. Dossie was aware of this, and deliberately positioned his method as a smaller-scale alternative to Stevens' elaborate process.

Dossie's description of how to assay potash emerged from his direct interest in claiming to be the author of an improved process. This extended to his claim about the material nature of the

[33] Stevens' own remedy for this defect – noted Dossie – was through "the choice of such materials for building the furnaces, as might resist the vitrifying power of the fire and salts; or such fabrication as might regulate the heat." Under Stephens' own management, "when he conducted the operations with the greatest care and skill" these worked; "but when they were left to the management of others, the furnaces were soon destroyed" – in Robert Dossie, "Of Improvements relating to our Trade with the British Colonies," *Memoirs of Agriculture,* 1768, **1**: 233 -308, at 250.
[34] *Ibid.,* 259.
[35] *Ibid.*

substance produced in the colonies, particularly through claims about what its pure forms should involve. As so often with the Society's projects, encouragement was intended for a process which was just on its way to perfection: "a prohibition of the exportation of all, that was not of a standard goodness, would check and discourage the manufacturers, so as to dispose them to quit the undertaking, before they had made themselves masters of the art."[36] From this perspective, Dossie argued that the American potash was made by a good procedure which was imperfectly managed on some occasions. He defined the American potash as a "different article of commerce from the European" which "must be judged of, as to its goodness and value, by a different standard of examination."[37] It was thus to be understood in terms of its provenance, though in the special sense that North America was the place which manufactured according to the techniques set out in Dossie's pamphlet.

Accordingly, he started from an ideal set of properties which the American ash should contain, and then described deviations from this as the results of imperfect management. Good American potash, he claimed, would be "white semi-crystalline", dissolving "easily and perfectly in water", and "separated from vegetable fixt alkaline salt on its dilution in water."[38] If it did not respond in this way, this was probably because "parts of the vegetables not perfectly calcined [were] put into the dissolving vat or steeper with the ashes", or through the makers "suffering part of the ashes to be drawn off with the ley into the evaporating vessels"; or by "not giving a due heat to the alkali after the water was evaporated"; or perhaps the heat was uneven.[39]

Lewis' approach was different. Rather than starting with an idealised picture of the American potash's properties, he sought to reverse-engineer it by imitating as closely as he could the process which had been used to make it. He gathered ashes from London kitchen hearths. The potash which he produced, on a small scale, appeared to be kin to the American because of their gross physical similarities: both were slow to dissolve, with a "compact texture occasioned by the fusion";

[36] *Ibid.*
[37] Robert Dossie, *Observations on the Pot-Ash brought from America*, (London, 1767), 6.
[38] *Ibid.*
[39] *Ibid.*

in solution they stained silver, and when added to acid, produced a fetid smell.[40] Lewis' potash also contained as much salt as some of the American samples. However, he argued that with respect to his own, he thought this impurity could be accounted for "from the common salt, which the ashes of kitchen-fires cannot fail to partake of."[41] However, he went on, the American colonies were much more sparsely populated, and so salt consumption should have been much less: therefore there should have been much less salt in the sample. Some, indeed, were so salty that he suspected their lye had been made from sea water. All of this involved speculation about processes of production which went beyond his laboratory procedures, and which continued to employ sensusous approaches.

Superficially, it was easier to demonstrate the source of the American ashes' causticity. Lewis' ashes were not caustic, and he ventured "that the causticity of the *American* Potashes does not proceed from the manner of their preparation, but from an addition of quicklime."[42] But he suspected that too might have been an offshoot of the production of the production process. Lewis had read in the Transactions of the Swedish Academy that Dr. Brandt had managed to use fire to convert wood ashes into quicklime. He tried to repeat Brandt's procedure, with unclear results: "though vegetable ashes may be brought by fire to have some of the properties of quicklime, and though in this state they should be capable of giving some causticity to alkaline salt, yet they do not become perfectly the same with the common quicklimes."[43] In any case, such conversions would have required much more heat than Lewis' ashes had received.

Despite the combination of precision and reverse-engineering which he brought to bear on the potash, Lewis' overall conclusions were extremely tentative. Unlike Dossie, he claimed that he could not judge "[w]hat proportion of vegetable earth may be allowed in a good Potash, and what proportion shall be deemed to render the commodity unfit for market"; though he also suggested that it would be helpful to fix some mark of the quantity onto the tubs in which it was sold.[44] He added that "[t]he best Potashes contain always some quantity of indissolvable earthy matter; some

[40] William Lewis, *Experiments and Observations on American potashes, with an easy method of determining their respective qualities* (London, 1767), 10.
[41] *Ibid.,* 11.
[42] *Ibid.,* 12.
[43] *Ibid.*
[44] *Ibid.,* 13.

of those which have been long used in certain businesses, as the *Russian,* a very large one."[45]

Lewis' potash assay was indeed precise, and intended to avoid the contingencies which were involved in other tests of the material. It was, however, only one part of his work on the potashes, and exclusive focus on it ignores the wider context in which the trials occurred. Lewis did not only use precision measurement: he also investigated ashes from hearths, speculated on the effects of different kinds of wood, and had to attempt to faithfully recreate the American process on the basis of the materials which he could obtain in England. (If Stevens' larger-scale process had been more successful in the American colonies, Lewis would probably have been unable to attempt similar re-creations). Both he and Dossie defined "pure forms" of the potash, but these were rather different in kind: Dossie insisted that these would be produced directly by the improved procedure which he had authored, which was radically different to the European; while Lewis thought that the alkaline salt was the only relevant consideration in determining the properties of potash. All of these were operations intended for specific uses of the material, and effectively restricting it from others (such pure potash could not be used for the purposes which Mitchell suggested, for example); it also left open the question of the relation between such samples and the qualities of "the best" kinds of potash, which continued to be identified in terms of provenance and impurity. As one weary American observer put it in 1808, "[t]he man of science, who only has read elementary books, talks of pot-ash as a thing perfectly understood. But his ideas apply to the alkali in its pure state, and have very little reference to it, mixed and adulterated as it actually exists in the market". [46]

4. Botany: *Toxicodendrons*

The potash trials required a product which was readily available, and which could be reproduced in different territories (even if, as Lewis found, there were some uncertainties about whether this really produced the same substance). Materials derived from plants faced different questions, because of doubts about the availability of given plants, how far they could be acclimatised to new settings, and whether workable substitutes could be derived from analogous species. The mere fact

[45] *Ibid.,* 15.
[46] Anon, "Inspection of Pot-Ash", *The Medical Repository and Review of American Publications on Medicine, Surgery, and the Auxuliary Branches of Philosophy*, 1802, **5**: 81-82, at 81.

that a plant contained a particular colouring matter was not sufficient for it to be useful in dyeing: there also had to be evidence that it could be grown on an extensive basis. This might involve experimental introductions through botanical gardens, or plant introductions – but the viability of these processes would require reference to existing practice. Did very high quality materials, like the varnish of Japan, *have* to be derived from their traditional sources, or could they be either imitated in alternative materials, or introduced to new territories?

I want to exemplify the different preoccupations of botanical writing work which focused on the possible substitutions of plants through a controversy between two men involved with the Society of Arts which raged in the pages of the *Philosophical Transactions of the Royal Society* during the early 1760s, about which plants which might grow or be grown in America might prove suitable for the production of black dyes. The antagonists were the gardener Philip Miller, and the botanist John Ellis (c. 1710-1776). Ellis was a linen merchant, probably of Irish origin, who alternated between affluent leisured natural history and bankruptcy, and served briefly as head gardener for the MP Philip Carteret Webb at Haslemere in the early 1760s.[47] Returning to London after this employment, he received a salary as an officer of the Irish Linen Board and agent for West Florida and the government of Dominica. Partly in this official capacity, and party through his involvement with the Society of Arts, Ellis published a number of works advocating the transfer of plants – particularly breadfruit and mangoes – and recommended Dominican coffee. This culminated in his manual *Directions for Bringing over Seeds and Plants* in 1770.[48] He was also a correspondent with Garden, Linnaeus, and other botanists.[49]

Twenty years older than Ellis, Miller was an influential gardener, who ran the Physic garden at Chelsea for half a century, and authored *The Gardener's Dictionary,* in which he adopted Linnaean taxonomy with considerable reluctance.[50] The two men adopted different styles of botanical argument. Ellis argued for species which were fixed, could be described in the language of Linnaean

[47] Paul F. S. Cornelius and Patricia A. Cornelius, "Ellis, John (*c.*1710–1776)", *Oxford Dictionary of National Biography*, Oxford University Press, 2004; online edn, May 2005 http://www.oxforddnb.com/view/article/8703, (accessed 23 Sept 2013).
[48] John Ellis, *Directions for Bringing Over Seeds and Plants*, (London, 1770).
[49] Stephanie Volmer, *Planting a New World* (Unpublished PhD Thesis, Rutgers University, 2008).
[50] Hazel Le Rougetel, "Miller, Philip (1691–1771)", *Oxford Dictionary of National Biography*, Oxford University Press, 2004 <http://www.oxforddnb.com/view/article/18734> (accessed 23 Sept 2013).

systematic botany, and whose properties had to be referred to their existing uses; Miller referred primarily to specimens from specific gardens, allowed for properties to shift according to the culture which plants received, and drew on pedigrees of identification by eminent botanists to make his case. These differences meant that Ellis could position himself as closer to a practical world of relatively fixed plants, which through encouragement might be exploited in new ways. For Miller, by contrast, identities and uses were decided largely by personal connection with privileged specimens, and the pedigree of certain samples. At the same time, however, both defined their interest in plants in terms of their useful properties. The dispute was certainly about substitution, and the viability of the Society of Arts offering premiums to encourage the cultivation of certain plants in North America.

I now want to turn to look at the letters themselves. I will analyse them in some detail, emphasising the material, written, and social aspects involved in identification for Miller, Ellis, and the others who were more peripherally involved in the dispute. In the first letter about *Toxicodendrons*, the Abbé Mazeas sent to Stephen Hales details of a promising plant, which had been communicated to him by Abbé Sauvages. Its juice, he wrote, "adheres, without the least acrimony, to a cloth, with more force than any other known preparation"; linen stained with it had remained black for five years, despite "the great number of washings in lye it has gone through."[51] Mazeas had gone to the Duke D'Ayen's botanical garden in St. Germain, hoping to confirm the plant's properties. He was shown "the plant mentioned", and told that it was "a native tree of Carolina"; the specimen in the garden was young, however, and its juice turned from brown to black extremely slowly.[52] Mazeas also examined all the other *Toxicodendron* plants in the garden – one of which was a shrub, apparently full grown, and remarkable "for having an infinite number of black points scattered upon the surface of its leaves, which seem'd to me to be a juice extravasated through the puncture of insects."[53] Pulling off a leaf, Mazeas found a milky juice, "which, the instant it was exposed to the sun, became the finest and deepest black I had ever seen."[54] Mazeas

[51] Abbé Mazeas, James Parsons and Philip Miller, "Two Letters concerning *Toxicodendron*," *Philosophical Transactions of the Royal Society*, 1756, **49:** 157-166, at 160.
[52] *Ibid.,* 157.
[53] *Ibid.*
[54] *Ibid.,* 158.

thought that if the Carolina trees had been fully grown, their colour would have been equally good. Washing the linen which he had stained with their juices, he found that the dye stayed in place. He took leaves from the *Toxicodendron glabrum*, and placed linen in a boiled decoction made from them – which was tinged an inferior and inconsistent green, sometimes tending to black. Thus it appeared that "the resinous juice of the internal parts of the plant was the only part capable of producing the desired effect."[55] He wanted to try experiments on the plant's roots as well, "but, as there was only one in the garden, I was afraid of injuring it."[56]

Several features are notable in the observations and experiments which Mazeas sent to Hales. First, he did not refer to his own botanical knowledge, or to existing practice elsewhere in the world – rather, he was confined to what was available in the Duke's botanical garden, what he observed himself, and the reports of the gardeners. Such resources were notably limited: he admitted that he had knowledge only of young forms of the Carolina trees, and had too few samples to try the roots.

Alongside Mazeas' letter, a commentary from Miller was published. Here, he criticised Mazeas' claim to novelty, because "whoever will give themselves the trouble to turn to the books, in which the plants is described, will find, that this *American Toxicodendron* is the same species of plant, from which the inhabitants of Japan procure the varnish, with which they stain all their utensils."[57] This was clearly a different strategy, based on an appeal to botanical authority rather than direct inspection of plants. It also allowed the botanist to state with some confidence how plants were used elsewhere in the world, on the basis of his knowledge of the literature. Thus the German traveller and botanist Engelburt Kaempfer had, Miller wrote, given an account of the Japanese plant in 1712.[58] Dillenius had also described it, transcribing the definition which was given by Kaempfer as well; giving both a Latin descriptive name and the one used by the inhabitants of

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[55] *Ibid.,* 159.
[56] *Ibid.,* 159.
[57] *Ibid.,* 162.
[58] For Kaempfer's botanical methods, see Wolfgang Muntschick, "The Plants that Carry his Name: Engelbert Kaempfer's Study of the Japanese Flora," in Beatrice Bodart Bailey and Derek Massarella, eds, *The Furthest Goal: Engelbert Kaempfer's Encounter with Tokugawa Japan*, (Folkestone, 1995), 71-95. As Muntschick notes, Kaempfer was a source for "botanical detail, the history of cultivation and economic significance," (85) of Japanese plants. Joseph Banks occasionally alluded to his work on the subject of tea – another plant where species identity and method of cultivation and preparation were in complex relation. Notably, though, Banks cited Kaempfer as an authority on the location of the best varieties of tea, rather than for providing a description of how it was prepared. See Joseph Banks to William Devaynes, 1788, letter 35 in Neil Chambers, ed, *The Letters of Joseph Banks, A Selection 1768-1820,* (London, 2000), 114.

Japan, which was "sitz vel sitz dsiu", or "urus seu urus no ki"[59]; Kaempfer had also described a wild form of the varnish tree, which was called Fasi no ki; Miller noted however that "the varnish, which comes from this tree, is of little esteem."[60] It had also been described by Catesby, in the *Natural History of Carolina*, who had, however, given it another name, and detailed some more local names and uses:

> The inhabitants of Carolina and the Bahama islands call it, Poison-tree, and Poison-ash, as the other two sorts of *Toxicodendron* are called Poison-oak in Virginia and New England. Mr. Catesby takes notice, that from the trunk of these trees is distilled a liquid, black as ink, which the inhabitants say is poison; but does not mention its being used there.[61]

The Royal Society had received seeds of the true varnish-tree, from Jesuits in China, but these were of the wild sort.[62] Miller also gave the details which the Jesuits had relayed of how the varnish was collected in Japan, and noted the provinces in which it was cultivated: the best variety of varnish was produced around the city of Jassino; however, "there are many other sorts of varnish, which are collected in Siam, Corsama, and other provinces, which are much inferior in their quality to this, and are produced by different plants"; one of the best, according to Kaempfer, was produced "from the Anacardium, or Cashew-nut-tree."[63] Finally, given the great abundance of both these shrubs and the Anacardium in southern America "it were to be wished, that the inhabitants of both would make some experiments to collect this varnish, which may not only produce much profit to themselves, but also become a national advantage."[64]

Miller moved beyond Mazeas' original observations by placing them in botanical and natural historical context, and relating them to the provenance of plants in prestigious collections. He understood the affordances of American plant life in terms of an analogy with the Japanese and

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[59] Miller, "Two Letters", 162.
[60] *Ibid.*, 162. Miller added that it was no surprise that the American and Japanese trees should turn out to be the same, for "the Genseng, the Bignonia, commonly called Catalpa, with many other plants, are found to be natives of both these countries." (165). Perhaps, Miller added, even the Tea-tree might be discovered in America, "if persons of skill were there to search for it."
[61] *Ibid.,* 165.
[62] *Ibid.,* 163.
[63] *Ibid.,* 164.
[64] *Ibid.,* 166.

Chinese, and this allowed him to claim that the properties of certain American trees had been neglected, and were worthy of further notice. However, he had made no experiments of his own.

Ellis' attention was probably drawn to the affair by a letter which he received from Garden, dated January 13, 1756. Garden reported that he had read Millller's report and claimed that he would

> be glad to know the species of the *Toxicodendron* which either Mr. Miller or the Abbe means, for we have several species of it here. And the Chinese Varnish-tree grows no where wiith us but in the Back Settlements. I never saw it within 80 miles of Charlestown, consequently it was never known to Catesby whether it grew here or not, as he never was 30 miles back from the coast during his stay here; so that I cannot help thinking that the comparison between our *Toxicodendron* and the Chinese Varnish, by the German there hinted at, must be very vague.[65]

Ellis picked up Garden's uneasiness at the identification of the different plants. Like Miller, he referred to botanical authorities, to which he added his own experiments, but he also referred to direct consultation with those who used, bought, and sold plants. Thus where Miller's account of the properties of plants depended exclusively on botanical authority, Ellis incorporated a more diverse range of views. However, he also had to find ways of mapping what was available in London – the trees in gardens, and dried botanical specimens in books – onto these reports from the wider world. Thus he noted that he had had the opportunity to examine the collection of exotic plants at Christopher Gray's nursery garden at Fulham, focusing on the *Toxicodendrons*, which Mazeas had described, in the hope that he could discover "whether in reality this pinnated *Toxicodendron* of our North American settlements, is the true varnish tree of Japan, as asserted by Mr. Miller."[66] To this end, he recreated the boiling experiments, and found that "the pinnated one called by the gardeners the poison ash, did not strike so deep a black as the other two trifoliate

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[65] Garden to Ellis, Jan. 13, 1756, in James Edward Smith, ed. *A Selection of the Correspondence of Linnaeus and Other Naturalists, from the Original Manuscripts,* vol. 1, (London, 1821), 370.

[66] John Ellis, "A Letter from Mr. John Ellis, F. R. S. to Philip Carteret Webb, Esq; F. R. S. Attempting to Ascertain the Tree That Yields the Common Varnish Used in China and Japan; to Promote Its Propagation in Our American Colonies; And to Set Right Some Mistakes Botanists Appear to Have Entertained Concerning It", *Philosophical Transactions of the Royal Society*, 1756, **49**: 864-876, at 867.

ones, being more of a rusty colour".[67] With this hint that the two plants were not the same, he retranslated Kaempfer's descriptions of both the true and the "spurious" trees, and found that they differed from the American specimens because of the shape and texture of their leaves; the error had crept in with Dillenius' assertion of the identity of the Japanese and American trees, "whereas had he been exact in the description given it by his author, he must evidently have made it another species." Linnaeus too had been misled.[68] Moreover, the identification of the two types of varnish, he argued, had also emerged because Kaempfer had relied on "the report of the common people of Japan", that "the true Varnish-tree degenerated into the spurious one for want of culture."[69] But, Ellis thought, "our knowledge in this science is so much improved, that such doctrines are not easily admitted among our gardeners".[70]

Finally, Ellis returned to Kaempfer's description of the varnish again. Here a report on the scarcity of a commodity became a key for what might make sense in terms of encouraging planting:

> After Dr. Kaempfer has described the true Japan Varnish-tree, he then tells us, that the Varnish is collected from it near the city of Jassino, and that it is the best Varnish in the world; but that it is in so small quantities, that there would not be sufficient for their own manufactories, were it not for a baser kind of Varnish, which is brought to them from Siam, and called Nam-Rak. This Siam Varnish he tells us, is got in the province of Corsima and kingdom of Cambodia, from the tree Anacardium, called by the inhabitants Ton-Rake, that is, Tree-Rak. The fruit of this tree he says expressly is called in our shops Anacardium.[71]

Kaempfer had observed that so much varnish had been derived from the oriental Anacardium that it served not only "to varnish all the utensils of China, Tonquin, and Japan, but that it is exported in wooden vessels to Bataia, and several other part of India."[72] Ellis therefore thought it

[67] *Ibid.*
[68] *Ibid.,* 869.
[69] *Ibid.,* 875.
[70] *Ibid.,* 875.
[71] *Ibid.,* 872.
[72] *Ibid.,* 873.

might have been what had been described in an earlier edition of the Philosophical Transactions as Toeng-yeou, which was "universally used in China for preserving and ornamenting their furniture."[73] Miller had asserted that this varnish was produced from the cashew nut tree; but Linnaeus had classified it apart from the "oriental Anacardium, Avicennia".[74] Ellis tried the dyeing properties of this "oriental variety", and consulted with "gentlemen in the East-India trade"; who had informed him that "[a]s the printers or strainers of callicoes in the East-Indies make use of some black dye, that holds its colour, and does not impair their cloths".[75] He was told that they were known throughout India as "[m]arking-nuts, and are sold for that purpose in their bazaars or markets". [76] This oriental Anacardium now seemed to Ellis the most promising candidate for growth in the American colonies. And he was friendly with an institution through which its growth could be encouraged directly:

> As our Premium Society for the encouragement of Arts and Sciences have a scheme on foot to promote the growth of many really useful vegetable productions, which are at present brought to us, at a great expence, from Spain, France, Italy, the Levant, Africa, and the East-Indies; I think this Anacardium orientale, or Avicennia of Linnaeus, claims a place among the rest; especially, when we consider of what use and importance it is in the two great empires of China and Japan, besides all the other parts of India.[77]

Overall, then, Ellis was less inclined than Miller to accept analogies between plants on the basis of the latitudes at which they grew, as if they would be found already growing in America: rather he wanted to claim that useful plants needed to be transplanted to new locations. This required careful

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[73] *Ibid.*
[74] *Ibid.*
[75] *Ibid.,* 872.
[76] *Ibid.,* 873. Ellis also tried the cashew-nut oil which Miller had recommended; it did no more to stain linen than olive oil would have; in any case he had authorities which showed that it was "of the same nature and mechanical use with gum arabic; and consequently will dissolve in water". To prove the point, he also obtained samples of both the Cashew-nut gum – which "dissolves in the mouth like gum arabic" – and of the China of Varnish, "from Mr. Margus, a great dealer in China commodities, just as it was imported from thence: this seems to answer the description of the Siam varnish" (874); Ellis had tried some experiments, and it did not dissolve.
[77] *Ibid.,* 874.

identification of promising species to be transferred, for which evidence was provided by existing usages.

Miller's next response was read at the Royal Society on December the 15th, 1757. He was now on his botanical honour, and claimed that in response to Ellis' charges he needed to "lay before the Society the authorities, upon which I have grounded my belief, that they are the same".[78] Unable to resort to information from those in the trade, he turned instead to very personal connections. He had named the American *Toxicodendron* himself, in 1730, and he claimed a direct personal pedigree and numerous expert witnesses for knowledge of its properties. He had reared plants from seeds sent from Carolina by Catesby, and dispatched samples to Paris and Holland. But even before that time, it was grown relatively widely. He had seen examples at the "gardens of the Bishop of London at Fulham, Mr Reynardson's at Hillenden, Mr. Darby's at Hoxton, and in the Chelsea garden, which were raised from seeds sent by Mr. Banister from Virginia."[79] Miller had been asked by Dr. William Sherard to bring a specimen to him, so that both he and Dillenius could compare it

> with a dried specimen in the collection of the former, which was gathered in Japan, and which, if I remember right, he told me received from Dr. Kaempfer some years before. It appeared to those two gentlemen, that they were the same; and their skill in the science of botany was never doubted.[80]

A year later, Miller brought another specimen to a gathering of botanists at Sir Hans Sloane's. Again, a number of eminences compared it to Kaempfer's specimen: "and it was the opinion of every one present, that they were the same."[81] No one had doubted this, who had "compared the American shrub with Kaemper's figure and description of his true varnish-tree, but Mr. Ellis." As to the question of whether Catesby's *Toxicodendron* was a poison-ash, Miller argued that "most of the plants in the nursery gardens about London were first raised from the seeds, which were sent by Mr. Catesby from Carolina"; indeed Miller had raised many of the plants himself, and distributed

[78] *Ibid.,* 431.
[79] Philip Miller, "Remarks upon the Letter of Mr. John Ellis, F. R. S. to Philip Carteret Webb, Esq., F. R. S.; Printed in the Philosophical Transactions, Vol. xlix. Part ii. p. 806", *Philosophical Transactions of the Royal Society,* 1758, **50:** 430-440.
[80] *Ibid.,* 432.
[81] *Ibid.*

them from the garden in Chelsea.[82] Personal possession was proof of his veracity, and the difference between the oriental and American cashew trees was a fact "of which I could not be ignorant, having been possessed of both sorts near thirty years."

Miller also made a number of statements to oppose Ellis' more botanical arguments. Ellis had erred, he claimed, in arguing only about the parts of plants, rather than their whole.

Miller's argument that Ellis was insufficiently attentive to the whole of plants extended to his account of their properties. He had been

> assured, from many repeated experiments, that the milky juice, with which every part of the [American] Cashew-tree abounds, would stain linen with as permanent a black as that of the oriental Anacardium; so I just hinted, that it was worth the trial. Nor was my hint grounded on those experiments only, but on the informations I had received from persons of the best credit, who had resided long in the American islands, that people are very careful to keep their linen at a distance from those trees, well knowing, that if a drop of the juice fell upon it, they could never wash out the stain.[83]

In other words, people who lived with the plants had reported on their properties – it did not require the testimony of linen dyers specifically to indicate what other uses they might find. Ellis, he claimed, had tried the wrong part of the plant – the oil of the nut not the juice of the tree: whereas Miller had read *The History of Jamaica* by Sir Hans Sloane, and there it said "that the inhabitants of Jamaica stain their cottons with the bark of the Cashew-tree."[84]

Ellis' final response was read to the Royal Society in January 1758. There, Ellis returned once again to Kaempfer, claiming that close reading proved decisively that Miller was mistaken, insisting once again on the lack of similarity between the Japanese varnish and the American tree, and emphasising the practical impossibility of using it in the ways that Miller had claimed. Kaempfer had described the true Japanese varnish tree as "a tree not a shrub" and gone on "to explain the manner of its growth; and tells us, that it grows with long sappy shoots, very luxuriantly, to the

[82] *Ibid.,* 434.
[83] *Ibid.,* 439.
[84] *Ibid.,* 440.

height of a sallow or willow-tree, which we may reasonably allow to be from 20 to 30 feet"; the Carolina tree, by contrast, "seldom rises above five feet high with us; and many people, who have been in North America, that it is but a slow grower there, and is one of the shrubby underwoods of that country."[85] Moreover, after Dillenius' identification of the two trees, "attempts were made by intelligent persons under his direction, to procure this varnish after the manner of Kaempfer", all of which had failed.[86] Ellis then observed how Dillenius had adopted Kaempfer's Latin, in relation to the flowers of the plant: an error which he had made had compounded an error about the trees' flowers, and spread the false synonym. This had misled Miller and "his botanic friends", because they had attempted identification "from the similitude of leaves only, without the parts of fructification, they determined these two plants, so different in their growth, to be one and the same plant."[87] Compounding error with error, Miller had inadvertently introduced yet another *Toxicodendron*: the one which Catesby had described only grew in the Bahamas, rather than in Carolina.

Ellis' greatest scorn was reserved for Miller's view of existing dyers' practice. He claimed that Miller's paraphrase had seriously distorted Kaempfer's account of where the varnish was collected and employed. Thus Miller had claimed that varnish was collected from Japan, but Kaempfer had said it came from "Siam and Cambodia". This fact was important especially because "the parts of those kingdoms, where Kaempfer informs us this Anacardium grows, lie in the latitudes of from 10 to 15 degrees north, which must be full as hot as our West Indies"; it could not bear the cold of the winters in Japan.[88] He also retranslated another passage from Kaempfer, which Miller had given as "this varnish is used without mixture to stain black: but the Chinese mix native cinnabar, or a red kind of earth, with it, to make a different colour".[89] Miller had, wrote Ellis, failed to understand the significance of the word "staining", and so had used this as evidence that it could be used as varnish

[85] John Ellis, "An Answer to the Preceding Remarks", *Philosophical Transactions of the Royal Society,* 1758, **50**: 441-456, at 442.
[86] *Ibid.,* 443.
[87] *Ibid.,* 445.
[88] *Ibid.,* 450.
[89] *Ibid.,* 452. In Latin: "Prostat non sincera modo, sed et colorata, vel cinnabari nativa Sinensi, vel terra rubra (quam Batavi antea, nunc Sinenses advehunt) vel altramenti popularis material." Ellis' version: "this varnish is not only sold quite pure, but likewise coloured, and that with Chinese native cinnabar, and a kind of red earth, which the Dutch formerly, but now the Chinese, bring them; and also with the materials that they make their common (or Japan) ink of."

directly, but this was not "the sense of the author, who, by mentioning the materials of Japan ink, shews, that even in varnishing black it was necessary to use this black mixture."[90] The Chelsea gardener had been trying to prove "that the art of painting or staining cottons of a fine deep black colour […] was practiced by the English forty or fifty years ago in Jamaica."[91] If this was so, scoffed Ellis, "it is somewhat surprising that, notwithstanding our great intercourse with that island, the calico-printers of England never got intelligence of this valuable secret."[92] It was this point which demonstrated the greatest point of difference between Ellis and Miller. Again and again, Ellis had insisted on existing uses as primary proofs of the identity of trees, and argued for the possibility of transplantation.

As a botanical controversy, the dispute was inconclusive. Ellis continued to seek information for at least another six years, writing to Garden in 1761: "pray let me into the history of the *Rhus* and *Toxicodendron.* You know how much I shall be able to triumph over Miller's blunders by that means."[93] In 1792 Thomas Horsfield from Philadelphia made experiments on a number of *Rhus* plants from North America. Alluding to the dispute between Miller and Ellis, he wrote that it

> certainly was carried on under very unfavourable circumstances: the difficulty of procuring specimens from foreign countries; the imperfection or fallacy of specimens when procured; and the variations, to which vegetables naturally are subject, when removed from their native soil to distant and unaccommodated climates, has led them, on both sides, into many inaccuracies and mistakes. Every person, acquinated with Botany, who has seen the trees in their native countries, will readily discover the sources of their deception.[94]

Horsfield then set about proving the equivalence between the varnish produced by North American *Rhus Vernix* trees with that which Kaempfer had described. He was convinced that they

[90] *Ibid.,* 452.
[91] *Ibid.,* 455.
[92] *Ibid.*
[93] Ellis to Garden, London, 8 April, 1761, in Smith, ed. *A Selection of the Correspondence of Linnaeus*, (London, 1821), 507.
[94] Thomas Horsfield, *An experimental dissertation on the rhus vernix, rhus radicans and rhus glabrum; commonly known in Pennsylvania by the names of poison-ash, poison-vine and common sumach*, (Philadelphia, 1798), 10.

were in fact the same plant, though he acknowledged that his experiments into the composition of the varnish were not as detailed as he would have liked.[95] Bancroft, likewise, had offered an account of various poisonous shrubs, and believed that the *Rhus vernix* grew in Japan as well as in North America; he also thought that a different American toxicodendron tree boded well for the production of a deep and permanent black.[96] Assertive and inventive as these claims were, they had moved away from Miller and Ellis' invocation of existing use and patterns of circulation through trade as guides to botanical identification. Rather than the scanty resources and tortuous personal contacts on which the toxciodendron dispute of the 1750s had been based, they appealed to direct personal experience. If doing so raised the status of the botanist, it also abstracted away from the questions of imitation of quality and the provenance of highly valued varieties which had animated Ellis and Miller, in their slightly different ways.

5. Metallurgy: Iron from Black Sand

In both the trials of potash and the controversy about *Toxicodendrons*, the perspectives of natural philosophers were shaped by what they inferred and imagined about existing uses, with the result that questions of provenance, existing uses, and locally-available materials shaped their investigations. Although these matters crucially informed their writings, however, they continued to work from relatively privileged surroundings – these were natural philosophers' representations of local practice, rather than voices which answered back. The final example of the Society's substitutive aspirations which I want to consider offers a much more reciprocal view. It concerns the efforts to form iron from black sand.

This was an initiative of the innovative cutler Henry Horne, whose views on the functional characteristics of iron and steel I quoted above. Horne worked in White Cross Alley in Clerkenwell, and was involved in the production of high-quality crucible steel for the production of razors, watch-springs, and pendulums; in his hands, steel was a "boutique material", a luxury to be produced on a small scale; he published his *Essays concerning iron and steel* in 1773, and tried to claim

[95] *Ibid.,* 12.
[96] Bancroft, *Philosophy of Permanent Colours,* 153.

priority for London in the invention of crucible steel. He was also an intimate of John Bird, instrument maker at the Radcliffe Observatory at Oxford, and Gowin Knight, who won the Copley medal for his procedure of magnetizing steel bars in 1747.

During the early 1740s, Horne became interested in the properties of the black sand which was imported from Virginia. The curious properties of such sands had long been a cause of curiosity among the learned. Peter van Muschenbroek wrote to Desaguliers in 1733, relating experiments which he had conducted on magnetic Indian black sand. (Noting that it was also found in Leghorn, Persia, Virginia, and Dalmatia, he added "[n]o Body knows how many kinds of this *Sand* there are." Any such sand was a curiosity, from the European perspective, and there was not yet even a prospect of ordering it according to provenance).[97] Seeking to increase the sand's magnetic powers, Muschenbroek combined it variously with potash, beef tallow, and a mixture of rosin, pitch, frankincence, and rape oil, and placed it in a crucible inside a reverberatory furnace. This caused the sand to liquefy, and seeming to Muscenbroek an analogy with the preparation of steel, he employed processes described in a book called *The Art of Turning Iron into Steel,* to see if these could be attempted on the sand as well. To this end, he added chimney soot, sea salt, powdered charcoal, and ashes – but the resulting substance was not as good as when the sand had been prepared with soap. On the basis of these suggestive but inconclusive experiments, Muschenbroek offered some speculations about the sand's identity:

> Is it an imperfect Magnet, or subtile Powder of it, which when it is grown up into a greater Lump, makes the vulgar Loadstones? So I conjectur'd at first; but when I found by Experience that common Loadstones expos'd to the Fire […] did rather lose some of their Force than gain, I alter'd my Opinion; and now confess that I have not yet penetrated into the Knowledge of the Nature of this Matter.[98]

Horne commenced his experiments independently of these earlier attempts. He related that he had procured "a sufficient quantity of the sand, and, in order to estimate its comparative weight

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[97] Peter Van Muschenbroek, "An Abstract of a Letter from Petrus Van Muschenbroek, M. D., F. R. S., Professor of Mathematicks and Astronomy in the University of Utrecht, in Holland; To Dr. J. T. Desaguliers, F. R. S. concerning Experiments Made on the Indian Magnetick-Sand," *Philosophical Transactions of the Royal Society,* 1734, **38**: 297-302, at 301.
[98] *Ibid.*

with that of iron ore, I procured some of the richest ore I could get, which having reduced to powder, I filled an ordinary tea-cup with it."[99] He found that the sand was heavier than the ore, and noting its magnetic properties, concluded that it must contain "a very considerable quantity of Iron." He claimed that his design was interrupted by communication from a friend of other earlier experiments: in 1693 Alan Moulen had published a report of trying "various chemical menstruums upon the sand", and produced a negative conclusion overall, reasoning that "there is no metal nor ore that some of these menstruums will not work on." Horne did not accept that this was sufficient to decide the identity of the sand, arguing that if Moulen had been more open-minded "he would rather have concluded that there might be some sorts of iron ore which his menstruums would not touch in the moist way, nor any regulus be produced from them in the dry, as he made use of them, which yet might, under some other hands, be subdued."[100] He was convinced that the sand *was* iron, but "strongly united with a very stubborn, fixed and permanent earth."[101] Thus he tried it mixed with a corrosive flux, in a wind-furnace, and found no metal there; then he decided the flux was after all too powerful, and had acted "to divide the particles of the metal, when separated so very minutely, as to be capable of subliming and carrying them off imperceptibly." So, finally, he spread the sand "over an iron plate over a strong fire", and roasted it, "trying to loosen the component parts to such a degree, as to make the separation and reduction of the metal more easy."[102] This worked: "more than half of the sand I put into the crucible" was reduced "to a very fine malleable metal".[103] In principle, this boded well for the production of iron or steel from this source – though Horne was not in a position to exploit them himself.

So things rested for almost twenty years. In 1762, Horne wrote a letter to John Ellicot, which was communicated to the Royal Society, (it was published in 1763) with a report of his experiments. As his rationale he stated that "[a]s the affair of the rich American Iron Ore, commonly known by the name of the Virginia black sand, has of late not only engaged the conversation of many of the

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[99] Henry Horne, "Observations on Sand Iron: In a Letter from Mr. Henry Horne, to Mr. John Ellicot, F. R. S.," *Philosophical Transactions of the Royal Society*, 1763, **53**: 48-61, at 49.
[100] *Ibid.,* p. 52. Moulen's experiments are here: Allen Moulen, "Some Experiments on a Black Shining Sand Brought from Virginia, Suppos'd to Contain Iron, Made in March 1689, By Allen Moulen, M. D. and Fellow of the Royal Society, Since Dead," *Philosophical Transactions of the Royal Society,* 1693, **17**: 624-626.
[101] Horne, "Observations", 52.
[102] *Ibid.*
[103] *Ibid.,* 52.

Virtuosi, but has been taken very particular notice of by the Society for the encouragement of arts and manufactures".[104] He also noted that Ellicot had furnished him "with a fresh parcel of the sand", which had enabled further experiments, adding that "should I be so happy as to confirm what I then observed, or to make any farther discoveries deserving your notice, I shall not fail communicating them to you."[105] Hopeful of success, Horne spoke to friends who were "engaged in trade to those parts of our American colonies, where I was informed this sand was to be easily procured, and in very large quantities", hoping that this would lead them to experiments – Horne claimed that he had "often wondered, that an affair of such consequence should have lain dormant for so many years."[106]

In 1762, the Quaker botanist Peter Collinson – another friend of Horne's – came into possession of "not only a pamphlet, but likewise a letter addressed to the Society for encouraging of arts and manufactures."[107] These were by Jared Elliot, in Connecticut, and seemed extremely promising; through Collinson, Horne communicated "two or three hints, which I judged might be of some service to him"; Elliot replied and Horne communicated his letter to be published.[108]

Elliot was a Congregrationalist pastor and doctor who was closely associated with Yale University, is now chiefly remembered as an agricultural writer. He saw the promulgation of useful knowledge as part of a moral mission, in which "Great Britain and its American plantations [would] flourish under a single moral and economic order that balanced ethics and economics, self-interest and public duty, colonial ends and the empire's greater good."[109] His writing turned the intimacies of private conversation to public ends. He also aimed to create sociable institutions for this end, promoting the establishment of agricultural societies and becoming a corresponding member of the Society of Arts, writing letters about making cloth from hop stalks, the properties of potash, fowl meadow grass, and wild lemon, growing vines; he also administered the attempt to introduce silk cultivation in Connecticut.[110] Richard Sanders Allen, an archaeologist who has studied Eliot's

[104] *Ibid.,* 48.
[105] *Ibid.,* 54.
[106] *Ibid.*
[107] *Ibid.,* 55.
[108] *Ibid.*
[109] *Ibid.,* 506.
[110] *Ibid.,* 515, 520.

surroundings in New England, has given a summary (based on Eliot's own writings) of the genesis of his interest in the black sand, on long rides along the Long Island Sound, where he "observed red, black and brown sands" which were "called 'scouring sands' and used to clean pots and pans in the winter": "From a brook leading to salt water, Eliot retrieved a skim of sand from which, with a magnet, he extracted some 15 grains of iron ore particles. This was identical in colour and configuration with the black-coloured beach sands of Long Island Sound."[111] On this basis, Eliot thought that the sand might be made into iron. The contrast with Muschenbroek is very clear: rather than seeking to resolve the sand into different types, Eliot reasoned by analogy that it might be made into iron. Likewise, his situation was very different than Horne's: rather than having a very small quantity of the stuff, which he had to subdue through various tests which focused on the behaviour of its individual grains, he was faced with a local abundance.

Moreover, the nature of the iron was more than an empirical matter: in Eliot's essays it was caught up in questions of the nature of matter, and its local abundance became the basis for analogies which almost extended into myths, and the question of what risks could reasonably be taken in the colonies. Where Horne had thought the sand he had tested was stubbornly united with some impure element, Eliot was convinced that his was unusually pure. He offered a speculative natural history on this basis which was also influenced by his own limited material resources:

> when Fragments of the Earth are broken off, or you dig into the Ground, you will find the same Sort of Iron Particles as you find on the Beach below; these Particles of Iron on the Ground, are of the same Colour and Dimensions with those on the Beach; at least they appear so to the naked Eye, with which I am obliged to rest satisfied, having no Microscope to ascertain and determine the Thing: I suppose that these Particles are Iron in their primitive and original State; and that these Particles were created at the Beginning with other Parts of the Earth, viz. Gravel, Clay, Chalk and Grit Sand.[112]

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[111] Richard Sanders Allen, "Connecticut Iron and Steel from Black Sea Sands", *IA. The Journal of the Society for Industrial Archeology*, 1992, **18**: 129-132.
[112] Jared Elliott, *An Essay on the Invention or Art of Making Very Good, if not the best IRON, from black Sea Sand*, (New York, 1762), 5.

Thus the sand on the beach seemed to him to be iron in its most reduced state – digging into the Ore sands found a "yellow substance" which resembled the "Mother of Iron" discovered alongside Bog Ore, "which they supposed to be the Pubulum and Food of the growing Bed of Iron".[113] Eliot thought this yellow stuff was "the Cement which holds the Particles of Iron together", which had been loosened by the sea setting the iron in motion. This view compares strikingly with both Muschenbroek and Horne's attitudes to the sand. For Muschenbroek, it was a curiosity which required investigation, appeared to behave in ways which were analogous to existing materials but also to possess some anomalous properties, which meant that it remained mysterious; for Horne, it was an impure material which could be persuaded to act as iron – the specific procedures to be applied to it depended on its particulate form, but not its ultimate identity.[114] Elliott had initially hoped that "if this iron sand could be wrought at all, the particles being so very fine, it would smelt very quick", but upon working it found that "every particle has a will of its own, and must have its own particular smelting."[115]

The work was done by a blacksmith whom Eliot had employed. According to Eliot, this man (probably named Elnathan Stevens) had his own theory about its identity, claiming that "if it were Iron Ore, it consisting of such very fine heavy Particles like Flesh without Bones, having nothing to sustain it, would run down among the Coals, sink to the Bottom, full too low, and consequently never gather into a Mass to form a Loop".[116] He also protested that he was a refiner, not a bloomer; judging that he was of steady habits, Eliot bribed him with a bottle of rum.[117] Eliot considered, however, that his objection was formidable, and requiring the mixture of bog-iron into the sand before it could be prepared. It was extremely demanding work:

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[113] *Ibid.,* 6.
[114] Elliott also noted that "if it had been tried with a Magnet and was not affected by it, it would not have alter'd my Resolution to try it if an Opportunity should present", *ibid.,* 12.
[115] Quoted in Horne, "Observations", 57.
[116] To Horne, Eliot downplayed the role of the smith. He noted that he and his son were inexperienced iron-workers, and so "we were forced to hammer out the skill by various trials as we could".
[117] This was of a piece with the rhetoric of his essay, which lamented the American unwillingness to take risks; he noted that his friend Benjamin Franklin had encouraged him by saying "that the Germans acted a wiser Part, for if a Project failed, unless it was ridiculous in its conceiving, the Undertaker was named with Respect, saying though it failed, yet it was well imagined." The effort to produce the iron had become a matter of public interest, with a "Number of People waiting to see the Issue of this singular Undertaking"; they began to grow restless, and "we diverted ourselves as well as we could." Horne, "Observations", 56.

> After some Time, he found a Substance adhering to the Crow-bar, which he shook off, tried with the Hammer, and found to be Malleable, says, this is certainly Iron; after five Hours Labour, long look't for came at Last, he drew out a large Loop; it bore Shingling and Hammering well, and when completed, the Bar weighed Fifty-two Pounds and a Half, and proved excellent good iron; Part of it was tried by the most Skilful of our black-smiths, who pronounced it to be equal to the best of refined or Swedes iron.[118]

Eliot now claimed that he felt emboldened by Horne's response, he was "glad that the iron has such qualities as to meet with your approbation; I knew that the iron was good, but did not know that it was so good as your superior knowledge has found it."[119] Rhapsodising about its possibilities, he added that "this black sand is a treasure that has long lain hidden from the world, and is what may render the colonies more valuable to Great Britain."[120] Now he wanted to know "what iron will sell for in England."[121]

In his final response, Horne tested a bar of iron and a bar of steel which Eliot had prepared. He reckoned that the steel was good, but the iron "broke out in flaws and hollows", when it was struck with a hammer.[122] So Horne remelted and reforged it, to prove that the problem was with the technique by which it had been prepared, rather than the natural properties of the material from which it had been formed. Satisfied with the result, he concluded that "the iron possest all that agreeable toughness and ductility for which the Spanish iron is so deservedly famous, without partaking of that vile red-shire quality, for which the latter is very remarkable."[123] Thus the standard of evaluating the actual worked iron and steel had to resort to comparison with existing superior forms – such as those from Spain and Sweden. Horne accepted Eliott's claim that *this* sand was uncommonly pure (rather than united with an impurity, as his initial sample had been). He argued that it was the mixture with the cinder which had led to the inferior quality of some of the iron: "I

[118] Quoted in *Ibid.*, 57.
[119] Quoted in *Ibid.,* 58.
[120] *Ibid.*
[121] *Ibid.*
[122] *Ibid.,* 59.
[123] *Ibid.*

found they had recourse either to this cinder brought from other iron works, or to a quantity of the bog mine"; he thought that the latter was an inferior variety, "whose constituent parts abounding with many impurities, some of which, by mixing with the metal, may have occasioned the defects above complained of, and which required so severe an operation both of the fire and hammer to separate from it."[124] In line with his interest in iron and steel as luxury, precision, materials, he recommended that the Society should offer a premium "to the person who shall produce the purest metal", rather "than to him who shall produce the greatest quantity".[125]

Shortly after receiving a medal from the Society of Arts for his achievements, Eliot died. His son Aaron continued to experiment with the black sand, but his efforts were frustrated by the outbreak of the American Revolution. Eliot though was not only working metal: he was preaching publicly as well. And his description of the iron was of a sociable material. He described riding out with his friends to collect enough of the sand in his saddlebags to make the initial tests – and, always witty, always curious, speculating with them about its ontology: how it had arrived at this form, in this particular place. So, in the midst of his pamphlet there was a vision of the iron cycle as a providential validation of the circulation of imperishable principles through human use and elemental combination; a process of balance and renewal which made all corruption temporary. This relied on the particulate form of the sand. He analogised widely, comparing the iron to other elements which appeared in different forms around the world, and to mercury, and to dust. It opened with a hymn to trade, and the circulation of water**:**

> and as Water continues its circular Motion and Round, so I conceive it is with Iron; by the Water the Particles of Iron are carried to a proper Bed or receptacle, then it is taken and wrought for the Use of Man, and is worn out in his Service; or contracts a Rust and is consumed when it is worn away, as by the Earth in plowing, or from Horses Shoes in travelling, or from Iron Shod Wheels in carting, or by grinding with a grind Stone: The Iron by these Means, reduced again to fine Particles, returns to the Earth again: When it is corrupted by Rust, this is much as

[124] *Ibid.,* 60.
[125] *Ibid.*

> when a Tree rots, or a Man dies, they Each return to Mother Earth again; these same Particles of Iron then worn away, are not annihilated or lost, but being joined with Sulphur, or those other Materials which constitute Iron Ore, it proceeds and takes the same Journey round till it comes to the Smith's Forge again: Under all these Changes and Revolutions there is no Addition; the same Quantity as there was at first, there remains the same still, and no more.[126]

In a sense, Eliot's description was intended to be universal, fixing the iron in the form of sand into the circulation of the material throughout the world and identifying in this way a "pure" form which could be recovered from all transformations. At the same time, it was also improvised from locally available materials; celebrating what glittered and sifted between his fingers on the Connecticut beaches near his home.

It is perhaps ironic that Horne's interest in defining iron in terms of its functional characteristics should, indirectly, have produced such a myth about its home. As we have seen, the different approaches which he and Eliot took to the sand depended significantly on its particulate form. Horne's interest in it was sparked by the ambiguity about how it could be treated, the failure of prior chemical tests, and its partial overlap with other forms of iron (such as its magnetic properties). And if it had been an ore, difficult to extract from the earth and clearly united with other materials, it could scarcely have played the same role in Eliot's vision of the iron cycle.

One remarkable feature of this episode is the fragility of the alliance between the two men, and the very different views of materials which their transatlantic collaboration enabled them to implement. While Eliot's hymn to the iron cycle played a distinct part within his own ideas about how to write about improvement, it also generalised a tendency which we have noticed in all these writings about substitution. The trade and circulation of all these materials, through their many existing uses, and the numerous locations through which they passed, were factors with which natural philosophers had to wrestle, even as they sought to define ways in which the materials could be considered to be the same.

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[126] Elliot, *Essay*, 9.

7. Conclusion

Overall, despite the lack of success of individual projects, substitution represented the fondest aspiration of the Society of Arts. The idea that, with a little encouragement, locally available resources could compete with the best in the world fit with goals of economic policy as well as the hopes of individual producers. Premiums were meant to discover and publicise best practice in these areas.

In this chapter I have focused on how substitution shaped natural knowledge, in botany and chemistry. Many eighteenth-century works talked about the substitution of materials through a rhetoric of reductive purity. In practice, however, questions of provenance remained paramount for projects of substitution because of a desire to imitate the best properties of existing materials, which could not easily be abstracted from the affordances of individual locations and processes of production. It raised quite complex questions of the sameness and qualities of different materials.

This made for natural philosophical writing of a very particular kind: it had to be concerned with the practical uses of materials, as well as a wide variety of geographically-dispersed producers. In the case of even a humble commodity like potash, recipes for preferred varieties were given in the manner of travel reports; in transferring the production process to a new place, it was not obvious which aspects of these recipes needed to be retained and which could be dispensed with. Chemists wanted to claim that they could say which parts of the process were essential, but even their works – exemplified here by Lewis and Dossie – had to contend with material contingencies, improvisations on the basis of what was locally available materials, and the question of whether two samples were really the same as each other. The botanical controversy between Ellis and Miller about the identity of *Toxicondendrons* was much more based on books, the identifications of botanists, and what was available within botanical gardens, as well as experiments on the staining properties of the plants and accounts of how they were used in the territories in which they were found. Despite the appeal to an analysis in terms of observable characteristics of plants, the argument was over-determined by this world of uses and marketable properties: this was what shaped the overall question of what it would mean for the cultivation of such plants to be encouraged in a new place. Finally, within Horne and Eliot's attempts to make iron and steel from

black sand two very different attitudes towards the purity of materials coexisted in a single project, with Horne arguing for the functional characteristics of iron – that it would be equal, wherever it was found in the world – and Eliot celebrating the specific pure form which existed near his home.

The "public" which was imagined by the writings of these natural philosophers was not simply the projected audience for their books. It was also the range of existing producers and cultivators whose productive efforts they sought to incorporate. Thus Lewis speculated about the contents of American kitchen hearths; Miller drew on the reported views of Japanese cultivators of varnish trees and his botanical acquaintances, while Ellis reported a more direct acquaintance with the claims of those involved in the linen trade; and Horne imagined steel in terms of the small boutique productions which he knew he could sell in London, while Eliot used his writings on iron and steel to recommend different forms of sociability to his fellows in the colonies. This public was more than an audience because it was the projected group whose knowledge and activities were constitutive of the ways in which materials might be used to replace each other.

The role of the anecdotal and personal – the Society's role as patron of these activities – can perhaps best be understood as the various claims of these investigators that they (with the Society which had helped to coordinate their activities) were credible spokesmen for these wider publics of producers and users. In the case of Eliot and Horne, this referred to a future possibility – Eliot's idea of the value of the colonies to Britain – rather than anything which had already happened, and hence their correspondence appears the most personal and experimental. The iron and steel could not have been made and judged in that way without their respective personal contributions. Like the anecdotal experiments on silk which I discussed in chapter four, these experiments seemed to glitter with promise, partly because they placed such emphasis on local, social factors (so that, for example, Eliot's managing to persuade his blacksmith to try the iron, and his resistance to the scoffing of his neighbours, was evidence of an improving spirit of encouragement) In other, perhaps less obvious ways, it was also present. Dossie was trying to claim that he was personally responsible for a process which had spread widely throughout the North American colonies, and was probably not a direct result of his writing. Ellis, meanwhile, sought to discredit Miller by suggesting that his narrow circle of botanical friends and the books which he consulted were out of

touch with the realities of how materials were used, in the wider world. Part of their dispute was about who could act as a credible spokesman for the ways in which plants were distributed and used: Miller, on the whole, preferred to describe this in personal terms, through the ways in which seeds had been circulated among his intimates. Thus each of the cases shows a slightly different idea of how substitution should contribute towards the public, and the personal role of natural philosophers in this process.

In a subtler way, the examples of substitution given here also focus attention on gardens and laboratories as places of *scarcity*, rather than arbiters of the qualities of materials. Horne did not have access to much of the sand, and so it remained a curiosity rather than an immediately workable industry; Lewis had to work with considerable difficulty to establish the relations between his laboratory practice and the materials which he had at hand; the *Toxicodendron* trees which grew in botanical gardens were ambivalent evidence for how these plants might be used elsewhere.

Finally, I have emphasised how the intense focus upon localities which emerges from each of these cases contrasts with what historians have told us about the effects of systematisation in eighteenth-century natural philosophy. In a sense, this is a very obvious point, as obviously preoccupation with uses meant that knowledge had to be applied to a world over which natural philosophy was not master. And it may be objected that I have focused on contexts away from the systemic sciences – particularly of botany and chemistry – which developed largely through decontextualisation. If the evidence of the plants which were available in botanical gardens was ambiguous, and anecdotal, how much more so are three case studies which happen to involve a muddling between systems and marketable properties! For present purposes, I think it is sufficient to note that natural philosophy within the Society of Arts could not resort to systems which stripped the world away. I will return to the question of the representativeness of these cases in chapter nine. It would be interesting to speculate whether the relation between system and use would seem more complicated if the attempt to identify the *Toxicodendrons* had been more widespread. The ambiguous balance between transferable properties and local, natural place was at the heart of the Society's attempts to encourage the cultivation of certain kinds of grass, and tree-planting. These are the subjects of the next two chapters.

Chapter Seven: The English Pan

1. **Introduction**
2. **Stillingfleet and the Grasses**
3. **Stillingfleet's Successors: Curtis and Sole**
4. **Straw Management**
5. **Conclusion**

1. Introduction

The previous chapter charted, in part, the Society of Arts' interest in botanical matters. One reason that the Society might be of historical interest, in this respect, is that its premiums were offered in the hope of connecting activities which historians have tended to treat distinctly, notably botany, and agriculture. These connections were to be made by enrolling a wider public in activities which might appear to be the purview of only a few. As we saw in the dispute between Miller and Ellis, questions of the identity of plants depended significantly on their existing uses and the possibility of transferring them to new locations.

In this chapter, I discuss another example of these intersecting interests: the various projects in which the Society showed an interest in collecting grass seeds. While these efforts did not have the effect which the Society's members intended, they did enable a sustained – and significantly neglected – focus on the botanical identifications of grasses and attempts to determine which species were best suited to different soils, an effort which was directly inspired by Linnaeus. At stake was the question of the relation between the naturalness and artificiality of grasses, the possibility of purifying pasture-lands, and the match between grass species and their various uses. Investigation of this subject culminated, during this period, with George Sinclair's remarkable experiments on grass-plots which were conducted at Woburn Abbey, and which were motivated in part by the projects of the Society.

Section two discusses how the Society came to offer awards for grass seeds through the influence of Benjamin Stillingfleet, who translated Linnaeus' investigations into fodder crops into

English. Stillingfleet's writings prompted an interest in trying to sow particular – especially desirable – strains of grass seeds, and were accompanied within the early Society by a number of experiments on other types of grass which appeared more nutritious or otherwise preferable. In intention, then, this was an attempt to employ Linnaean botany directly for agricultural improvement; in practice, however, grasses were much less pure, and much more bound to their local circumstances, than the purifiers imagined. It was incredibly difficult to discern different species with any precision. Writers on grasses after Stillingfleet continued, in the tradition of seventeenth-century local floras, to specify their 'natural places' and the wide variety of uses which people found for them. I exemplify the tensions which this style of botanical writing produced in section three, with a discussion of two of Stillingfleet's most impressive inheritors: William Curtis, and William Sole. Section four then takes up the experiments which George Sinclair undertook into the properties of grasses at Woburn Abbey, which attempted to artificially recreate their natural conditions as far as possible, and which were conducted in direct response to the vogue for philanthropic straw-plaiting in which the Society of Arts became involved during the 1820s, under the influence of the conservative radical writer William Cobbett. Influential and powerful, and playing the boundaries between nature and artifice which had characterised writings on grasses in English for the previous seventy years, Sinclair's experiments can be regarded as the (unintended) culmination of the Society's interest in grasses. Finally, section five concludes, by discussing the relation between the Society's concern with grasses and its expansive public, and aspirations to disembed practices and natural places.

2. Stillingfleet and the Grasses

Eighteenth-century botanical interest in grasses involved complex relations between properties which could be associated with given localities, and the possible introduction of new or different species. There was of course a strong strand of eighteenth-century botany which focused upon the locally available properties of plants. As Linnaeus put it in a speech entitled "On the Necessity of Travelling Within One's Own Country": "whoever, before he sets out to visit regions warmed by other suns, has laid the first foundations of his studies in his native country, will be most likely to bring back materials of far greater price, than we usually see amongst the greatest part of our

travellers."[127] The local floras which had proliferated in the seventeenth century presented nature as rooted, specified, and interconnected with the human world. As Alix Cooper puts it

> The issue of location and origins was to become an even more prominent theme […] while recording the presence of individual plants, local floras linked them to the early modern landscape and countryside where they thrived. These landscapes were rarely presented as "wild", though, but rather as firmly linked to the community, whether that of the University or of the town. By reporting where plants were to be found, the local flora incorporated them into the institutions of a human world.[128]

Cooper presents this local flora tradition as one which went into eclipse in the mid-eighteenth century, particularly under the influence of Linnaeus.[129] Of course, grass was an agricultural commodity, not simply of botanical interest. Histories of botany have mainly been written separately from those of agriculture; though allusions are sometimes made to the connections between botanical and agricultural networks, they are rarely systematically pursued.[130]

Explicit botanical concern, and common English names, for grass species appeared with the polymath Benjamin Stillingfleet's translation of a number of Linnaean texts into English in 1759, as *Miscellaneous Tracts relating to Natural History, Husbandry, and Physick, translated from the Latin, with Notes.*[131] The edition was made up of six essays from Linnaeus' work *Amoenitates Academicae*, with an afterword of Stillingfleet's own composition about English grasses. The book's preface was a defence of botanical pursuits as such, on the grounds of their utility across a range of different domains, the "great and extensive views" they offered "in relation to husbandry, physic, and the

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[127] Carl Linnaeus, "An Oration Concerning the Necessity of Travelling in One's Own Country", in Benjamin Stillingfleet, *Miscellaneous Tracts Relating to Natural History* (London, 1758), 11-12. Quoted in Staffan Müller-Wille, "Walnuts at Hudson Bay, Coral Reefs in Gotland", in Londa Schiebinger and Claudia Swan, eds., *Colonial Botany: Science, Commerce, and Politics in the Early Modern World.* (Philadelphia, 2005), 34-48, at 34.
[128] Alix Cooper, *Inventing the Indigenous,* (Cambridge, 2007), 81.
[129] *Ibid.,* pps. 152-172.
[130] Some exceptions include John Sheail, "Grassland Management and the Early Development of British Ecology", *The British Journal for the History of Science*, 1986, **19**: 283-99, and Mario Ambrosoli, *The Wild and the Sown: Botany and Agriculture in Western Europe 1350-1850,* (Cambridge, 1997). As is suggested by the extremely long period which Ambrosoli's work covers, these works do not contain much detail about the specific interactions of individual botanical and agricultural work, which is attempted here.
[131] Stillingfleet, *Miscellaneous Tracts*.

general oeconomy of human life in these few specimens"[132] Anticipating the objection that botany was a mere collection of particulars, Stillingfleet mentioned Dellenius' description of more than 600 species of moss and asked

> to what end? I will not endeavour to answer this question by shewing the particular use of every moss that grows, although I am certain that the Lord of nature has made nothing in vain. But I will venture to assert, that posterity will, some time or other, derive as many advantages from mosses as from other vegetables; and in this I am justified from those which our few experiments on mosses have enabled us to ascertain.[133]

Distinguishing between different species was a way of accessing the providential and prodigal variety of uses which could be found for them. Supporting this view, the sixth chapter of the *Miscellaneous Tracts* was a translation of *Pan Svericus,* an elaborate experimental study made by Linnaeus and his students in 1748 and 1749 of the "devouring army of pan, which lays waste the provinces of the Swedish Flora". It offered a tabulation of the grasses which domestic animals most liked to eat, with the justification that "although plants have been constantly obvious to the eyes of every man […] we have nothing delivered down to us in any book concerning the kinds of plants proper for the different kinds of cattle."[134] Or, indeed, horses. Part of the experiment's goal was to enrol the botanical knowledge of that choosy quadruped, as "horses easily distinguished wholesome from noxious food; for, being very hungry, they devoured all sorts of plants, except the following: meadow sweet, valerian, lilly of the valley, angelica, loose-strife, marsh-cinquefoil, crane's-bill, hellebore, monks-hood and many shrubs."[135] Linnaeus instructed his followers to examine the plants which a whole range of animals – including "cows, sheep, goats, deer, horses, hogs and monkeys" – would not touch. A providential understanding underwrote this botanical vision: given species of fodder plants were associated with the animals which lived within a given geographical range, "every species must leave certain plants to certain animals', a just-so matching which meant

[132] *Ibid.,* vii..
[133] *Ibid.,* 177.
[134] *Ibid.,* 342.
[135] *Ibid.,* 343.

that the lichen or liverwort of the cold Alps obliged "rehn deer" to live there; the dwarf-birch brought "the rough-legged partridge to its habitats", and the camels hay "draws the camel".[136] The overall rationale of the experiment emphasised the choices which animals would make, if given their freedom, and associated them with existing geographical distribution of different plant species.

Lisbet Koerner has given a detailed account of how the *Pan Sverica* was assembled:

> Linnaeus farmed out tasks to his students. Each young man was assigned a test animal (cow, pig, goat, horse, sheep). Clutching goose quills, scrap paper, and inkwells, the students tracked their animal subjects as they foraged the meadows girdling Uppsala, freed from foot hobbles, snout-irons, chains and muzzles. Throughout the day the students wrote down the plant species their animal subjects ate. Linnaeus' students listed 836 species while watching the botanical specimens disappear the moment they realised that they needed to identify them.[137]

Stillingfleet's concerns were more domesticated than his Swedish master. Rather than thinking in terms of the preferences of unbridled animals, he added "some notes on English grasses", emphasising their value as feed for cattle and horses. He gave English names to the grasses, by offering translations of the Linnaean ones, and offered observations on what English animals liked to eat which were based on anecdotal reports rather than experimental pursuit. Thus he reported, for example, that four acres of stote fescue kept in "good heart five cart-horses from *April* to the end of harvest", adding that in one marsh he had observed, the fescue was the only grass which the horses would eat, and this seemed a powerful proof because they had come by choice and "the horses would not have come to this marsh, and eat its edges, did they not love the *stote fescue*; and what animals love, is *generally very wholesome* for them."[138]

Notwithstanding these browsing horses, Stillingfleet believed that most fodder crops would be sown from seed rather than growing wildly. The model for his discussion of English "natural" grasses was the "artificial grasses" which were widely associated with improving farming techniques,

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[136] *Ibid.,* 348.
[137] Lisbet Koerner, *Linnaeus: Nature and Nation* (Harvard, 1999), 49.
[138] Stillingfleet, *Miscellaneous Tracts,* 343.

and included clover and legumes. In this light, "grass" was an operational rather than a taxonomic botanical category: it designated anything which an animal would feed on. Both natural and artificial grasses might be sown by farmers, though the former might also come up of their own accord. Stillingfleet was scornful of the possibility that this would lead to good results:

> Some say then, that if you manure your ground properly, good grasses will come of themselves. I own they will. But the question is, how long it will be before that happens: and why be at the expense of sowing what you must afterwards try to kill? Which must be the case, so long as people sow all kinds of rubbish under the name of hay-seeds.[139]

If the best way was to allow the ground its natural productions, "why is the farmer at the expence of procuring the seeds of the white and broad clover, which come up in almost all parts of England spontaneously?"[140] And if this was true of clover, "what reason can be in nature why grass-seed only ought not to be sown pure?"[141] He drew a further analogy with other crops; "would not any one be looked upon as wild, who should sow wheat, barley, oats, rye, peas, beans, vetches, buck-wheat, turnips, and weeds of all sorts together?"[142] Mixed grass seeds produced "land filled with weeds not natural to it, and which never would have sprung up, if they had not been brought there."[143] Stillingfleet looked forward to a time when each farmer, by separating out the best seeds, and taking care to sow them separately "would have wherewithal to stock his farm properly, according to the nature of each soil, and might spread these seeds separately over the nation by supply from the seed shops."[144] They might be gathered by children "of ten or eleven years old"; by this means he had acquired "the creeping bent, the fine bent, the sheep's fescue, the crested dog-tail, &c. in sufficient quantities, to begin a stock".[145] But he lacked the resources to cultivate them, and "my collections of this kind hitherto have only proved, that the scheme is in itself feasible."[146]

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[139] *Ibid.,* 366.
[140] *Ibid.*
[141] *Ibid.*
[142] *Ibid.*
[143] *Ibid.*
[144] *Ibid.,* 365.
[145] *Ibid.,* 368.
[146] *Ibid.*

Purification was to come, not a *fait accompli.*[147]

Not all agricultural writers favoured purification. For David Henry, writing in 1771, planting pure was a kind of violence: "it is not for farmers to break up commons, heaths, marshes, downs, and extensive wolds, to change their natures, and to fill them with seeds they are not accustomed to bear."[148] William Marshall, more sympathetic to collection and resowing, claimed in 1796 that it was "easy to collect the *native species* which abounds on the old grasslands, and thus raise a new variety adapted on a certainty to the value of the land"; he also supported the collection of seeds from grazing grounds, in preference to shop-bought varieties.[149] For others, attention to grasses was indicative less of the need to purify pastureland than an index of the quality of the soil. For example, the land agent Nathaniel Kent related that Stillingfleet had taught him to judge the quality of land "not from local enquiry which might mislead my judgment, but from the wild plants and grasses;…Accordingly, when I found the oak and elm as trees, and the rough cock's-foot and meadow fox-tail as grasses, I was assured that such land was good. And where I found the birch tree, the juniper shrub, and the maiden-hair, and creeping bent-grasses, I was equally certain that such land was poor and sterile."[150] Kent also laid down pastures with pure strains of seeds. His example also, however, suggests a difficulty in isolating grass species from the soils in which they grew, which was to run throughout subsequent discussions of attempts to purify grasslands.

Stillingfleet's interest in grass seeds found a receptive home at the Society of Arts, which offered premiums for seed-gathering from 1762 onwards, and distributed engravings of Stillingfleet's grasses. These premiums were dedicated to the promotion of particular grasses – initially sweet vernal, meadow fescue, crested dogstail and common poa; later sheep's fescue, and yellow oat grass, and perennial ryegrass; timothy grass was included in 1802 and cocksfoot in 1817.[151] Thus interest in the cultivation of particular species of grasses was a long-lasting project of the Society. The first

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[147] Cp. G. E. Fussell, "The Grasses and Grassland Cultivation of Britain, II, 1700-1900", *Grass and Forage Science*, 1964, **19**: 212-217, at 213.
[148] David Henry, *The Complete English Farmer, or, a System of Husbandry Founded Upon Natural, certain, and obvious PRINCIPLES*, (London, 1771), 338.
[149] William Marshall, *The Rural Economy of Gloucestershire; including its Dairy: Together with the Dairy Management of North Wiltshire; and the Management of Orchards and Fruit Liquor in Herefordshire,* (London, 1789), 164.
[150] Nathaniel Kent, in the *Gentleman's Magazine,* LXXXI, p. 183, quoted in Pamela Horn, "An Eighteenth-Century Land Agent: The Career of Nathaniel Kent (1737–1810)," *The Agricultural History Review*, 1982, **30**: 1-16.
[151] A. R. Beddows, "A History of the Introduction of Timothy and Cocksfoot into Alternate Husbandry in Britain 1. The Year 1763 and its Significance", *Grass and Forage Science*, 1969, **23**: 317-321.

editions of the *Museum Rusticum* contain several communications describing the difficulty with collecting pure strains in the ways Stillingfleet had envisaged. In a series of letters, the farmer Thomas Comber reported his difficulties with collecting seeds. Comber wrote that "Mr *Stillingfleet's* delineations appear accurate, and are probably as much so, as a common engraver can execute: yet, I believe, whoever compares *real grasses* with them, will often find reason to doubt whether, by the copy, he has found out the original."[152] Comber thought the gathering of grass seeds remained a considerable difficulty; the habits of cattle were now the enemies, rather than the allies, of improvement: "a gentleman, who is skilful, may make a boy gather a pretty quantity in a bye place; but as cattle of all kinds greedily eat the heads of the good grasses, we must not hope to meet with them anywhere in any considerable plenty, except in meadows; and the damage of gathering them there is notorious."[153] What Comber meant by "damage" is obscure, but his criticisms suggest the difficulties of collecting seeds where animals grazed. Comber also queried some of Stillingfleet's identifications of grasses, returning to Ray and other earlier botanists who had described grasses in their local situations. Comber was also keen to accentuate the interaction between his ways of treating the soil and the production of more thriving and productive grasses, in a way which would break through all mere taxonomic restraint. Thus he reported the discovery of what he called a "*nameless grass,* because I know no name by which it goes with us. The truth is, I never saw it in any meadow but my own, nor ever before this year, nor in any part of this meadow, except such as has been dressed with the richest manure, *viz,* human ordure."[154] Clearly such richness did not rely on seeds alone, and could not be stabilised taxonomically.

At the same time, however, the close connection between natural and artificial grasses which Stillingfleet had introduced played out within the Society, by introducing novel varieties of grass which could be sown pure. Again, this depended initially on an appeal to a providential matching between animals and their food which preceded domestication. Peter Wyche, chairman of the

[152] Thomas Comber, "On the Difficulty of finding out the Grasses, for gathering whose Seeds Premiums are offered, by the Delineations," *Museum Rusticum et Commerciale, Or, Select Papers on Agriculture*, 1765, **4:** 290-292, at 291.
[153] *Ibid.,* 292.
[154] *Ibid.*

Society's committee of Agriculture, approached the improving farmer Bartholomew Roque and told him that

> as there are many animals which subsist wholly on the fruits of the earth, there must certainly be some plant or herb which is fit food for them, that naturally vegetates in winter; otherwise we must suppose the Creator, infinitely wise and good, to have made creatures without providing for their subsistence; and that, in fact, if there had been no such plants or herbs, many species of animals would have perished before we took them out of the hands of nature.[155]

Roque set to searching "with great assiduity", and "finding that a pimpernel called burnet was of very speedy growth, and grew near as fast in winter as in summer, he took a handful of it and carried it into his stable, where there were five horses, every one of which ate of it with the greatest eagerness, snatching it even without first smelling it."[156] He travelled to London, where he bought eight pounds of the seed, which was as much as he could find, all the rest having been used "for sallads."[157] For a crop to be trialled as Wyche envisaged it needed to be slightly unusual (as it was not part of the run-of-the-mill of farming practice) obtainable (because it had to be grown for the trial to take place) and noticeable (because it had to be picked up as a possibility in the first place).

At the same time as Roque became enlisted in the search for new varieties, Wyche also arranged for the Society's Committee of Agriculture to distribute letters on foreign grasses to Northern Europe, England, and colonies in North America: in December 1760 they were addressed by Benjamin Franklin who offered "an account of a very useful grass, which had been lately propagated through several Provinces of North America, called by the name of *Timothy* grass."[158] Further communications on Timothy were sent by Jared Eliot; Wyche received seeds in 1763 and in May of that year members took the seeds to try on their land. In fact the new grass was already

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[155] James Caldwell, "A Letter to the Dublin Society, from Sir James Caldwell, Baronet, Fellow of the Royal Society; Giving an Account of the Culture and Quality of several Kinds of Grass lately discovered", *Museum Rusticum et Commerciale*, 1765, **5**: 13-22, at 22.
[156] *Ibid.,* 15.
[157] *Ibid.,* 16.
[158] Quoted in Beddows, "History", 318.

indigenous to England, but it was not notable there, for as John Mills observed it "is scarcely noted in our meadows, but as a deformity."[159] It was the attention lavished on the grass by Roque and its American cultivators which suggested that its special properties, creating a sward which firmed loose and miry ground. Roque sowed the seed "in land so boggy and wet, that no horses could stand upon it; and therefore he was forced to dig it: it was a black boggy soil, and has never had any dung upon it, but as it was necessary to kill the weeds and natural grass, he planted beans upon it the May before."[160] Horses found it sweet; and "[d]eer, than which no creatures are nicer in their choice of food, prefer it to every other grass, and even to corn."[161] The ideal of providential matching was giving way to the suggestion that a given variety might be straightforwardly superior.

Such a belief could be trialled experimentally. Roque grew the artificial grasses lucerne, sainfoin, clover and Timothy on equal quarters of a field, and when

> they were all arrived at a proper growth, horse, black cattle, cows and sheep, were promiscuously turned into the field, with an intent to observe which of the grasses the several sorts of cattle would soonest take to, it not being at all imagined, that they would all prefer one kind.[162]

They did, though: "the Timothy grass was eaten by them quite bare before the other sorts were touched, though they were at liberty to range over the whole field."[163] Mills thought that Timothy afforded "a remarkable instance of the great advantages which may accrue to the nation, from that attention to our native grasses which our laudable Society for the Encouragement of Arts &c. endeavour to inculcate."[164] It had been able to do so, however, initially through the colonial connection.

The studies of English grasses thus produced a paradoxical alternation between "natural" and "artificial" understandings of grasses. Operationally, the natural were those which belonged to a

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[159] John Mills, *A New System of Practical Husbandry,* Vol 5, (London, 1767), 357.
[160] Caldwell, "Letter to the Dublin Society", 18.
[161] "A Society of Gentlemen, Members of the Society for the Encouragement of Arts, Manufactures and Commerce", *The Complete Farmer: Or, A General Dictionary of Husbandry,* (London, 1777), n.p., entry "Tim",
[162] A Member of the Society of Arts, "A Letter to the Editors, from a Member of the Society, on the superior Excellence of Timothy Grass, and the Great Advantage that will accrue to the Farmer, by cultivating on low damp or wet Meadows, and boggy or fenny Land, &c.", *Museum Rusticum et Commerciale*, 1762, **2**: 60-63, at 61.
[163] *Ibid.*
[164] Mills, *New System,* 357.

particular place, and arose as its "automatic" productions, while the artificial was anything planted. But "artificial" could also entail crops like burnet which were used for fodder and other purposes. How far individual authorities believed that the properties of an individual grass could be disembedded from its particular situation varied according to their beliefs about the possibility of purifying land and matching species to soil, rather than attending exclusively to local properties of grasses. We can see in Stillingfleet's appropriation of the *Pan Sverica* an attempt to define natural grasses according to their membership within a small number of species, which were meant to be sown pure by analogy with artificial grasses. To focus enough on a 'grass' to make it seem worth cultivating artificially required some reason to believe that it had unusual properties, and a way of obtaining its seeds. And even this purification continued to rely upon beliefs about the natural – providential – propensities of animals. This might seem like a peculiarity of the way in which Stillingfleet's concerns interacted with those of the early Society of Arts, but the same set of problems kept recurring among Stillingfleet's successors as well.

3. Stillingfleet's Successors: Curtis and Sole

Botanical publications on grasses appeared intermittently in the decades after Stillingfleet's work appeared, during the period of the Society of Arts premium awards. The two most striking publications during the 1790s were William Sole's "Account of English Grasses, with Descriptions of their respective Excellencies and Defects, in regard to Agricultural uses", and William Curtis' *Practical Observations on the British Grasses: Especially such as are best adapted to the laying down or improving of meadows and pastures: to which is added, an enumeration of the British Grasses.*[165] Both works were written in the tradition of the local flora, emphasizing the connections between plants and human uses; both drew on Linnaean classification systems as well. The two men were correspondents, and had

[165] William Sole, "Account of English Grasses, with Descriptions of their respective Excellencies and Defects, in regard to Agricultural uses," *Letters and Papers on Agriculture, Planting, &c, selected from the correspondence of the Bath and West of England Society*, 1799, **9**: 131-159; William Curtis, *Practical Observations on the British Grasses: Especially such as are best adapted to the laying down or improving of meadows and pastures: to which is added, an enumeration of the British Grasses*, (London, 1798).

trained as apothecaries: this is likely to have shaped their attitudes towards the useful properties of grasses, which focused much less on the predilections of animals than on the wide range of uses to which they could be put. As a reviewer of Curtis' flora put it, he had "formed a plan to draw and describe all the plants which grow in the environs of London, giving an account of their medicinal powers, and their uses in agriculture, rural oeconomy and other arts, as far as they are hitherto known, directing the farmer at the same time when to expect their time of flowering, and remarking their places of growth."[166]

Sole was born in Cambridgeshire and practiced as an apothecary in Bath. He kept a botanical garden in which he grew and named varieties of mint, composed a flora for the Bath region, and was an early associate of the Linnaean society.[167] A version of his *Practical Observations* was published in the *Transactions* of the Bath and West of England Society; its primary form was a unique book of watercolours of different species of grass.[168] Curtis, who initially served as demonstrator of plants at the Chelsea Physic Garden, founded a botanic garden exclusively for British plants, which between 1773 and 1789 moved from Bermondsey, to Lambeth, and at last to Brompton, to escape the London smog. His reputation but not his fortune had been made by his *Flora Londinensis*, which exquisitely illustrated the flora of the London region; Curtis subsequently established and edited the *Botanical Magazine.*[169] Again, he was preoccupied with the useful properties of plants, although he had more immediately commercial ends in mind as well: his book on grasses advertised the Brompton garden, and perhaps tried to expand its clientele to agricultural improvers; it was also sold together with packets of grass seeds, and focused on a much small number of species of grasses than Sole considered.

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[166] Anon, "Flora Londinensis", *The Critical Review,* 1777, **44**: 288-292, at 288.
[167] G. S. Boulger, "Sole, William (*bap.* 1741, *d.* 1802)", Rev. Anita McConnell, *Oxford Dictionary of National Biography*, Oxford University Press, 2004; online edn, Jan 2011. http://www.oxforddnb.com/view/article/25987, (accessed 1 July 2013).
[168] Now in the archive of the Bath and West Society. I am grateful to the librarians of the University of Bath for permission to consult this work.
[169] W. H. Curtis, *William Curtis, 1746–1799, fellow of the Linnean Society, botanist and entomologist*, (Winchester, 1941).

Two of Sole's watercolour paintings of grasses – Agrostis Capillaris and Agrostis Stolonifera, (with thanks to the Librarians of the University of Bath for permission to reproduce these images).

Sole and Curtis adopted somewhat different strategies for presenting the grasses, but both continued to write in the tradition of connecting botany to human uses and institutions. Sole listed all 108 varieties found in England, with very brief descriptions of their existing uses and suitability for cultivation. So, for example, he noted the use of *Aira Coerulea* for making besoms in the Isle of Ely, and *Arundo Phragmites* for its "economical use […] for thatching, for which purpose it is

superior to any thing growing in England, being neater and more durable than any other thatching. And since the improvement of the fens, by draining, it is become so scarce as to render those pieces of water, which produce it, of almost equal value to the drained ground, as it bears at this time a considerable price."[170] All of these plants were directly and thoroughly involved in a human world; as in Ellis's arguments about *Toxicodendron* plants, systematic botanical classification was not meant to abstract from these uses, but rather to distinguish precisely between them.

Curtis' recommendations for specific grasses also drew on existing practice and what geography made possible, as much as their inherent virtues. The meadow fox-tail grass, for example, was praised for its early growth – but this benefit was "entirely lost at a distance from London, where hay-making commences late, and where the husbandman seems to wait for a crop of general indiscriminate herbage, rather than of grass."[171] *Bromus mollis* (soft brome-grass), by contrast, was

> a grass which predominates in most of our meadows about London, in the spring, and which, if it were cut on its first coming into ear, would form the principal crop, and might make no bad hay; but as at this period, the general herbage is not considered as sufficiently forward, it is suffered to ripen and shed its seeds, before the meadow or pasture is mown, and thus is lost, or becomes of little value; […] as an early grass, it might probably be cultivated to advantage, in the manner of rye; at present we cannot but consider it as a weed, usurping the place, and hindering the growth, of better herbage.[172]

The general properties of grasses could not easily be abstracted from the circumstances of their management, even by the keeper of a botanical garden who sold seeds.

Like Hall before him, Curtis found a tension between attempts to transplant grasses and the natural economy of the soil. All through Curtis' descriptions of grasses, individual grasses seemed

[170] Sole, "Account of English Grasses", 137.
[171] Curtis, *Practical Observations,* 10.
[172] *Ibid.,* 25.

to give way to accounts of particular localities, even while he was stressing their inherent qualities as species. He took issue with the high opinion which previous authors (particularly Linnaeus) had entertained of *Festuca ovina* (sheep's fescue grass), when they claimed that it was especially well adapted as a food for sheep. This might have been true in the context of the elevated parts of northern Europe, Curtis claimed, but in the environs of London "it grows spontaneously on dry elevated heaths and commons; in such situations its produce is extremely trifling, its foliage hard and wiry, and its appearance in dry summers unpleasantly brown." This led on to an argument which associated the plant's virtues with its 'natural place':

> [i]f we force a plant on a soil or situation foreign to that in which it is *constantly* found, we deceive ourselves; were the *Festuca ovina* to be sown in a rich moist soil, the grasses and other plants natural to such a soil and situation, would quickly overpower it, and in the space of a year or two scarcely a blade of it would be discernible; or were we for the sake of our sheep (taking it for granted that they are uncommonly attached to it, the reverse of which we have heard asserted, by men of observation) to plough up our elevated heaths and downs, and sow them with this grass, the sheep would starve on them in dry summers. Where then is the boasted value of this grass?[173]

Where indeed? Despite the emphasis on locality, however, abundance and adaptability were the indications of the best grasses. *Festuca pratensis* (meadow fescue grass) was preferable to rye grass because it was "strictly perennial [..] very hard and will thrive not only in very wet, but also in dry ground" and it grew everywhere "from the sandpits at Charlton, to the osier-grounds at Battersea; and it abounds in the very best meadows about London".[174] It also produced more seeds than all its rivals. Even adaptable grasses might vary enormously, depending on the conditions in which they grew. The rye grass which Curtis despised, for example, "appears to vary *ad infinitum* even in its wild state", with the result that much yet remained to be learned of its qualities: "in some pastures, and

[173] Curtis, "observations"*,* 28-9.
[174] *Ibid.,* 18.

such as were not very moist, we have seen its stalk viviparous towards autumn; in some situations again we have seen it produce foliage chiefly, in others little besides flowering stems, and to prove almost annual."[175] The best grasses were much more stable than this.

Both Sole and Curtis entered into a long-running dispute as to which grass species made up an unusually fecund meadow, near Salisbury, which had been mentioned by Stillingfleet. This meadow had first been described by the agriculturist John Worlidge in 1681, who described the plot "at Maddington, in Wiltshire, about nine miles from Salisbury" where a grass grew

> in a small plot of meadow ground […] to a prodigious length, sometimes twenty-four feet long, but not in height, as is usually reported; the length being caused by the washing of a sheep-down, that the rain in a hasty shower brings with it much of the sheep dung over the meadow; so that in such springs as are not subject to such showers this grass thriveth not so well.'[176]

Worlidge had been much less interested in the species of this grass than in its local conditions. The eighteenth-century botanists came to the same conclusion, but also tried to isolate the plants' species from their local properties. Curtis asked for turfs to be sent from this meadow and planted them in his garden in Lambeth, concluding from their recognisability of these grasses after they had been transplanted that "the extraordinary fertility of this meadow arose not from any new grass peculiar to it, but from several unusual circumstances concurring and favouring in an uncommon

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[175] *Ibid.,* 37-8. This continued to present a challenge for the identification of grasses all the way into the 1930s. As John Sheail notes, "[f]rom his detailed studies of Cocksfoot (Dactylisg lomerata), [Reginald] Stapledon concluded that "it was largely impossible to form a correct picture of the attributes of any particular species unless and until truly representative individuals are collected from every characteristic habitat upon which the species occurs, and are brought together and grown under one set of uniform conditions" Sheail, "Grassland Management", 295.

[176] Quoted in George Sinclair, *Hortus Gramineus Woburnensis, or, an Account of the Results of Experiments on the Produce and Nutritive Qualities of Different Grasses and Other Plants* (London, 1824), 149. The length led Sinclair to remark that "[t]he report of a grass growing twenty-four feet in height must have excited not ordinary attentions." For Worlidge see Ernest Clarke, "Worlidge, John (*d.* 1693)", Rev. Anita McConnell, *Oxford Dictionary of National Biography*, Oxford University Press, 2004 <http://www.oxforddnb.com/view/article/29975> (accessed 6 Feb 2013).

degree the growth of certain well-known grasses, especially the *Poa trivialis* and *Agrostis palustris.*"[177] In his description of the meadow, Sole claimed that "this most excellent grass, whose fame is spread all over England, needs no eulogium here".[178] *This* in that sentence is initially ambiguous: in context, it specifies a location rather than a species. Sole found four grasses, which grew at different months, "which I take to be the reason of every author describing a different grass, for he who goes in May finds this *Poa* in bloom; he in June, *Stote-Fescue;* he in July, *Couch-grass;* he who goes at Michaelmas finds *Agrostis Palustris."*[179] Sole concluded that "it is the ground itself, and not the kind of grass, which constitutes the vast product."[180] So the qualities of the soil needed to be specified:

> it resembles, as deep as I could penetrate with a long knife, (viz, eight inches) an old mushroom bed… this ground being overrun by streams of water from the street, farm-yards &c. upon every downfall of rain, it is rendered so prolific as to bear four crops a year; and by the course of the water the grass is kept couchant, and in that spongy soil strikes at the joints, so that it will creep a vast length some wet years.[181]

This was more or less what Worlidge had reported in the first place. But for both Curtis and Sole the initial question had concerned the relation between species and quality of soil, with the hope that some special variety might be identified, and its seeds sown elsewhere.

As keepers of botanical gardens, Sole and Curtis had slightly different attitudes towards grasses than the strictly agricultural concerns of Stillingfleet and Kent. Curtis was able to assemble plots of sufficient size to compare local variability, and to compare his own situation with grasses from other locations. At the same time, he was a seed merchant, concerned to peddle mixtures for agricultural use. Unlike Roque, however, he was not the advocate of any particular individual species, and did not employ a particular rhetoric of purification. At the same time, the question of the relation between seeds and natural place for species – as well as the wider entanglement of grasses in human uses – was in constant agitation in their writings.

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[177] Curtis, *Observations,* 65.
[178] Sole, "English Grasses," 155.
[179] *Ibid.*
[180] *Ibid.*
[181] *Ibid.*

4. Straw Management

This question returned, through abstraction of a different kind, in the remarkable series of experiments which were performed by George Sinclair, the gardener of John, Duke of Bedford (who was a vice president of the Society of Arts), and which were published in the several editions of the *Hortus Gramineus Woburnensis*.[182] These experiments, which lasted from 1809 until 1824 were first described publicly in the first edition of Humphry Davy'd *Elements of Agricultural Chemistry* in 1813.[183] They have been celebrated by a number of historians of science, who have seen in their attention to specificities of soil and interaction between species hints of an "ecological" approach, as well as directions for the appropriate species to choose for laying down pastures.[184]

At the same time, however, Sinclair's experiments were meant to prove the suitability of grasses for a particular manufacture, closely associated with the Society of Arts, and intended to substitute for foreign imports. The second appendix of the 1824 edition concerned all the "Grasses which afford the best culms, or straw, for the manufacture of Straw Bonnets, such as will equal, and may surpass, the finest Leghorn Manufacture".[185] They were direct inheritors of the difficulty of isolating grasses from their surroundings. This was intended for a school on the Duke's estates which would teach straw plaiting, and it put him in the curious company of the radical conservative William Cobbett.[186]

To understand what Cobbett was up to, we need to step back and look at straw-plaiting, and how it had come to be entangled with questions of the properties of English grasses. Pamela Sharpe argues that there are "two intertwined historical stories about straw-plaiting. It was a

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[182] Sinclair, *Hortus Gramineus*. These experiments are discussed (briefly) by Sheail, "Grassland Management", 288-289, and in Ambrosoli, *The Wild and the Sown*, 358. Ambrosoli assumes that they must have been primarily concerned with artificial grasses. The best overall discussion of them is in Paul Smith, *The landed estate as patron of scientific innovation: Horticulture at Woburn Abbey, 1802-1839*. (Unpublished PhD Dissertation, Open University, 1983), 149-166.The ecologists Andy Hector and Rowan Hooper also note Darwin's reference to the Woburn experiments, describing this as a prototypical ecological experiment. Andy Hector and Rowan Hooper, "Darwin and the First Ecological Experiment", *Science*, 2002, **295**: 639-640.

[183] Humphry Davy, *Elements of Agricultural Chemistry: In a Course of Lectures for the Board of Agriculture* (London, 1813).

[184] Sheail, "Grassland Management", p. 289

[185] Sinclair, *Hortrus Gramineus*, p. 422.

[186] For the vicissitudes of Cobbett's political fortunes, and the different political positions by which his legacy has been appropriated, see Martin Wiener, "The changing image of William Cobbett." *The Journal of British Studies*, 1974, **13**: 135-154.

profitable employment for women and children, yet a pauperised occupation charitably offered to the poor."[187] It dominated the rewards of the Society of Arts' Committee of Manufactures during the 1820s. Plaiting was prized highly because it was a "domestic occupation" which could not be mechanised, and as such was "free from the objections which so strongly attach to congregating in factories children and young persons removed from the control and inspection of their parents, and also because it is not very likely that the occupation thus offered to manual labour should be superseded by the substitution of machinery."[188] There had been precedents for the Society's interest in straw hats. Thus in 1805, a gold medal was given to William Corston from Ludgate for the use of rye straw. Corston's hats were manufactured in a school in Fincham, and he thought growing straw would be a good use of waste-land.[189] This was a typically expansive scheme, and like so many others which the Society supported it did not lead to significant imitation.

That the 1820s saw so much interest in straw-plaiting at the Society was largely due to Cobbett's rhetorical gifts. He was a long-standing and unpredictable irritant, who claimed to speak for the independent spirit of the yeomen of Britain. A great partisan for locust trees, Cobbett wrote in the persona of a farmer, who was able to read the landscape and its needs; he used this representation and claim to common-sense building to denounce "the Thing", which was made up of 'tax-eaters', Jews, Quakers, barracks, unwanted improvements, road-building projects, and debt.[190] He received a reward from the Society in 1822**,** for his contributions to straw plaiting. Some criticised his reward, claiming that Cobbett had traduced the Society of Arts. Another publication, sympathetic to Cobbett, imagined Government ministers claiming that "the most perfidious and malignant of these libellers […] has become a commentator on Swedish turnips and leghorn bonnets", then added that "if his Majesty's ministers, either in their individual or aggregate capacity, had ever rendered a service to their country, of a tenth part equal to the service of that person, whoever he was, who introduced therein the Swedish turnip, they would have some claim to public

[187] Pamela Sharpe, "The Women's Harvest: Straw-Plaiting and the Representation of Labouring Women's Employment, c. 1793-1885," *Rural History,* 1994, **5**: 129-142, at 129.
[188] Anon, "British Leghorn", *Transactions*, 1826, **44**: 58-61, at 59.
[189] William Corston, "Paper in Manufactures", *Transactions*, 1805, **23**: 223-232.
[190] For Cobbett as a farmer, see, particularly, Ian Dyck, *William Cobbett and rural popular culture*, (Cambridge, 1992); G.E. Fussell, "English Agriculture from Arthur Young to William Cobbett", *The Economic History Review*, 1936, **6**: 214-222; A. J. Moffat, "William Cobbett: politician and soil scientist," *Geographical journal,* 1985, **151**: 351-355.

approbation."[191] In other words, discussion of agricultural pursuits was represented as evidence of patriotism and non-partisan utility, very much in line with the Society of Arts' traditional self-image.

With typical rhetorical verve, Cobbett made the Society's prize-giving his own. Having been addressed by the Duke of Sussex, who was giving the prizes, with great respect, Cobbett

> begged that his Royal Highness would allow him to deviate a little from what he observed was the usual practice upon these occasions, and to make a few observations. He was always of opinion that it was of the greatest importance to the people of this country, that the manufactures should be carried on by themselves. It was impossible to look round, and not to observe that thousands of pounds, which ought to be expended in this country, were sent into foreign countries. He was satisfied that if the Ladies and Gentlemen of this Society, many of whom were present, would exert themselves, there would be very little sale for Leghorn bonnets, and this would be one way of putting a period to that despicable cant which was daily dinned into the ears of the poor, that they should be content with their condition as paupers, and that the grace of God directed them to live in poverty, both of food and of dress [applause].'[192]

The manufacture of straw hats had gone into temporary decline in the 1820s. In 1822, Sophia Woodhouse, from Connecticut, sent a straw bonnet to the Society of Arts, and was rewarded with a premium for a new material –"the stem of a species of grass growing spontaneously in that part of the United States, popularly known by the name of ticklemoth."[193]. It was reportedly finer and more beautiful than the Italian, "the maker stated to consist of the straw of a sort of grass, of which she sent, along with the bonnet, some of the seeds."[194] Cobbett was asked to get some of the seed from America, and retorted with his usual priggish sense of the immediately obvious that "there could be no sort of grass in Connecticut, that would not, and that *did not* grow and flourish in

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[191] Anon, *An Answer to the State of the Nation at the Commencement of the Year 1822, and the Declarations and Conduct of His Majesty's Ministers Fairly Considered,* (London, 1822).
[192] *Morning Chronicle,* 23 May, 1823.
[193] Anon, "New Material for Straw Plat", *Transactions* 1823, **40:** 217-22, at 219.
[194] William Cobbett, *Cottage Economy*: *Containing Information Relative to the Brewing of Beer, making of Bread, etc;*, (London, 1823), N.P., para. 213.

England."[195] Cobbett sent his son to see Miss Woodhouse, to get a description of how the straw was cut and bleached, together with a specimen of the plait. Woodhouse had described her grass as *Poa pratensis*, the smooth-stalked meadow grass; Cobbett reasoned "that we had grass enough in England, if we could but make it into straw as handsome as that of Italy."[196] He later decided that Woodhouse's sample was probably the *Agrostic vulgaris*, common couch grass. Whatever the botanical value of this identification, it played a polemical role, as the couch grass was a weed "to extirpate which from our fields, or, rather, to keep it in check, costs millions of money every year. It was certainly not necessary to send to Connecticut for the seed of this greatest of all the curses of English agriculture."[197] As with the earlier Timothy grass, the Atlantic exchange drew attention to a plant which already abounded in England, but which had gone unnoticed before.

Cobbett conducted experiments to ascertain if the difference was the availability of sun (he gave no details of what these experiments were); this seemed propitious because "there is no part of the world which can equal what might be obtained from some of our downs merely by keeping the land ungrazed till the month of July."[198] Cobbett attended the Society of Arts; his samples were sent to manufacturers of plait, and got an unfavourable response. He then "sent some parcels into Hertfordshire, and received fifteen specimens in return" – which he sent to the Secretary of the Society, claiming that he had found wheat grass too tough and that common bennet answered best.[199] Cobbett also sent his instructions for preparing the grass, according to Williams' method. Cobbett emphasised the difference between the grass in Hertfordshire and that in Sussex – the former cut when the wheat was in full bloom, while in the latter "the wheat was ripe, for reaping had begun; but that grass is of a very backward sort, and, besides, grew in the shade, amongst coppice wood and under trees, which stood pretty thick."[200]

Identifying appropriate English plants for producing straw was thus as maddeningly difficult as settling on the definition of a *toxicodendron* tree, and for very much the same reasons. Use, treatment, climate and the possibility of substitution all merged ambiguously into each other. This was the task

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[195] *Ibid.,* para 214.
[196] *Ibid.*
[197] *Ibid.,* para 224.
[198] *Ibid.*
[199] *Ibid.,* para 225.
[200] *Ibid.*

which the Duke had set for Sinclair, because he (and the Duchess) hoped to establish a girls' school for making the hats. Sinclair sowed the wheat which Cobbett had recommended, alongside five varieties of oats, and a "number of the different species of perennial grasses, on a separate space of ground". The wheat was very unsatisfying, turning out to be "the common bearded spring or cape wheat, which in this climate is very subject to the rust disease".[201] This suggested that it would make unsuitable straw, "even should a mode of culture be found out, under the circumstances of a British climate, that would afford culms or straw of this grain sufficiently fine, and at the same time of a texture sufficiently tough and firm for the Leghorn plait; but experience will prove, that these last-mentioned properties are not to be obtained here by this plant."[202] Of the options available in England, Sinclair preferred perennial grasses. He communicated information about them on the grounds that they might be cultivated, and manufactured, far beyond the confines of Woburn:

> As several of these species of grasses affect soils of a different nature, it may be useful to mention the different soils peculiarly adapted for the growth of certain species, that those who may be locally circumstances as to a particular soil, and who may be disposed to encourage the introduction of so valuable a manufacture among the females of the labouring classes, may be saved the temporary disappointment caused by cultivating a grass not adapted to the sol, or not calculated to afford the finest straw for the intention.[203]

Sinclair was able to specify the different qualities of straws grown in different soils because his experiments were trying to recreate, in as much detail as possible, the natural conditions in which grasses flourished. The goal was to imitate natural productions of pastures, but more rapidly: "for one seed of a valuable species of grass supplied to the soil by the slow and gradual process of nature, in one season, a thousand are supplied in the same space of time."[204] Sinclair noted that

> As every different soil produces grasses peculiar to itself, and as no other kinds can be established or cultivated upon it without first changing its

[201] Sinclair, *Hortus Gramineus*, 424.
[202] *Ibid.*
[203] *Ibid.*
[204] *Ibid.,* 249

> nature to resemble that which produced the kinds of grasses we wish to introduce; it becomes a point of the first importance, in making experiments on different species of this numerous family of plants, and in stating the results, to determine with sufficient accuracy the nature of the soil or different soils employed, and to describe them accordingly.[205]

This meant the transplantation of existing turfs into the Duke's garden, to ascertain which grasses grew upon them. Also, "new soils [were] supplied, or mixtures of soils were made in them, to furnish, as far as possible, to the different grasses, those soils which seem most favourable to their growth."[206] Sinclair concluded that "[t]heir comparative value… in regard to produce, and the particular seasons at which it was in perfection, with the kinds of soil most favourable to their growth, and the peculiar habits of the different species, were, by these means, satisfactorily ascertained."[207] Sinclair described the effect of the experiments as follows:

> Seeds of all the grasses peculiar to each soil were sown on distinct spaces of each bed. The seeds of the different grasses vegetated on all the soils, except on the inert peat, which remained completely barren. In the ensuing season it was remarkable to see the different degrees of luxuriance exhibited by the same species of grass on different soils. The superior grasses, or those which constitute the produce of rich ancient pasture lands formed nearly a perfect convex ridge of grass; beginning at the poor siliceous sandy soil.[208]

What Sinclair felt he had learned from these experiments was that grasses had a "gregarious or social propensity… and by combining those valuable species which ripen their seed at the same period, affect the exclusion of the seeds and plants of inferior species of grasses, and thereby insure the supply of pure seed, and render extraordinary expense in weeding unnecessary."[209] Natural

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[205] *Ibid.,* 115.
[206] *Ibid.,* 1.
[207] *Ibid.,* 2.
[208] *Ibid.,* 123.
[209] *Ibid.,* 39.

pastures were superior to artificial ones not because they were pure but because they were less reduced; their luxuriance came "in respect of a constant never-failing supply of herbage throughout the season" which owed "to the variety of habits which exist in a numerous assemblage of different grasses."[210] This could be discerned, Sinclair claimed, "by comparing the different states of productiveness in natural pastures, during a season of changeable weather, with those of artificial pastures under the like influence of soil and climate."[211]

This was hardly the result which Stillingfleet had imagined, and it did not rely on a providential matching between animals and their food stuffs; indeed, Sinclair advertised Davy's analytic methods as an advance on all older attempts to match animals to their food.[212] Moreover. Nevertheless, it continued the productive series of questions about the relations between grasses and their habitats which had practically informed botanical work on these plants for the preceding seventy years. One reason that historians have wanted to read an 'ecological' import into Sinclair's experiments is that he was trying to contend with the relations between species and locality, in a way which preserved something of the complexity of living systems. He was doing so in an experimental plot which artificially gathered different examples of local thriving; and part of the reason for doing so was the Duke's controlling, philanthropic hope of establishing straw-spinning school to compete with Italian imports. The grass plots were not quite the same as the Society of Arts' repository in London; but they were not so distant either.

5. Conclusion

Historians often characterise improvement as the disappearance of doctrines of 'natural place', and botany as the erasure and uses for plants. The works and experiments on grasses reviewed in this chapter provide an important counter-example to these claims. Certainly, some English improvers – from Stillingfleet onwards – hoped to be able to purify grasslands, and sow pure, as though natural grasses could be sown like their artificial kin. These were accompanied by a concept of the providential matching between animals and the foods which they ate, which was taken over from

[210] *Ibid.,* 157.
[211] *Ibid.*
[212] *Ibid.,* 4-5.

Linnaeus, and apparently proved by observation of animal behaviour.

In attempting to do this, though, botanically-minded improvers came across the local variety of grasses, their matching to different soils, the sheer difficulty of distinguishing between different species. In the case of grasses, the local was not so easily dispensed with, and central to the botanical works of Curtis and Sole was an itemisation of existing local uses for different grass species, which closely recalled the earlier tradition of local floras. This was accompanied by considerable suspicion of the idea that any one grass would always be found useful, in every place.

Sinclair's experiments at Woburn gathered these questions together with the Society of Arts' search for effective English substitutes for Italian straw. In the process, the Woburn grass plots were intended to recreate something of the locales from which the grasses had been drawn. Thus investigation into grasses showed a productive, even unpredictable balance between local properties and precise identification of species; these were understood in terms of their existing uses; and a wide range of people (not only botanists, but farmers and land agents, and gardeners) described them.

Chapter Eight: A Planting Public

1. **Introduction**
2. **Experimental Accounts**
3. **Quick-Growing Timber**
4. **Conclusion**

1. Introduction

On the 26th March 1755, Henry Baker presented the Society of Arts with "a quarto pamphlet" written by Edward Wade, which was intended "to promote the planting of timber trees in the common and waste ground all over the kingdom for the supply of the Navy, the employment and advantage of the poor, as well as ornamenting the nation."[1] Over the following eighty years, the Society gave out almost 200 rewards for tree planting. The Society sought to encourage new kinds of people to plant trees in new ways, appropriating conventional Georgian approaches to tree planting so that it appeared the kingdom could be embodied in a concatenation of large and small woodlands; and they supported attempts to turn histories of plantations into transferable, general knowledge. This occurred against a backdrop of extravagant criticism and attacks on the sequestration of land for tree planting, and the relation between the growth of trees and their presence within certain soils. The Society's planting public was exceptionally fractious.

Tree planting is perhaps the best known of the Society's projects, and existing histories have interpreted it in three ways. First, as a triumphant national achievement, which sought to solve the problem of timber supply for the Royal Navy. According to Trueman Wood "thousands of acres were planted, and, as a practical result, the supply of timber was, to a certain extent, renewed. Many of the woods throughout the country owe their present existence to the initiative of the Society of

[1] Edward Wade, *A Proposal for Improving and Adorning the Island of Great Britain: For the Maintenance of Our Navy and Shipping, Etc., by Parochial Plantations of Timber and Other Trees, Upon the Forests, Chaces, Commons, and Waste Grounds Throughout the Kingdom,* (London, 1755).

Arts."[2] The second view holds that the awards were part of a more general fashion for plantation. As Henry Darby puts it in his historical geography of Britain, "[i]t scarcely needed the repeated exhortations of John Evelyn's *Silva* […] or practical hints from William Marshall, or the generous prizes of the Royal Society of Arts, to induce gentlemen to 'adorn their goodly mansions and demesnes with trees of venerable shade and profitable timber.'"[3] The third view dismisses the awards. Oliver Rackham argues that they premiums

> had not quite the influence on the development of the landscape that they have sometimes been credited with. During 89 years, as its *Transactions* show, the Society offered about 2000 medals and prizes for planting trees, but awarded only 178. Many medal-winning plantations were very small. Anyone sowing or planting 5 acres (2 hectares) who applied for a gold medal would be almost certain to get it, unless the trees were the popular oak or "Scotch fir".[4]

All of these views speak to part of the Society's attempt to encourage a planting public into being: the triumphant account draws on the rationale and rhetoric for planting without attending to its empirical realities, the note of the fashion shows how widespread the practice was among some social groups, and Rackham's extreme caution is a reminder that the overall number was not very great. What I want to add to these three views, in line with the general preoccupations of this thesis, are the ways that the Society's encouragements turned on the idea of an expansive public, on the one hand, and disembedded practices, on the other. As with other projects in which the Society was interested, knowledge of planting was extremely widely distributed. Individual planters had to learn afresh basic facts about what plantation involved, and old hands justified their knowledge in terms of long-standing personal experience. It was not obvious, *prima facie*, which of these would be the most successful, or produce timber with the greatest speed. Thus neither the triumphalist view, nor

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[2] Henry Trueman Wood, *A History of the Royal Society of Arts*, (London, 1913), 145. The same view is expressed in G. D. Holmes, "History of Forestry and Forest Management", *Philosophical Transactions of the Royal Society of London, Series B, Biological Sciences,* 1975, **271**: 69-80; N. D. G. James, *A History of English Forestry*, (Oxford, 1981); Simon Schama, "The tree that shaped Britain," <http://news.bbc.co.uk/1/hi/8668587.stm> ; (accessed 30 April 2012): Anon, "RSA Trees", http://www.thersa.org/projects/past-projects/rsa-trees (accessed 30 April 2012).
[3] Henry Clifford Darby, *A New Historical Geography of England*, (Cambridge, 1973), 30.
[4] Oliver Rackham, *Woodlands,* (London: Collins, 2006), 451.

Rackham's criticisms are quite on target: it was precisely small-scale planting according to experimental techniques which the Society sought to encourage.

Section two contextualises the Society's interest in plantation in terms of the contradictory and politicised Georgian attitudes towards trees, wood, and timber supply, setting up a contrast between the Society's approach and what historians have described about their cultural significance, "German Scientific Forestry", and timber supply for the Navy. It then reviews the Society's attempts to consider the descriptions of plantations as experimental reports, comparing these goals with the challenges which the Board of Agriculture's reporters found in describing private plantation practices. Section four looks at how plantation reports were presented as speculative financial accounts – which were intended to emphasise the profitability of tree growing over long periods. These forms of accounting were also naturalised by correspondents writing to the Society as tables describing the regular annual growth of trees; such tables were in turn occasionally employed to rationalise new or existing plantations. They were intended to make trees behave interchangeably with other uses for land – but also attracted considerable criticism on the basis of their uncertainty and sequestration of productive land away from other purposes. Section three exemplifies the local stakes of these debates by describing how questions about experimental growth, accounting, and the right use of land flared into a noisy public quarrel during the 1820s between the Norfolk attorney and planter William Withers and a number of Scottish planters, including Sir Walter Scott. Section four concludes, discussing how experiment, accounting, and local differences in approach contributed to form the Society's distinct approach towards the planting public.

2. Experimental Accounts

Writing in 1833, the Society's secretary was clear that the reports of plantation which its premium candidates had submitted amounted to a mass of local detail, without coherent follow-up. What was needed, he wrote, were "histories of plantations sufficient in number and in their details to allow of a fair comparison to be made of different modes of management, modified by varieties

of soil, of climate, and of exposure."[5] The goal was to make the plantation reports work in the same way as other agricultural experiments. But trees were a special case. Most experimental crops would grow within one year; in consequence "all the particulars... of an agricultural experiment, together with its final result, are easily observed and registered."[6] So one person could perform many experiments, "with the reasonable hope of deciding in a few years the comparative advantages of different modes, either of general management, or of the culture of any particular crop." But in general trees would not be ready for fifty years; oaks would take a century. As such, single experiments in planting could rarely be "conducted from beginning to end by the same person".[7] Moreover, memoranda recording effective practice were likely to be lost "in the course of time, or by transfer of the property from one owner to another." This was the source, he believed, of the "contrariety... both in principle and in practice"[8] between planters.

The problem of how to aggregate the details, and generalise from them had a long pedigree. In *Silva*, the first major work on plantation in English, John Evelyn had written "I have often wished, that *Gentlemen* were more curious of transmitting to *Posterity,* such *Records,* by noting the Years when they begin any considerable *Plantation;* that the *Ages* to come may have both the Satisfaction and Encouragement by more accurate and certain *Calculations.*"[9] Much had changed between the 1670s, when Evelyn was writing, and 1833, but a clear sense of the principles which could lead to reliable planting in all situations had not been developed. That it had not do so in Britain (and particularly in England) was due to two main factors: the very complex interplay between public and private interests in planting, and the significant local differences between plantations, and their role within regional economies. Despite the lack of principles, however, planters had developed relatively sophisticated ways of talking about their own practices as if they were generally applicable – presenting them in the form of financial accounts, comparing them with other uses of land, and recommending particular techniques which were meant to guarantee the rapid growth of trees. Historians have offered two major narratives of knowledge about trees and plantation during the

[5] Anon, "Plantations", *Transactions* 1832, **49**: 3-10, at 4.
[6] *Ibid.,* 5.
[7] *Ibid.*
[8] *Ibid.*
[9] John Evelyn, *Silva,* (London, 1679), 198.

eighteenth century. The first emphasises the varied and sometimes conflicting cultural meanings which Georgians ascribed to trees. Steven Daniels describes an analogy between "planting and power in the land"; an elision between timber supply and maritime strength, which included disputes about the relative returns of corn and the more gradual advantages associated specifically with oaks; the rather different symbolisms associated with coniferous and deciduous trees, with the former represented by some conservative observers as no better than a "vegetable manufactory"; as political symbols for radical causes; and as one aspect of picturesque design of gardeners like Humphrey Repton.[10] Many of these senses played through the Society of Arts' premium awards.

These meanings for woodland are complicated, however, by the second tradition, which associates the eighteenth century with the rise of Scientific Forestry. The location for this was German territories, rather than England – and it is a classic story of the imposition of rational management, based on techniques of "simplification, legibility and manipulation".[11] Its application involved the systematic exclusion of local properties – "foliage and its uses as fodder and thatch; fruits, as food for people and domestic animals; twigs and branches, as bedding, fencing, hop poles, and kindling; bark and roots, for making medicines, and for tanning; sap, for making resins; and so forth".[12] Through the use of yield tables, the forester could reduce all woodland into a mere resource. Ultimately this would transform the forest itself:

> By radically narrowing his vision to commercial wood, the state forester had, with his tables, paradoxically achieved a synoptic view of the entire forest. […] in the regulated, abstract forest of the *forestwissenschaftler,* calculation and measurement prevailed, and the three watchwords, in modern parlance, were "minimum diversity", the "balance sheet", and "sustained yield".[13]

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[10] Stephen Daniels, "The Political Iconography of Woodland in later Georgian England," in D. Cosgrove and S. Daniels, eds. *The Iconography of Landscape: Essays on the Symbolic Representation, Design and Use of Past Envrionments,* (Cambridge, 1988), 43-82.
[11] James C. Scott, *Seeing Like A State,* (New Haven, 1998), 11. Scott's primary source for German forestry is Henry E. Lowood, "The Calculating Forester: Quantification, Cameral Science, and the Emergence of Scientific Forestry Management in Germany," in Tore Trangsmyr, J.L. Heilbron, and Robin E. Rider, eds., *The Quantifying Spirit In the Eighteenth Century* (Berkeley, 1991), 315-42.
[12] Scott, *Seeing Like a State,* 12. Cp. Also Laura Auricchio, Elizabeth Heckondorn Cook and Giulia Pacini, eds., *Invaluable Trees: Cultures of Nature 1660-1830,* (Paris, 2012).
[13] Scott, *Seeing Like a State,* 15.

The rise of scientific forestry is associated with the formation of schools for training foresters, and closely associated with the goals of the state. Such a panoptic view was not available in British (and particularly English) woodlands at this time. This does not mean, however, that no natural philosophical approaches were applied to them. Rather, as the secretary's words made clear, the distinct experimental predicament of British planters emerged from the great variety of sites for planting which were proposed, and the difficulty of knowing how far techniques of planting, management, and measuring yield, could be transferred from one location to another. In this sense, the small plantations which Rackham lamented were all experiments – just as the secretary proposed. British natural philosophical forestry was based on the complex question of publicising private, local knowledge.

The very great difficulty of constructing general knowledge about plantation, and its local aspects, has been missed because historians have focused almost exclusively on the Royal Forests. This is puzzling because, even though no one has yet worked out in detail the contributions which private woodlands made for naval timber, we have rough estimates of the amount which was provided by different locations – and private estates were the most major source in Britain. Despite this, however, Sara Morrison focuses her analysis of timber supply for naval purposes on what she estimates to be the 10% or so which were contributed by the Royal Forests.[14] Her emphasis effectively mirrors forestry policy during the Reign of Charles II, which devoted attention to the Royal Forests simply because it was possible to survey them without opposition, and due to a "want of money to buy timber from private men". Furthermore, the sense that the royal forests could provide a check on private timber supplies persisted into the eighteenth century; in 1706, Wilcox, surveyor general of the forests south of the Trent, wrote that the timber of the New Forest "should not be cut except on extraordinary occasions, but should be preserved as a check upon the

[14] Sara Morrison, "Forests of Masts and Seas of Trees", in Nancy L. Rhoden, ed., *English Atlantics Revisited: Essays Honouring Ian K. Steele,* (Montreal, 2007). The "Timber Supply Problem" is an old historiographical riddle, and was never as simple as a lack of resources. The situation for timber is outlined in Robert Albion's classic *Forests and Sea Power, the Timber Problem of the Royal Navy*, (Cambridge, 1926), and revised in R. J. B. Knight, "New England Forests and British Seapower: Albion Revised," *American Neptune,* 1986, **46**: 221-9. For the longer historical treatment, and comparison of European traditions, see Paul Warde, "Fear of Wood Shortage and the Reality of the Woodland in Europe, c. 1450–1850," *History Workshop Journal*, 2006, **62**: 28-57, which finds a credible lack of timber during the Napoleonic period, which would be remedied by scientific forestry. The naval side is described in Clive Wilkinson, *The British Navy and the State in the Eighteenth Century*, (Woodbridge and Rochester, 2004).

timber merchants, who, when it was gone, would impose what rates they pleased."[15]

Part of the reason for the Crown to focus on the Royal Forests was a lack of information about resources elsewhere. This remained true into the early 1830s. In *Rural Rides,* William Cobbett wrote darkly that "[i]f I were a Member of Parliament, I *would* know what timber has been cut down, and what it has been sold for, since the year 1790."[16] In 1828 William Withers, an attorney from Holt in Norfolk and disciple of Cobbett, wrote to the Royal Dockyards, seeking information about the contributions of privately grown timber for naval construction – and received the response that "the various forests of the government do not produce, on an average, more than one sixteenth of the oak timber consumed in his Majesty's yards; the remainder is collected in the various parts of the kingdom, without having regard as heretofore to the part of the kingdom in which it grows."[17] The need to seek such information indicates that it was not readily available by other means.

The closest thing to a comprehensive estimate of private timber resources during the eighteenth and early nineteenth centuries were the scattered notes in the Board of Agriculture surveys, which abounded with local and particular detail. At the same time, the surveys did not give a comprehensive picture of English practice. Evaluation of counties often concerned their suitability for potential or future timber growth, rather than currently existing woodlands. The county reports seemed to carry the hope that bad land could be well appropriated for an effective overall timber supply. Such land should ideally be suitable for trees and nothing else, so that the growth of oak would not conflict with the use of land for corn. The Surrey reporters noted that

> a full and proper account was given of every common and piece of waste land, or barren heath, that is to be found in the whole district, marking distinctly, as we proceeded, the quality of the soil, and its aptitude to the growth of oak and other timber; from whence it will be deduced, that there does exist in this county a large tract of land, uncultivated and unemployed, and which, without injury to any

[15] Morrison, "Forests of Masts and Seas of Trees", 151.
[16] William Cobbett, *Rural Rides,* vol. 1, (London, 1830), 141
[17] William Withers, *A letter to Sir Henry Steuart, Bart on the improvement in the quality of timber, to be effected by the high cultivation and quick growth of forest-trees*, (Holt, 1829), 54.

> person, might, under a proper system, be in part appropriated to the growth of timber, and ultimately tend to a lasting benefit to this kingdom.[18]

Durham noted the absence of oak trees in the surrounding area, and the commonness of the ash – "[y]et the soil and substrate appear to be very similar to those of the Wealds of Kent and Sussex; the latter of which, more particularly, has long been celebrated for its oak timber."[19] Along the same lines as the general discourse about naval timber, estimation on these grounds was not about current resources, but about possible future sources of supply.

Second, the Board's different reporters varied enormously in the attention they paid to woodlands. This mapped partially, but not completely, to the significance of woods in each county. So the county report for Berkshire contained twenty-four pages of details about individual forest trees; that for Essex incorporated what William Marshall described as "an undigested mass of materials, giving the general idea that South Essex abounds in woodlands, but no estimate of aggregate extent"; and that for Norfolk described the significant efforts of individual planters, while noting that there was little significant woodland in the county overall.[20] So, as with the Society's premium awards for agriculture, it was difficult to tell which locations featured scattered exemplary efforts at plantation, and which had significant resources of timber and other forms of wood.

Third, the presence of timber (in old-growth woodlands) was described alongside other woodland industries and management practices, especially the cutting of coppice, which relied heavily on local markets. There was little clear distinction between the profits which landowners could gain from their woods and the longer-term growth which timber for the navy was held to require, and hence little prospect of overall evaluation of timber supply. Northumberland's woodlands were evaluated as follows**:** "[t]he demand by the collieries and lead mines for small wood, has induced the proprietors of woods on the Derwent, Tyne, &c. to cut them at an early age. From twenty-five to thirty years growth is the general term for oak, elm and ash; but birch, willow and alder, are cut sooner; and hazel for cords, once in three or four years."[21] The report for the

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[18] Quoted in William Marshall, *Southern and Peninsular Districts,* (London, 1818), 301.
[19] Quoted in William Marshall, *Northern Department,* (London, 1818), 146.
[20] John Bailey and G. Culley, *A General View of the Agriculture of the County of Northumberland,* (London, 1813), 124.
[21] Rennie, Broun and Shirreff, *General View of the Agriculture of the West Riding of Yorkshire,* (London, 1794), 14.

North Riding of Yorkshire contained a section on the Disposal of Timber, noting that "it is the practice in this Riding to sell the falls of wood to professional wood-buyers, who cut up the trees in the woods, according to the purposes for which they are best calculated, and the most valuable."[22] William Marshall responded to this claim with bemused dismay:

> The wood-buyers certainly separate the trees that are fit for ship timber from those that are proper for "country uses:" – and not unfrequently cut off a crooked top, for the use of the ship or boat builder from a straight stem, which is fit for the house carpenter. But when he says […]"All the ship-timber grown in the Riding is thus cut up in the woods, into shapes ready for the builder to make use of," he is certainly wrong. It is not probable that in any part of the Riding such a practice prevails: it being impossible for the woodman to know exactly the wants of the ship builder, unless the latter were to furnish him with molds.[23]

This pointed towards the different users of timber – the wood buyer, the carpenter, the shipbuilder – without specifying how they contributed to the production of, or market for, timber in particular areas.

Finally, the Board's reporters were quite hesitant to give a detailed picture of the activities of private landowners. Marshall, in discussing the management strategies of Joseph Banks on his estate, thought that "many of my readers will probably censure me, for entering thus widely into calculations, concerning the private property of an individual."[24] Even where private practices were described, it was sometimes in terms which were so idiosyncratic as to be quite incomprehensible. The Northumberland reporter described the management system of Anthony Surtees, of Newbiggen: "He takes his away in *patches;* and as the older trees interfere with the younger springs, and where a thriving healthy oak is in a convenient situation, he lets it stand for timber; by this means the young spring is sheltered, and an annual produce of upwards of £100… is obtained

[22] John Tuke, *General View of the Agriculture of the North Riding of Yorkshire,* (London, 1794), 89.
[23] William Marshall, *The Review and Abstract of the County Reports to the Board of Agriculture,* vol. 1, (London, 1818), 466.
[24] William Marshall, *A Review of the Reports to the Board of Agriculture from the Eastern Department of England,* (York, 1811), 125.

from sixty acres of woodland"[25]. Marshall observed of this that "I insert this passage, though I confess I do not clearly understand any part of it, except the conclusion."[26]

Thus the premium reports which were submitted to the Society could appear to be valuable because they provided direct reports, by landowners and other planters, of effectual techniques. These were not readily available by other means.[27] As with other agricultural experiments, accounts of tree plantations were often couched in terms of profit-and-cost accounts, of which two examples are given in figures one and two.[28] These were intended to prove the superiority of trees to other ways of using land, by projecting profit over long periods of time and comparing the 'rent' of the augmenting timber with what the land would otherwise have earned.

The speculative nature of plantation accounts was often criticised, particularly because they attempted to generalise too much – an intense example of the need for agricultural experiments to specify local conditions. In William Marshall's words, "the proper management of woods, the advancement and progressive value of their produce, the most profitable state of growth, and the most suitable application, depend on the *given* soil, substratum, and climature, and the market to which the produce can be sent with the greatest profit."[29] John Sinclair thought that the element of risk should temper planters' enthusiasm: "the profit of a plantation must, in a great measure depend, upon a number of local circumstances. The expense is immediate, and can be easily ascertained; but the returns are distant, and the planter is disposed to form too sanguine expectations for the future."[30] By contrast, in 1767 Robert Dossie had hoped that the Society of Arts' encouragements could mobilise a wider public to plant, by promising more rapid returns. Under the present system, he wrote the return of profit for planters was "so far distant", that "the original disbursement appears almost as so much property lost"; in consequence planters had to be

[25] John Bailey, George Culley, *General View of the Agriculture of the County of Northumberland*, (Newcastle, 1797), 109.
[26] Marshall, *Review and Abstract,* vol. 1, 46.
[27] There was a huge literature of planters' guides, together with other attempts to collect information, but these rarely referred to specific timber markets, plantations and local experimental details. Cf. Beryl Hartley "Exploring and Communicating Knowledge of Trees in the Early Royal Society", *Notes and Records of the Royal Society of London*, 2010, **64**: 229-250.
[28] This made for a startling contrast with Evelyn, who did not believe the value of a living tree could be reckoned with any precision. For him, a timber-tree was a "Merchant-Adventurer, you shall not know what is worth till he be dead." (Evelyn, *Sylva,* p. 51).
[29] Marshall, *Northern Department,* 224.
[30] John Sinclair, *The Code of Agriculture: Including Observations on Gardens,* (London, 1832), 339

very wealthy landowners, who would "be content with the remote advantages that are to be reapt by their posterity."[31] Dossie hoped that novel systems, described in the Society's publications, would allow "those who cannot afford to let the money disbursed lye dead for a long term of years" to plant as well, "[a]s means will there be explained, of conducting such plantations in a manner, by which, the capital employed will be soon regained; and a future profit acquired on the whole long before the timber-trees attain to their maturity."[32] This meant focusing on different kinds of trees: particularly willows and poplars, which (Dossie thought) would become mature in "thirty or forty years".[33] In this light, the rather scanty plantations which invoked Rackham's scorn can be seen as part of a deliberate policy of encouraging different kinds of landowner to become planters, and communicating knowledge about smaller-scale but still profitable plantations. And while the new plantations might lack the diversity of old-growth forests, they would not entirely resemble monocultural simplifications either; instead they were characterised by avid experimentation and significant regional variation.

The attempt to grow profitable trees rapidly led to attention to particular species. The premium awards record a number of prizes for Spanish chestnuts during the 1790s, and a flurry of awards for osiers in the twelve years between 1794 and 1806: these were supported because of a representation which had been made to the Society of Arts by London-based basket makers about the difficulties of obtaining imports during the Napoleonic wars. By the logic of the timber supply argument they were to be grown alongside timber trees, but in fact most of the plantations which were rewarded were dedicated solely to them. Besides selecting certain species, one main way in which planters could be sanguine about regular returns from woodland was through exploitation of underwood. This was a crop, often of a different species, which grew alongside timber trees and were meant to shelter them in their early years. The advantage of underwood from the perspective of reckoning profits was obvious: with an appropriate mixture of trees, it enabled a regular return. Job Hanmer of Holbrook Hall in Suffolk planted 8,100 oaks, with their "interstices planted with ash, raised from

[31] Robert Dossie, "Of the Improvements in Agriculture", *Memoirs of Agriculture,* 1762, **1**: 36-88, at 39.
[32] *Ibid.*
[33] *Ibid.*

keys, to remain for underwood, poles, coopers stuff, &c."[34] John Christian Curwen reported of the ash which he cultivated for underwood that "I question if there be any thing so profitable. The demand for hoops has within twenty years doubled the value of the woods in this neighbourhood."[35] Regarding chestnuts, Lewis Majendie wrote that "amidst the numerous advantages attending this Tree, none is of greater import, than the early state in which it is convertible .. except where this tree is wanted for large scantlings in the great scale of building, it will answer best as underwood, by furnishing a periodical return of fresh wood, superior… to its timber."[36] Arthur Young noted with some irritation in a review of the Society's *Transactions* in 1793 that "it is obvious that underwood is something; but not yet *proved* that two crops in this case are better than one; much vague observation may be found, but few experiments."[37]

As so often with Young, this complaint reflected the difficulty of generalising from any singular site. Those "experiments" which were conducted were connected indissolubly to local economies and particular situations. On the grand scale of an anciently established plantation, the Earl of Fife's agent noted that "underwood is only promoted with a view to the thriving of the Timber, which is Lord Fife's principal object". This meant that only poor trees would be cut down, "in order to give room for a more valuable neighbour to prosper".[38] By contrast, improvers who planted new land generally established mixed plantations meant to allow a regular crop, while their timber grew, offsetting the loss of land. This led in some locations to a fashion for extremely close planting (which might have made less sense in an already-established woodland). David Day, a great enthusiast for ash, reported that he had been criticised by old planters because "in thirty or forty years, my wood will be too thick; supposing that to be the case (though I do not believe it) my answer is, would you lose a crop for thirty or forty years, when you may have as good a one that first fall as you will get at the forty years end?"[39] By 1807, when he received a third reward, Day was

[34] Job Hanmer, "Account relative to the PLANTATION of OAK and other TREES, made by him", *Transactions*, 1794, **12**: 105-108, at 106.
[35] John Christian Curwen, "Papers in Agriculture", *Transactions*, 1804, **22**: 23-33, 26.
[36] Lewis Majendie, "On the CULTURE of the CHESTNUT TREE", *Transactions,* 1794, **12**: 109-124, at 116.
[37] Arthur Young, "Transactions of the Society for the Encouragement of Arts, Manufactures and Commerce, 1791, vol. ix", *Annals of Agriculture and Other Useful Arts,* 1792, **17**: 307-315, at 307.
[38] Earl of Fife to Samuel Moore, Feb. 9, 1788, published in *Transactions*, 1788, **6**, 20-37, at 23.
[39] David Day, "Account, containing the method made use of in, and the success attending, Mr. David Day's Plantation of Ash, for which he received a premium of twenty pounds, in the year 1779", *Transactions*, 1783, **1**: 109-118, at 116.

advertising his successes with the claim that his plan was "no speculation; I know from long experience it will yield an ample profit to the persons who engage in it with attention."[40] Among gentlemen who were planting for the first time, failure to understand the importance of regular cropping was presented as one indication of undue innocence. Thus William Marshall censured the natural philosopher and Bishop of Llandaff, Richard Watson[41]:

> several years ago, he was so fully convinced of the accumulating value of woodlands, that he determined to purchase young woods,--to fence them securely,--and leave them to their natural propensities; as a provision for his younger children;--without being aware, perhaps, that some considerable part of the profits of timber woods arises from judicious thinnings; and by relieving, from time to time, such promising young trees, as are most fit to stand for a crop of timber.[42]

Samuel Kilderbee, finding that his early crop of acorns mixed with ashen keys had failed because "mice destroyed the greatest part of the former", while the "latter, having no shelter to protect them, burnt up the next summer", sowed wheat alongside them.[43] When this was ripe, "the reapers were ordered to leave the stubble high for their protection and defence."[44] The first load of wheat was sold for thirty-five pounds; a second was traded with the tenant farmer for tilling the ground. Kilderbee thought "he will be amply recompenced by it."[45]

The first effort to do this in England was in two papers by the Society of Arts vice-president Robert Marsham, which were published in the *Philosophical Transactions of the Royal Society* in 1758 and 1759.[46] Marsham's two papers described the growth of a number of trees in Stratton, in Norfolk, representing their annual increase explicitly as a form of rent. Marsham generalised from twelve individual trees, drawing attention to how differences in species led to different levels of rent:

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[40] David Day, "Paper in Agriculture", *Transactions*, 1807, **25**: 4-14, at 4.
[41] For Watson, see Colin Russell, "William Watson: Gaiters and Gunpowder", in Mary D. Archer and Christopher D. Haley, eds. *The 1702 Chair of Chemistry at Cambridge: Transformation and Change*, (Cambridge, 2005), 57-82.
[42] Marshall, *Review and Abstract,* 222.
[43] Samuel Kilderbee, "Paper in Agriculture", *Transactions*, 1797, **17**, 119-129 at 121.
[44] *Ibid.*
[45] *Ibid.,* 123.
[46] Robert Marsham, "Observations on the Growth of Trees", *Philosophical Transactions of the Royal Society,* 60, **51:** 7-12; "A Supplement to the Measures of Trees, Printed in the Philosophical Transactions for 1759", *Philosophical Transactions,* 1797, **87**: 128-132.

> If all the trees were of the same kind, 109 feet pay 3 *per cent* for standing: and the six oaks pay near the same interest […] But if you take only the five thriving oaks, then their content is, from 57 feet 3 quarters 267 inches, to 103 feet 2 quarters 57 inches; *i.e.*[…] near *5 per cent.* And the increase of the most thriving oak, No 8 appears, by the above table, to pay above 12.5 per cent, and the Scotch fir […] pays above 18 ¾ *per cent.*[47]

Marsham also measured the monthly increase of a number of trees, recording the conditions of weather alongside the eighths of inches by which they had grown. Such measurements were, quite clearly, attempts to correlate specific trees with certain climactic variables: it was a project of inches, not national yields. Yet for some of Marsham's readers, the idea of regular and predictable growth was appealing because it gave a mechanism by which the value of trees could be guaranteed over time, particularly as it slowed down. Thus, according to Richard Watson, "if profit is considered, every tree of every kind ought to be cut down, and sold, when the annual increase in value of the tree, but its growth, is less than the annual increase of the money it would sell for".[48] Watson supposed, on the basis of Marsham's results, that timber grew more slowly as it aged. There was thus an incommensurability between the rate of increase of the size of timber and the increase in profit: and "that large trees sell for more per foot than small ones do, yet the usual increase of price, is not a compensation to the proprietor for letting his timber stand to a great age."[49] He described an experiment he had performed:

> on the 27th October, 1792, I measured at six feet from the ground, the circumference of a very fine oak, of eighty-two years growth, from the time of its being planted, and found it to be 107 inches: on the same day of the month, in 1793, it measured 108 inches.—There is not one oak in fifty (at the age of this) which gains an inch in circumference in one year. The length of the boll of this tree was about 18 feet; it contained about 84 feet of timber, and was worth at 3s. a foot, 12l 12s. It gained in one year very little more than a foot and one half of timber, at 4s 6d in value; but the

[47] *Ibid.,* 132.
[48] *Ibid.,* 290.
[49] *Ibid.,* 291.

> interest of 12l 12s at 4l per cent, amounts in one year, to above twice the value of the increase, even of this tree, which is a singularly thriving one.[50]

Because of this slow increase, Watson thought that the Government ought to offer "a much greater than the ordinary increase of price on timber of a large scantling". The Navy Board should pay £8 or £9 a load for timber trees which contained more than a hundred cubic feet "instead of [£]4… or [£]5," then "every man in the kingdom would have a reasonable motive for letting his timber stand till it became of a size fit for the use of the Navy; whereas, according to the present price, it is every man's interest to cut it down sooner."[51]

Responding to Watson's views in his summary of the reports for the Board of Agriculture, Marshall thought this would be problematic – marvellous news for those with existing plantations, and an "eligible speculation" for those who could expect their oaks to reach maturity "in ten, fifteen, or twenty years". But it would be a huge problem for "proprietors of younger timber, to play so high a game," given that oak timber as a rule would take 150 years to grow:

> Suppose a man to be possessed of an unentailed estate, stocked with oak timber of fifty to a hundred years growth, -- would it be right, even in a man so circumstanced, to look forward, for himself and his successors, fifty or a hundred years, in expectation of a high price, without any other certainty of reaping it, than an order, or a law, which, in any sitting of Council, or session of Parliament, might be annulled?[52]

Guaranteed prices would not be sufficient to induce private men to take a risk against the caprices of the state. Marshall therefore argued that the Government could not rely upon individuals for supply – "a supply that requires several generations of men – with different, perhaps opposite, views, propensities, opinions, or wants – to bring it to the required market!"[53] So the government should purchase lands suitable for oak, "already stocked with timber, where such is to

[50] *Ibid.*, 227.
[51] *Ibid.*
[52] *Ibid.*
[53] *Ibid.*

be had, or to be seeded with acorns, if at present unwooded."[54] Marshall's other main objection to Watson's observations on oak was that the bishop had naively drawn on Marsham's claims about the growth of oak, without recognising that Marsham's soils were peculiarly well adapted for growing this tree. In this case we again see the confluence of public and private interest, together with local factors in plantation.

Similar tables of growth were used on an ad hoc basis in other locations. At Woburn, Robert Salmon believed that they could be used to demonstrate the efficacy of a system of regular pruning.[55] These were private accounts; others were published, and like Marsham's experiments played a role in more public disputes. Charles Waistell, from High Holborn, received a gold medal from the Society of Arts for his tables. Waistell reported that he had "last autumn viewed some plantation made under my direction about thirty years ago", he found "the value of one of them much to exceed my expectation."[56] So he wanted to develop a "means of estimating what its value might probably be at different future periods." He claimed to have found in various authors the measures of trees, "in girth and height, at different ages, and obtained similar information among my acquaintance." Rather than supplying particularities of situation and individual tree as Marsham had, however, he generalised an average increase of "one to two inches annually" in circumference and "from twelve to eighteen inches the annual increase in height." The tables were meant to serve two purposes: first, they showed the "rates per cent per annum at which all trees increase, whether they grow fast or slow, provided their rate of growth does not vary."[57] As such, the table "may be the means of saving young thriving woods from being cut down, by showing how great a loss is sustained by felling timber prematurely."[58] Second, they might encourage the felling of old trees "by showing the smallness of the interest they pay for the money they are worth, after they are 80 or 100 years old"; a period which fell within the optimum window for naval timber, as it was commonly treated. The tables were an abstraction, because trees did "decrease in their rate of

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[54] *Ibid.*
[55] Paul Smith, *The landed estate as patron of scientific innovation: Horticulture at Woburn Abbey, 1802-1839,* (Unpublished Dissertation, Open University, 1983), 122-137.
[56] Charles Waistell "Method of ascertaining the Value of growing Timber Trees, at different and distant Periods of Time", *Transactions,* 1808, **26**, 49-79, at 51.
[57] *Ibid.*
[58] *Ibid.*

growth before they appear to do so"; but they were a useful one because they allowed the value of a plantation to be grasped over an extended period of time.[59] Other tables which Waistell produced were meant to show how many mature trees could stand upon an acre of ground, the effects of thinning, and other predictable rates of growth.[60]

Among all the English productions of this period, Waistell's tables and the experiments of Marsham most closely resemble the aspirations of 'scientific forestry'. But how different this science is from what historians have told us of the German case! To the extent that tables like Waistell's were employed, it appears to have been a way of reckoning risk, alongside other practices of accountancy, rather than as an overall simplifying optic for general scientific management.

3. Quick-Growing Timber

The various questions of how locality might shape the quality of timber, how profit could be reckoned over long periods of time, converged in a dispute during the 1820s, which was instigated by a premium candidate from the Society of Arts, about the possibility of propagating techniques of growing oak quickly throughout the kingdom. The instigator of the dispute was William Withers, an attorney from Holt in Norfolk who we met above in his inquiries about the sources of timber; he was pitched against a group of Scottish landowners, which included Sir Walter Scott and Sir Henry Steuart.

The dispute had some precedents in submissions to the Society. In the Twentieth Volume of the *Transactions,* Richard Yates, Chaplain to the Royal Hospital at Chelsea, reported his experiments on oaks, which – he claimed – were "founded upon a sedulous and active experience of fifty years."[61] Yates was writing against the received opinion "that the Oak is particularly slow in its growth, and requires a great number of years before it affords any advantage." In fact, all it required was careful cultivation, and "[t]hose who have been accustomed to notice the slow growth and stunted

[59] *Ibid.*
[60] *Ibid.*
[61] Richard Yates, "OBSERVATIONS on the CULTIVATION and GROWTH of OAK TIMBER", *Transactions* 1802, **20**: 80-95, at 81.

appearance of Oak Trees, when denied the assistance of art, and left to themselves in the common way, would observe with astonishment the vigorous and rapid increase of plants under the management now pointed out."[62] The management required trenching before planting; to protect the tree's taproot; to prune it carefully; and to avoid transplanting saplings which were intended for timber. Overall, Yates concluded, oak grown without such management "can never be depended on to form good timber."[63]

More conventionally, the properties of oak were known to be associated with particular soils. Withers noted that:

> the various counties produce a different description of timber in point of quality, there can be no doubt. This was well known to our forefathers, as it was a *standing rule* with the government, in the making of contracts for building ships of war, to give a preference to the timber of the growth of Sussex and Kent, and to *exclude* that of others, particularly of the growth of *some parts of Yorkshire.*[64]

Likewise, Steuart appealed to the widespread knowledge that Scottish timber was preferable to oak from Italy or Spain, and appealed to the notions of "extensive timber-dealers", all of whom were aware "of the superior hardness of oak raised in Cumberland and Yorkshire, over that of Monmouthshire and Herefordshire".[65] He continued, however, that "such a dealer, in selecting trees in the *same* woods in *any* district, will always give the preference to oak of *slow growth,* and found on cold and clayey soils, and to ash on rocky cliffs, which he knows to be the soils and climates natural to both."[66] What was at issue was how the qualities of timber were associated with conditions of growth, and how these might be replicated in different soils.

Withers described his own experience of growing trees in Norfolk. He had purchased an acre of land, one rood of which was planted with trees, having been trenched beforehand. Eight years later

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[62] *Ibid.,* 83.
[63] *Ibid.*
[64] Withers, *Letter to Sir Henry Steuart,* 53.
[65] Henry Steuart*, The Planter's Guide, or A Practical Essay on the Best Method of Giving Immediate Effect to Wood by the Removal of Large Trees and Underwood,* second edition, (Edinburgh and London, 1828), 476.
[66] *Ibid.*

he reported that the plantation was in a good state: its elms, oaks and locusts stood between nineteen and twenty-eight feet high. Withers bought more land in 1820, prepared it according to the method which Cobbett had directed, and planted a further twelve acres, half of which he planted with flag ashes; he then planted trees on the lot. The comparison told in favour of the ashed land: "the trees upon the land where the ashes had been spread showed a most decided superiority over the trees where the ashes had been removed, and the difference *has become more manifest every succeeding year.*"[67] On some of the unashed land, Withers spread marl and brick-earth, which also had good effects. Thus, on poor, light, soils manuring appeared to be an effective technique.

Then, in 1823, Withers hired heathland which was owned by the Fishmongers Company of London for forty years, to plant fifteen acres. He would take the benefit of the crop for this period of time, but leave one hundred timber trees per acre to the corporation at the end of the lease. This meant that "the faster I could make the trees grow, the better they would pay."[68] So he manured the land with marl and muck: the trees produced shoots very quickly; the oaks appeared to have grown three feet in height.

After receiving a reward from the Society, Withers continued to publicise his practice, publishing additional pamphlets about his techniques and entering into correspondence with other planters throughout the kingdom. Increasingly, his account was framed in opposition to what Withers described as the "Scottish system" of planting by digging pits. One of his pamphlets was a broadside against the techniques which had been advocated by Sir Walter Scott in his "Essay on Planting Wastelands", which appeared in the *Quarterly Review* in 1827.[69] Withers adapted Waistell's tables and projected them forwards for sixty four years. He claimed that this proved that early manuring brought about an accelerated rate of growth, which persisted through the life of the tree.

Steuart –who was sympathetic to Scott because they both supported plantation on a very large scale – publicly attacked some of Withers' reviews in the second edition of his *Practical Planter;* in 1829, Withers responded with a further pamphlet, which was intended to expand his scheme into

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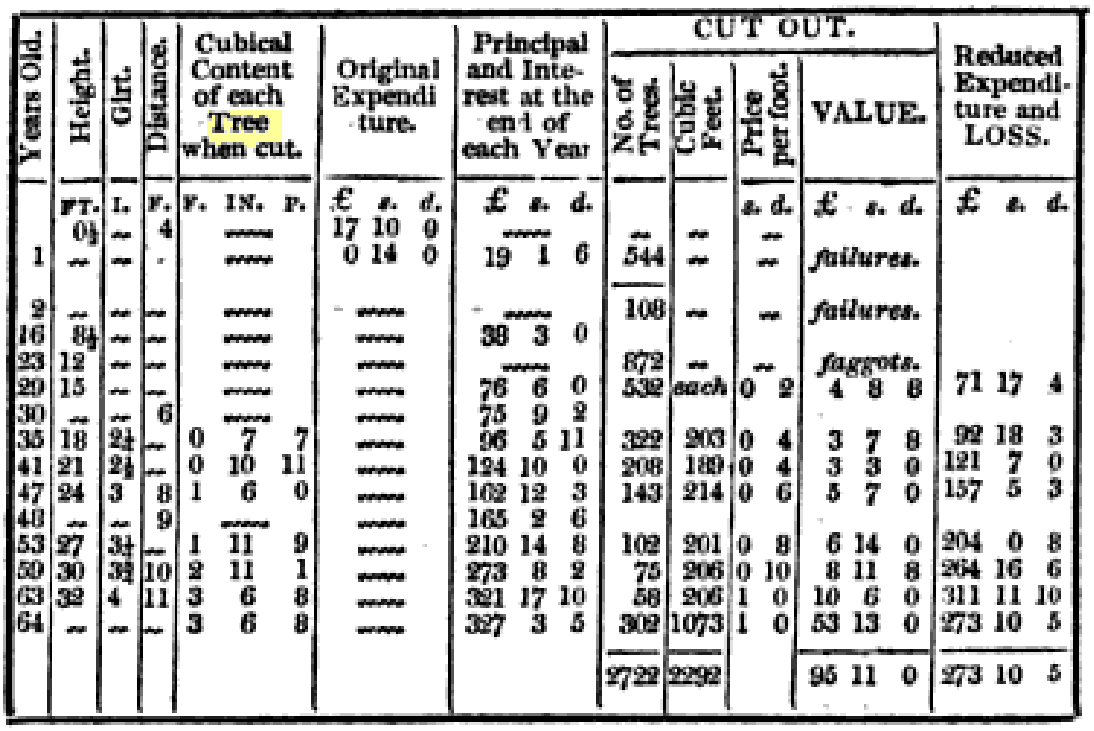
[67] William Withers, Jun, "Management of Plantations", *Transactions*, 1827, **45**, 19-35, at 28.
[68] *Ibid.,* 29.
[69] On which, see Susan Oliver, "Planting the Nation's 'Waste Lands': Walter Scott, Forestry and the Cultivation of Scotland's Wilderness." *Literature Compass*, 2009, **6**: 585-598.

the Royal Forests.[70] The controversy continued through several more publications: my primary interest here is in Withers' claims to have overcome traditional notions of "natural place" in planting trees, and the range of views which he solicited in support of his claims. What was at stake was how far the rapid growth of trees could be disembedded from the soils with which they were traditionally associated, and the range of knowledges required to evaluate the qualities of timber.I will begin with the Steuart's objections to his system, and then look at how he responded to them.

In his criticism of Withers, Steuart offered six principles of planting. First, "that all timber trees thrive best, and produce wood of the best quality, *when growing in soils and climates most natural to the species.*"[71] Second, "that trees may be said to be in their natural state, when they have sprung up fortuitously, and propagated themselves without aid from man, whether it be in aboriginal forests, ancient woodlands, commons, or the like."[72] In such trees "whatever tends to increase the wood, in a greater degree than accords with the species when in its natural state, must injure the quality of the timber." Third, that "whatever tends to increase the growth of trees, tends to expand their vegetable fibre."[73] Fourth, "slowness of growth is essential to the closeness of texture and durability of all timber, but especially of the oak".[74] Fifth, culture was appropriate in some cases – but only when trees were "in a soil and climate worse than those that are natural to them".[75] Sixth, it was only by "diligent study of the peculiar habits of trees, and the characters of soils, illustrated and regulated by facts drawn from general experience, that rash or ignorant systems of arboriculture are to be best corrected."[76] Steuart adverted to chemical analysis and experimental investigation of how fertiliser increased fertility. As Withers paraphrased his opponent, Steuart had argued "that on comparing the practice of trenching and manuring with the laws of nature, and the results of science and experience, you were obliged to say, that there were some *errors* into which I had fallen; and particularly by applying *universally* to the soil those agents, that cannot properly be so applied unless under *peculiar circumstances.*"[77] And finally, that Withers had illegitimately abstracted from the

[70] William Withers, *Letter to Sir Henry Steuart.*
[71] Steuart, *Practical Planter,* 477.
[72] *Ibid.*
[73] *Ibid.,* 478.
[74] *Ibid.*
[75] *Ibid.,* 479.
[76] *Ibid.*
[77] Withers, *A letter to Sir Henry Steuart,* 9.

real patterns of growth of timber trees, offering "a comparison between the returns under two assumed rates of growth in trees." Withers had assumed that manured trees would increase by fifteen inches each year, whereas those without would grow only six; and that this growth would continue evenly throughout the trees' life.



Years Old.	Height.	Girt.	Distance.	Cubical Content of each Tree when cut.	Original Expenditure.	Principal and Interest at the end of each Year	CUT OUT. No. of Trees.	Cubic Feet.	Price per foot.	VALUE.	Reduced Expenditure and LOSS.
	Ft.	L.	F.	F. IN. P.	£ s. d.	£ s. d.			s. d.	£ s. d.	£ s. d.
	0½	"	4	-----	17 10 9	-----	"	"	"		
1	"	"	"	-----	0 14 0	19 1 6	544	"	"	*failures.*	
2	"	"	"	-----	-----	-----	108	"	"	*failures.*	
16	8½	"	"	-----	-----	38 3 0					
23	12	"	"	-----	-----	-----	872	"	"	*faggots.*	
29	15	"	"	-----	-----	76 6 0	532	*each*	0 2	4 8 8	71 17 4
30	"	"	6	-----	-----	75 9 2					
35	18	2½	"	0 7 7	-----	96 5 11	322	203	0 4	3 7 8	92 18 3
41	21	2½	"	0 10 11	-----	124 10 0	208	189	0 4	3 3 0	121 7 0
47	24	3	8	1 6 0	-----	102 12 3	143	214	0 6	5 7 0	157 5 3
48	"	"	9	-----	-----	165 2 6					
53	27	3½	"	1 11 9	-----	210 14 8	102	201	0 8	6 14 0	204 0 8
59	30	3½	10	2 11 1	-----	273 8 2	75	206	0 10	8 11 8	264 16 6
63	32	4	11	3 6 8	-----	321 17 10	58	206	1 0	10 6 0	311 11 10
64	"	"	"	3 6 8	-----	327 3 5	302	1073	1 0	53 13 0	273 10 5
							2722	2292		95 11 0	273 10 5

Figure four: Withers' table projecting the losses of the Scottish system.

Withers seized on Steuart's apparent acceptance that trees treated according to his system would grow as quickly as he claimed. Addressing Steuart, he wrote that "you deprecate all preparation whatever, because its effects will be fatally experienced after the lapse of a hundred years."[78] While this was hardly the only argument which Steuart made, it suggested that the major point of disagreement was about whether quick-growing wood could be substituted for slow-grown varieties. To suggest that it could, Withers published letters from his many correspondents, who ranged from chemists and timber merchants, to Peter Barlow at the Dockyards in Woolwich.

The letters offered responses to Withers' enquiries about the source of the timber which the

[78] *Ibid.,* 5.

navy actually used, as well as statements which supported Withers more directly. Thus Withers could prove that existing practice was on the side of using different-growing timber interchangeably. John Barnard and Son, timber merchants from Lambeth, wrote that "[a] very large proportion of the timber used in his Majesty's dock-yards is procured from various parts of the kingdom."[79] Another wrote to say that Withers had correctly assumed that "the oak timber delivered by contract is obtained from various parts of the kingdom, wherever it can be had, *without enquiry being made as to the soil upon which it was grown.*[80] William Norton, another timber merchant from Uxbridge, argued that "it is impossible timber can grow too fast, provided they will let it stand the same time they do slow-growing timber. The misfortune generally is, in marking for falling, they look to the size, not to the state and condition of the timber." Another wrote that "if timber could be cut down at the age of eighty or ninety years, it would be *far better for ship-building* than one hundred and twenty years."[81] John Stenning, from East Grinstead, claimed that "the more rapid the growth of oak timber, the greater in proportion will be the sap"; on the other hand "the heart of such timber is infinitely to be preferred to the heart of timber grown on thin sterile soils, or where the growth from any cause has been retarded."[82] Accepting the view that there were significant differences between the timbers of different regions, another merchant chided Withers that he could not be "sanguine enough to imagine that the growth of oak timber on Holt heat […] can by the most judicious system of culture, even be brought equal to that of Kimberley or ***, two spots perhaps the best adapted to the growth of oak of any in this county".[83] Nevertheless, he continued, it was not true "that the strength of timber is in an inverse ratio to the quickness of its growth: the contrary is proved by every day's experience" – as no wheelwright would choose a piece of slow-growing ash for constructing "the shafts of a light cart".[84] On the other hand, Peter Barlow, at the dockyard at Woolwich, reported to Withers that there was a significant difference between varieties of English timber:

[79] *Ibid.,* 76.
[80] *Ibid.,* 106.
[81] *Ibid.,* 103.
[82] *Ibid.,* 82.
[83] *Ibid.,* 73.
[84] *Ibid.*

> I had much conversation with the different officers of the dock-yard here, on these and other practical points; and I know it was the decided opinion of those gentlemen, and I have proved it by experiment, that different specimens of English oak vary in their comparative strength in the proportion of five to four, and in some cases in the proportion of seven to five, and that they always considered the strongest and best to be the produce of the best soil. The grain was straighter, and more compact and dense, and of brighter colour.[85]

But, Barlow admitted, he had not made "particular enquiries as to the soil and circumstances of the growth of the trees", and so could not match his conclusions with actual conditions of growth.

With the possibility – at least – shown that timber from different locations could be of equal quality to that of slow-growing oak, Withers presented letters which argued specifically for the merits of preparing the land according to his system. As so often in writing on English plantations, the scattered and geographically complex questions associated with different private locations were meant to be resolved by focusing attention on the public forests instead. One wrote that if Withers' system were "adopted in the public forest, it would not fail of being highly beneficial; and the timber arising therefrom would *unquestionably be fit for any purpose.*"[86]

All Withers' busy efforts and correspondence were not enough, in the long term, to prove the superiority of his techniques. Predictably perhaps, the *Edinburgh Literary Journal* scoffed at his appeal to timber merchants, pouring particular scorn on the claim of a Mr. Farrow that he had compared wood from trees grown "in the same field, the same soil, and the same climate." One of them grew near the "'rackyard of the farm and close to a ditch or drain, which conducted the moisture from the yard"; the other was out in the open soil. The second tree was found to be heavier, and when tested by Barlow, required considerably more weight to fracture it. The reviewer was outraged: the claims were incredible, Farrow, "a very ignorant individual", was the only evidence for them; they were like "a well-authenticated ghost story", because they contradicted the "laws of Nature, and the

[85] *Ibid.*, p. 99.
[86] *Ibid.*, p. 102.

general results of experience."[87] While the sneers were directed against Withers, the defence was really of the "peculiar soils and climates" in which all trees would thrive best.[88] The *Journal Of Agriculture* in 1830 gave an extended review to Withers' work, again from the perspective of a landed proprietor, and was very nervous about the replacement of the existing system of plantation by one of greater cost; and it censured Withers because "[h]is own experiments […] seem to have been limited to a few acres."[89] The contrast was with a nobleman who had planted "ten to fifteen thousand acres," and seen "the wood of his own planting fashioned into ships of war."[90] While views in favour of "phytological affinity" – natural place – generally correlated with sympathy for Scottish landowners, there were some exceptions. Patrick Matthew (1790-1874), author of *On Naval Timber and Arborioculture,* noted with evident relish that "the discomfiture of the knights has been wrought by simple hands." [91] Matthew also thought, however, that Withers was imperfectly acquainted with his subject, and gave some "facts" to resolve the issue: these turned out to be observations of trees growing on his own property and elsewhere in the Scottish Highlands. One of his examples was a prodigal "Celtic" oak, locally associated with "miraculous virtue", but turned out to have "*soft tender*" wood; Matthew thought that this might be because it "fed" on slops, and "like an animal under similar circumstances" was "of soft flabby consistency".[92] Matthew was decidedly eccentric, ironic in his reference to local custom and whimsy, he also insisted on his own extremely extensive local experience, and conducted his own experiments into the hardness of timber.[93] He thought that Barlow's experiments on the pieces of wood which Withers had submitted were inconclusive, because they had not attended to the point of the tree from which the timber had

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[87] Anon, "A Letter to Sir Henry Steuart," *The Edinburgh Literary Journal, Or, Weekly Register of Criticism and Belles Lettres,* 1830, **3**: 109-112 at 111.
[88] *Ibid.,* 112.
[89] Anon, "On Economy in Planting", *The Journal Of Agriculture,* 1831, **2:** 411-442, at 415.
[90] *Ibid*., 416.
[91] Patrick Matthew, *On Naval Timber and Arboriculture,* (London, 1831). Matthew is now remembered chiefly for devising a theory of artificial selection which Darwin thought might have anticipated his own theory; all commentators have emphasised the obscurity of publishing such a view in a work on Naval Timber. See, for example, Kentwood D. Wells, "The historical context of natural selection: The case of Patrick Matthew." *Journal of the History of Biology,* 1973, **6**: 225-258, and W.J. Dempster, *Natural selection of Patrick Matthew: evolutionary concepts in the nineteenth century*, (Edinburgh, 1996). Matthew's work has rather more piquancy than that in the present context, because he moved past the stark insistence of contemporary writers on planting about either natural place or the possibility of making timber grow quickly upon any soils. He accepted – as did the others considered here – that properties of timber did depend significantly on how quickly it had grown, however (at, e.g., 214).
[92] Matthew, *Naval Timber,* 202.
[93] *Ibid.,* 209.

been taken: "any person may satisfy himself by proving one piece of timber taken from near the root, another half way up the tree, and a third near the top".[94]

By contrast, the *Gardener's Magazine* gave Withers a sympathetic review, though noting it was only suitable for certain situations; JC Loudon, the Magazine's editor, also noticed the dispute in his Encyclopedia of Agriculture, in which he claimed that "general experience" suggested that oak, ash, willow and poplar would be stronger if grown quickly, but that "strength and durability are properties that depend on different qualities of organisation, and it is generally considered that slowly-grown timber is the most durable."[95] In 1832, the Society for the Diffusion of Useful Knowledge published a book by George Sinclair on *Useful and Ornamental Planting,* which gave a sympathetic account of Wither's techniques. Even this, however, treated the question of the effect of early trenching and manuring on the growth of trees as unproven, and dependent upon local circumstance, and requiring more experimental observation. Like so many observers of experimental accounts of plantation, there were "no satisfactory records of the comparative rate of increase of timber, or of solid vegetable fibre, after the first twenty or thirty years' growth of the different species of forest-trees, which had been planted on trenched and manured ground".[96]

As a correspondent and controversialist, Withers was cast in the same mould as Cobbett, trumpeting local achievements as sound common sense. By his own lights, it was a way of promoting public knowledge, against the vicious particularity of the old slow Scots. While Withers hoped his method would reform plantation practice throughout the kingdom, it drew strength primarily from its rootedness within local circumstances and the independence which could be claimed to spring from them. Or, as Withers put it:

> I have nothing to expect or desire which the government has power to bestow. I live among friends and connections whom no consideration could induce me to

[94] *Ibid.,* 212.
[95] Anon, "Withers on Planting", *The Gardener's Magazine,* 1828, **4**: 40-43; J. C. Loudon, *An Encyclopedia of Agriculture,* Third Edition, (London, 1835), 637.
[96] George Sinclair, *Useful and Ornamental Planting,* (London, 1832), 64.

> quit, and my only ambition is to render some service to my native country, which I most anxiously wish to see prosperous, happy, great, and powerful.[97]

It was a national campaign, based on the transfer of experiments which appeared compelling on a local level, but which culminated in an affirmation of Withers' independence, which came about through his rootedness in his own turf.

4. Conclusion

The Society of Arts' awards for plantation did not converge into anything anticipating "German Scientific forestry". Even so, in their diversity and attempt to generalise from private and local experience to general practice they were indicative of what was involved in conducting, and writing about, experiments connected with trees in England, from the middle years of the eighteenth century, to the third decade of the nineteenth. By the end of this period, the Society was still able to hope that all the premiums it had awarded might lead to some significant observations, over a protracted period of time.

Though they lacked the centralisation and official management which came to characterise scientific forestry, the plantations did involve some similar techniques – including regular cropping, yield tables, and the idea of a regular return alongside the ultimate crop of timber. The use of these techniques was determined by the private situation and local conditions of individual woodlands, which made generalisation – never mind overall simplification – extremely problematic. Individual submissions to the Society reveal repeated reinvention of first planting principles, extreme optimism based on the condition of young trees, and speculations about future markets for timber which were based largely on local conditions. Nevertheless, reports of plantations were couched in terms of financial accounts, some of which were extended far into the future. They were part of the discourse of agricultural improvement, and they did crowd out other possible uses for trees in favour of a reckoning of profit. In agricultural writings, discussion of the merits of woodland were understood in terms of calculations of interest which were meant to provide ways to understand the relation of private to public interest. These accounts were phantoms, in the sense that they tried to

[97] Withers, *Letter to Henry Steuart,* 133.

regularise unforeseen future events, to guide against insecurity: thus they could be inserted into public debates about how naval timber might be supplied in the case of future shortages. This phantasmal quality of the possible future uses of woodland permeated the views of the reporters from the Board of Agriculture, as well as candidates for the Society's premiums.

This context of local experience and private interest provided the setting within which science connected with woodlands was performed. It might be argued its disunity, lack of coherent experimental programme, and often-anecdotal character meant that this was not "science" at all. But that would be to miss the experimental tests on the strengths of materials, range of knowledges about the conditions of timber, and attempts to relate the annual growth of trees to their increase in value which were published in the *Philosophical Transactions* of the Royal Society, and which were solicited by William Withers. Withers drew on these networks and the difficulty of obtaining knowledge about how trees varied from soil to soil to make his arguments about the possible general value of quick-growing timber: while his opponents sought to discredit many of his claims, they were not able to reject them entirely, and the spectre of timber which could respond to an active culture, growing more rapidly while still retaining their high quality, hung over later works on planting as well. If not science, this was certainly natural knowledge, and constructing a case about it required consultation with people from a wide variety of occupations. This is reminiscent of the range of strategies for identifying the sameness of plants and other materials, which I discussed in chapter six, and raised many of the same issues about whether things grown in different soils could be considered to possess the same properties.

Rather than the enumerations of numbers of trees planted which I quoted in the introduction, then, the Society's rewards for planting can best be considered as an immense collection of rich particulars, anecdotal reports, and attempts to construct general knowledge about plantation in Britain. In their stubborn association of local achievements with an overall image of the public, the awards for planting recall the general paradoxes of the premiums which have been discussed in the course of this work. In the next, concluding, chapter, I draw some general conclusions from the specific subjects which have been discussed here.

Chapter Nine: On Top of the Material

1. **Introduction**
2. **Review of Overall Argument**
3. **Prizing**
4. **The Society and Public Science**
5. **The Society and Improvement**

1. Introduction

A challenge which all of the chapters of this thesis have faced is that they contain *too much material*: too many grass seeds and handtools, an overabundance of dibbling sticks, silkworms, carriages, horses. All of these things have been immensely unruly, despite my efforts, and those of others to comprehend them. I opened chapter one with quotations describing the crammed world of the Society of Arts' repository, and the scattered variety of its schemes. I now want to draw some overall conclusions. Section two offers a review of the overall argument of the preceding chapters. Section three contrasts the picture of the Society which has emerged here with what historians have told us of prize-giving institutions during the same period. Section four examines how the Society of Arts might suggest a different approach towards public science. Finally, section six discusses the Society in relation to improvement.

2. Review of Overall Argument

I will now summarise my overall argument.

The Society for the Encouragement of Arts, Manufactures and Commerce was founded in the mid-eighteenth century, by a group of philanthropically inclined gentlemen with natural philosophical interests. From their first meetings, the Society's members envisaged their aims in

terms of a wider public who could be encouraged to make discoveries, plant favoured crops, and imitate favoured foreign materials. As the Society grew rapidly in size up to the early 1760s, it also grew more directly inclusive in terms of its membership; at the same time, its plans became increasingly expansive, meant to improve the kingdom as a whole. This meant that the Society's ethos was profoundly ambiguous: on the one hand, it intended to support commercial activities, but on the other it meant to raise them beyond particular and private interest. But interaction with specific trades also meant that the public rhetoric of the early Society came under increasing pressure, visible in the ways in which projectors dealt with it, the accusations thrown at its publicly prominent members and, most spectacularly, in its attempt to support the supply of London with fish during the first half of the 1760s. Satirists and newspaper reports indicate contemporary awareness – and criticism – of the Society's idea of a public based on general ideas and wide-ranging schemes, on the one hand, and sustained by particular interests and specific material things on the other. These tensions were never internally resolved, for although the Society's membership made efforts to resist claims that they were acting partially, adoption of these protocols coincided with a collapse in its membership. As it began to rebuild, its self-presentation and increasingly fashionable public events were based on an augmenting sense of politeness and respectability, so that by the early nineteenth century the Society's public face was primarily as a forum for staging respectable patronage. This had always been a part of its make-up, but was now the central aspect of how its activities manifested publicly. As an improving institution, it was widely regarded as venerable and a little dated, and while contrary voices could be heard within its meetings, it was far from being a location for debates about political economy, improvements to breeding, or anything else. Instead the material things which it rewarded provided an ostensibly uncontroversial way of manifesting a kind of benevolent patronage.

This analysis revises our picture of the Society of Arts in two ways. First, it suggests a much stronger break between the early society and its later appearances than existing histories have suggested. Second, it argues that – especially within the early Society – the question of what it meant to be a "public" institution was the subject of debate, negotiation, and even slander. This means that we should understand the Society in terms of a wide range of different projects and

aspirations, which collided or glanced past each other, and which were meant to secure its public role.

The Society's premiums have often been compared to patents, and found wanting. Comparison with a wider range of alternative institutions suggests their rather more ambiguous role: they were not intended solely for novelties in need of protection, but also to encourage the wide diffusion of existing techniques, and to celebrate local achievements. In this, they did resemble patents, but only if we recognise that eighteenth-century patents were still in the process of shifting away from monopoly enterprises in specific areas, and towards the protection of inventions which were understood as original ideas. Each of the Society's committees, in turn, used premium rewards in slightly different ways: from rewards intended to spur emulation in the manufacturing and fine arts classes, to the interconnection with other institutions and relations of patronage in the mechanics; to the more stringent requirements of the chemistry committee. How the premiums were used depended significantly on the composition of each individual committee, particularly on its chairmen. At the same time, and again especially within the early Society, premiums were used to project the idea of an improving public, geographically dispersed but all bent on the same kinds of pursuit: these hopes were particularly prevalent within the committee for Colonies and Trade, where the Society's example seemed to promise meliorist forms of production in plantations which were reliant on slave labour.

The account in this chapter was meant to go beyond the comparison of premiums with patents, and to unpack the wide range of activities which could be considered worthy of reward. It was because the range was so wide that the Society's early members could believe they were inculcating a general spirit of improvement. Within the later Society, however, premiums often *were* compared directly with patents, and found wanting, although in aggregate a relatively wide range of activities continued to receive rewards. The association of premiums with patents is less about two directly equivalent institutions, and more indicative of a tension in the Society's rewards: were they meant to go for exemplary experimental achievements, or for activities which could be widely diffused, with a little encouragement?

The area of the Society's activities where this tension was most clearly discussed was in its

support for agriculture, where the problems of singular experiments were notorious. Seeking to reconcile the details of particular locations with a wide-ranging record of practice, agriculturists and social investigators during the late eighteenth century resorted increasingly to detailed surveys. But while members of the Society were involved with some of these surveying efforts, they were more often interested in anecdotal accounts of exemplary local achievement, intended to demonstrate what was possible even if it went against the run of existing practice. This clearly informed the rich, enormously personal tenor of letters describing the domestic production of silk from worms and spiders, and flax cotton. The continued circulation of these reports is a striking example of how reports which had been submitted to the Society could circulate afterwards: as curious facts of natural history, and potential alternatives to existing practice. This was the reason that, despite their overt concern with the marketable properties of materials, the Society's premiums were able to retain a sheen of utopian possibility: unexploited and yet proven, they seemed to show what could be done, if conditions were different; to act as a warning to the Dutch or a spur to new forms of British industry.

While chapters two and three aimed primarily to give a different account of the Society itself, chapter four engaged more broadly with questions in the history of science. In emphasising the anecdotal, local quality of submissions to the Society – and kindred institutions – I hoped to resist the teleology implicit in many histories of this period, according to which seventeenth-century natural philosophy cherished rarities while the eighteenth flattened through systematisation. Certainly, eighteenth-century rarities were different, but (much like eighteenth-century novels) this was because they emphasised particular and personal qualities within the quotidian run of things. This set one of the themes for the remainder of the thesis: how did particular, locally workable things and processes intersect with more systemic presentations of knowledge? What local features remained, even when the aspiration was to eliminate local properties? For the Society of Arts, this question operated on a humbler level: how could the premiums, in their diminutiveness and particularity, relate to more systematic forms of surveying and analysis? And how could a wide public continue to contribute to the Society's improvements in the face of forms of knowledge which would only have allowed a role to certain privileged forms of enquiry?

Chapter five took up these questions in the case of mechanics. Its analysis started from the observation that many of the machines rewarded by the Committee of Mechanics were praised for their "simplicity", and noted two readings for mechanical simplicity: as simplification through sub-divided labour processes, which allowed the eventual mechanisation of tasks; and as an attempt to analyse mechanical operation in terms of the "simple machines". Neither way of understanding simple machines entirely fits with the Society of Arts. The tools which the Society rewarded were not regarded as dismembered parts of elaborate machinery, but as the direct foundation of improved practices. These simple machines might be reinvented in multiple locations, but were also valuable in their own right for the particular work which they had proved able to do. They were thus associated with the "particular machines" which were often recommended to the Society, on the basis of their utility in certain locations. The use of an analytical language of simple machines can be regarded as an attempt to abstract away from local conditions towards more general and manageable principles: for the Society's machines, such abstraction was usually stymied by the extraordinary difficulty of separating the mechanical part from material properties and the contributions of human and animal labour. Attempts at mechanical analysis, and comparative trials, often foundered against – or were brought into question by – the significant difficulty of determining comparative measures for machines, and working out which of their aspects could be separated out for mechanical analysis. Opponents of the Society gleefully seized upon such difficulties, highlighting the extraordinary difficulty involved in simplifying a machine away from its immediate surroundings.

This chapter aimed to give a rationale for the immense range of particular things which were rewarded by the Society's committee of mechanics, and to move beyond discussion of the Society's failure to encourage powered looms, steam engines, and the like. It also engaged with the mechanical lecturers, particularly James Ferguson, who were involved with the Society's projects, arguing that the content of their lectures was often concerned directly with the machines of common use during the eighteenth century, such as cranes and wheel carriages. Natural philosophers struggled to find a privileged perspective to define these machines because they were so entangled in local situations and so dependent on material particularities. At the same time,

however, contributors in mechanics often employed a rhetoric of simplicity and simple mechanical principles precisely because they hoped that machines could be easily transferred from one place to another, and the Society of Arts hoped to encourage this goal.

A similar set of evaluative questions emerged in the Society's interest in projects of import substitution. Always intended to be more than mere mercantilism, these were a source of considerable excitement, especially during its early years. They drew on discussions common in the natural philosophy of this period, about whether the properties of materials should be associated with their provenance or with more functional characteristics. In the works on substitution which were written with the Society's goals in mind, these questions took on particular salience. Even the strongest efforts to escape the merely local qualities of materials, such as Henry Horne's investigations of iron sand, Edward Bancroft's discussions of colours, or William Lewis' investigations of potash, collided with personalisation of exchange of materials and information, questions of local availability of skills and materials, the particular excellences associated with imports for existing locations, and existing uses. The question which emerges from close reading of their works is what features of a particular process need to be described for substitution to work, and how these efforts meant that the "true" identity of materials was much less significant than the range of uses for which they could be employed.

This chapter sought to show the creativity and difficulty faced by natural philosophers involved with the early Society, who had to contend with existing uses of materials, and the difficult question of whether the samples which they tested were representative; it also analysed the strategies which different natural philosophers employed to overcome these difficulties. Thus Lewis reverse-engineered the American potash, while Dossie simply insisted that samples made according to his directions would be pure; Miller referred back to botanical authority and provenance of samples for his claims about *Toxicodendron* trees while Ellis sought to employ the descriptions of working dyers and the reports of merchants. In each case, the commodity was embodied in and through a variety of relationships and existing practices: natural philosophers had to work with these, even when they wanted to assert the primacy of their own techniques.

Chapter seven discussed one of the agricultural projects associated with the early Society, and its

aftermath. As with the other kinds of natural knowledge developed at the Society, Benjamin Stillingfleet's campaign to purify the grasslands hoped to be able to artificially isolate the most productive varieties of grass and to match them to their most effective uses. The practicalities of collecting grass seeds and identifying grass species daunted the Society's contributors, producing extremely dubious responses and proud boasts of novel species identified according to their locations. After the 1760s, when the Society's initial interest in grass seeds had largely petered out, the question of the relation between locality, species, and utility was taken up in local botanies, botanical gardens, and experiments on grass plots. Characteristic of these works was the great difficulty of separating grasses from given soils and situations: this was the reason that George Sinclair's experiments at Woburn would appear as proto-"ecological" experiments to later observers. Sinclair's experiments were also, however, responses to the Society's interest in the potential properties of English straw.

As with material substitutions, the repeatedly reinvented campaign to purify grasslands shows the difficulty of overcoming locality and existing practice, of isolating a particular unit – whether a species of grass, or certain reproductive properties – from its surroundings and encouraging its use elsewhere. This chapter spent much more time than the others beyond the bounds of the Society: the reason for this was the common features of different attempts to describe grasses, and their overlap with the Society's networks.

Finally, chapter eight described the Society's involvement in tree planting. Opposing attempts to evaluate the Society's encouragements in terms of the sheer number of trees which were planted, I argued that the plantation premiums were instead rather ambiguous attempts to create imitable experimental knowledge about local successes in plantation. Such knowledge scarcely looks "scientific" to modern eyes, but it shares many features with the celebrated German equivalents, particularly through the attempt to analogise between rates of growth and levels of profit through yield tables. Plantation always seemed to point towards more than mere profit, however, because of its entanglement in questions of future timber supply and attempts to compare the use of land for tree planting with other crops – public questions which shaped the language around plantation though they did not directly determine how trees were used. Planters who contributed to the

Society did so on the basis of extremely local experiences, which depended on markets, relations between trees and the soils on which they grew, existing conditions of woodlands, and regimes of management. This led to noisy public confrontations between planters who had contributed to the Society and Scottish landowners, who stood very much at cross-purposes, but who also attempted to give general – and scientific – accounts of the properties of timber.

This chapter suggested the extraordinary difficulty of developing general knowledge of plantation, or an overall view of British resources, given the recalcitrance of owners of private woodlands, and enormous differences in local experience. Nevertheless, attempts were made – and, as with the grass campaign, it seemed to some that local properties of woodlands could be generally transferred throughout the kingdom.

4. Prizing

I now want to examine how the Society might revise our view of prize-giving institutions. I have focused throughout on the humble, material aspect of the Society's rewards. There is a very clear contrast between this approach and the kinds of prize competition which Jeremy Caradonna describes in his recent book, *The Enlightenment in Practice.* The project of this work is in many respects similar to mine, focusing on the wide range of contributors to the prize competitions sponsored by French academies, and so a detailed comparison is quite instructive.

Caradonna advances three main arguments. First, that France as a whole "possessed a veritable *concours* culture, in which a whole range of intellectual and creative activities were construed as competitions."[98] I do not think the Society of Arts shows anything similar for Britain, because participation in the premium awards was so patchy, and clustered around the pursuits of individual candidates. This is instructive in itself: the Society's approach to competition was much more "private". Second, Caradonna argues that prize competitions "provided amateur and marginalised savants with a viable entryway into the world of letters […] the academies welcomes thousands of other contestants from a wide range of social classes, geographical locations, and national

[98] Jeremy Carradonna, *The Enlightenment in Practice: Academic Prize Contests and Intellectual Culture in France, 1670-1794*, (New York, 2012), 2.

origins."[99] As we have seen, a relatively large number of "marginalised" contributions were received by the Society of Arts as well, but their contributions were in line with the Society's ideals of patronage, and reflected primarily on the Society's own ideas of benevolence. Similarly, we very rarely have a sense of careers being founded on contributions to the Society, though people sometimes came to London under its auspices. And third, Caradonna argues that the prize competitions moved from their sixteenth century models, where "deferential academicians allowed prize contests to advance the Sun King's cultural politics", "exchanging prize money and prestige for flattery and adulation" into a "much more critical and pluralistic intellectual forum."[100] In this new dispensation, academies focused upon social utility, offering contests on "slavery, women's education, tax reform, land enclosure, justice, poverty, begging, orphans, physiocracy, and health care," which offered opportunities to "voice critical views on the norms of Old Regime society."[101] Again, the Society's interests touched on these themes as well, but there is no sense that it offered a distinct forum of cultural criticism, or emphasised a distinctly intellectual debate. Rather, it provided a space where local contributions could be shown and, in certain problematic senses, evaluated. Certainly there were debates about its public role, especially in its first two decades, but these were not quite the same as critical public debates.

It is tempting to ascribe these differences primarily to national approach: after all, it fits with the respective national stereotypes of France and England that the former would be more intellectualist and philosophical in outlook, while the latter would be more empirical in approach. A caveat is required before we endorse the national contrast whole-heartedly, however. As I have emphasised throughout, the Society of Arts' concern with the concrete and particular emerged largely because of the difficulty of generalising from local experience – rather than a formal philosophical outlook. This means that my analysis of the Society's premiums and their accompanying documents is different to the way Carradonna approacahes the French essays submitted to the Academies – where analysis proceeds according to their themes and overall approach – thus the "subject matter of the *concours* reflected the general trend toward the practical interests of the broader society", and

[99] *Ibid.,* 6
[100] *Ibid.,* 7
[101] *Ibid.*

the "purpose of the prize contests was to systematize, focus, and direct the intellectual energies of the enlightened public sphere."[102] Carradonna quotes James McClellan in support of this view: "in posing prize questions, provincial academies overcame their particularism and their closed, elitist social base and opened themselves to fresh scientific input from all over France and, indeed, the international community."[103] McClellan also offers some evidence that the researches of some savants were directed partly according to the concerns of the Academies.

The *concours* topics which Caradonna identifies as involving significant debate do appear to have been universal in aspiration: questions on physical causes of African skin colouration, which tipped into criticism of France's involvement in the slave trade. Others, on "poverty, begging and poor relief" were more locally focused, with questions focusing on individual towns, and plans for the commerce of individual towns: these avoided the problem of relating local to more general experience by their regional focus, and there is little suggestion in the analysis of their connection with specific materials – though sometimes prizes led to direct appointments for administration of specific schemes. Those on agriculture, finally, allowed "agronomy fever" to "pass […] directly to the public".[104] But again the analysis offered does not allow us to tell how far such questions were posed generally, how far they were adapted to particular conditions, what role they give to singular experiments, and so on. Caradonna points to the connection of agronomic prize questions with the rise of physiocratic policy, and the emergence of statistical data collection. There is a suggestion that "essay competitions became a strategy for gathering data, sparking debate, and rallying the public to the cause of economic liberalism."[105] This resembles some of the surveying practices described in chapter four. Overall then, while in many respects the French prize competitions were more literary and less particularist in focus than the English premium awards, there is some indication that they were concerned with local experience, and how this might contribute to broader goals of policy – though this was configured differently in the two territories. I suspect that this subject would benefit from additional research, which might well make the French look more

[102] *Ibid.*
[103] James McClellan III, *Science Reorganized: Scientific Societies in the Eighteenth Century* (New York, 1985), 94. Quoted in Carradonna, *The Enlightenment in Practice,* 149.
[104] *Ibid.,* 169.
[105] *Ibid.,* 6.

"empiricist" than national stereotypes would suggest. We would still have significant differences: the French agricultural essays would appear to have been more directly entangled in matters of policy, and the desire for more general, "philosophical" accounts does seem to have been rather greater in France. But the problem of publicising material improvements and local experience was general, and it would be instructive to know how authors in different territories dealt with it (rather, that is, than claiming that it was a distinctively English problematic).

5. The Society and Public Science

I suggested in the introduction that the Society of Arts offered a different model of public science to the one which historians have offered us to date. I will begin by reviewing the main features of the existing story of public science, and then talk about how the Society might shift our view of this subject. As I suggested in chapter one, public science has been understood in five main ways. First, by noticing places through which knowledge circulated, which had different values than the controlled spaces of experiment. In this sense public science is regarded as exceptional with respect to more disciplined spaces and subsequent general developments in scientific practice, and as possibly shedding light on present debates on the "public understanding of science". Second, by relating the rise of such knowledge to the consumer revolution, and the emergence of a world of goods, so that scientific lectures, spectacles and the like are understood as goods within a marketplace. Third, by multiplying the contexts in which science was practised, so that agriculture and more informal botanical practices, for example, are included. Fourth, by analysing appeals to the public as ways of legitimating natural philosophical knowledge, and how this shaped the rhetoric, and sometimes even the content, of science – by emphasising that experiments should be easily replicated, for example. Fifth, by looking at the media through which scientific knowledge was published, read, and circulated.

These views offer some parallels with the public science of the Society of Arts. Certainly, it did not represent a cloistered form of natural philosophy: it was not remote from market concerns; it operated in a wide range of different contexts; all of its encouragements made appeals to the public;

it emphasised simplicity and replicability; and its publications were regarded as a crucial part of its public goals.

In a recent essay, Larry Stewart has argued for the political role of eighteenth-century public science, which consisted in a "feedback loop" between auditors and natural philosophers.[106] The enlightened public was "essential to a process of circulation, a feedback loop that lasted as long as it had something to offer and questions to ask"; audiences were not passive but also "reflected to the experimental demonstrator what might matter most and what seemed most convincing"; this led to a "convergence between the early-modern public sphere and ideals of reflection and response, indeed in the right to be taken seriously, a feedback strongly embedded in the republican rhetoric of Europe and America".[107] The experimental realm – instanced through lightning rods and electrical demonstrations, mesmerism, pneumatic medicine, and the optical instrument trade – was "[d]eeply attached to market economy and to expanding commercial empire," and became in the process "the great symbol of the eighteenth-century republic."[108] The impacts of this were liberatory, in allowing a shift from limited "cultivated, gentlemanly practice", to a "broader social and intellectual spectrum where a public encountered natural philosophy and experimental phenomena". In this climate, continuing efforts at exclusion by "the Gentlemen of the Royal. Society", and subsequently the Royal Institution, were "perhaps" no more than "the finger in a very public dike that, by the late eighteenth century, was leaking profusely, impossible to police, and the outcome inevitable if not uniformly desired."[109] While Stewart does not actually specify what he takes the outcome to be, we may assume that it was the further "expansion of scientific knowledge", through channels which could no longer be restricted by social status.

I can say with some confidence that the public – experimental, theatrical, and national – of the Society of Arts was not like this, and that consideration of the Society's public culture considerably refines and complicates Stewart's view. I agree with him that the "public" of eighteenth-century science was neither passive nor "popular", in the sense of receiving a simplified version of elite

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[106] Larry Stewart, "Feedback Loop: A Review Essay on the Public Sphere, Pop Culture, and the Early-Modern Sciences." *Canadian Journal of History*, 2007, **42**: 463-483.
[107] *Ibid.,* 466.
[108] *Ibid.*
[109] *Ibid.* 483.

theoretical practice. And he is certainly right to claim that wide participation and a wide variety of experimental spaces were major features of natural philosophical works and experimental demonstrations during this period. His account is too partial in three ways: politically; in the range of experimental practices, sites, and forms of knowledge which it considers; and in ways in which a public ethos might be shaped in natural philosophical contexts.

Politically, Stewart considers enlightened public natural philosophy in its connections with republicanism but not with loyalism; he also associates a wider circulation of knowledge with an emancipation from relations of patronage. Most contributors to the Society of Arts understood their experimental reports in patriotic (and, often, loyalist) terms; even radical views such as those which were espoused by Cobbett could be re-appropriated by the likes of the Duke of Bedford. As I pointed out in chapter five, James Ferguson struggled to assert his mechanical experimental knowledge against patronage; individual inventors and projectors construed the Society's public support in a number of different ways, but they were rarely radicals, and for the most part their political commitments took on a subdued note within the Society. Stewart might object that all this shows that the Society was remote from the "proper" experimental world of the eighteenth century which was politically radical in the ways that he claims – we might say that the reason there was little electricity, or pneumatic medicine, or ballooning at the Society was precisely because all of these things carried disquieting political connotations. This leads on to my second objection to his overall argument.

The public science and experimental demonstrations which Stewart describes are urban, focused on novelties. Here, the "demonstrator's self-evidence, from electric shocks or the effects of new airs, was made obvious by public exposure."[110] And they occurred in a wide range of sites, so "[t]he tavern and the coffee house were little different than the field."[111] But Stewart does not talk about the field: there is no agriculture in this picture, nor of the tragi-comic sights of gentlemen attempting to reason about which of two groups of horses were working harder on a London road, no trials of carriages or ploughs, never mind the faltering attempts to bring enough working artists to judge the quality of new inventions or materials. There are no grass seeds, or curly potatoes.

[110] *Ibid.,* 471.
[111] *Ibid.,* 467.

Needless to say, there are no pails filled with silkworms. Not all of these things are exactly the same as the culture of experiment which is Stewart's primary concern, but their absence impoverishes our sense of the experimental culture of the eighteenth century. This is most obviously the case when we miss the connection between attempts to understand these everyday things and the actual content of lectures – as in James Ferguson's discussions of horses and wheel carriages, discussed in chapter five, and the various popular accounts of potash which I talked about in chapter seven. More than this, though, it means that histories of public science attend primarily to those aspects of eighteenth-century experimental practice which link the seventeenth-century Royal Society with (certain aspects) of nineteenth-century science, such as Davy or Faraday's demonstrations and series of experiments on electricity. The focus is on questions of trust, strategies of legitimation, and the shifting role of instruments and precision measurement. In particular, they rarely attend to the details (as opposed to the rationale) of agricultural experimental practice.

I do not mean to suggest that we have no history of agricultural experiments. What has been lacking, I think, is consideration of such experimental practices in comparison with other aspects of experimental culture during the eighteenth century. In chapter four, I drew on work from agricultural, political and economic history to suggest the richness and distinctiveness of these practices, and queried the emphasis on survey which Liam Brunt and Joanna Innes offer by stressing the odd situation of the exemplary experiment, based on local and personal factors and not easily assimilable to a compilation of best practice. In subsequent chapters, I then employed a similar tension between local-exemplary and surveying practices to talk about the Society's interests in other areas. What I take overall from this approach is a stubborn persistence of local and personal questions, even in knowledge practices which were rhetorically framed to exclude them. Again, this should shift our overall picture of public science because they belong to a different public, and second because they emphasise the value of local achievements which sought wider patronage and public acclaim.

Serious consideration of agricultural experiments should upset some of our preconceptions about the practices and locations of experimental knowledge during the eighteenth century. As I argued in chapter four, eighteenth century agricultural improvers had serious experimental

epistemologies of their own, based on questions of local place, the challenges of replicating results in different locations, and developing detailed surveys of local practice which could not necessarily be reduced to points of principle. These do not fit with the canons of our histories of how experimentation developed during this period, because they could not be based on the increasing control of phenomena, or ability to manifest results at will. Nevertheless, *they were experiments*. In certain cases – such as George Sinclair's work on the English grasses, they led to novel experimental set-ups which compensated for the relation between local and general knowledge in new ways. In others, as in the repeated attempts to demonstrate the superiority of drill husbandry over broadcast sowing, they bundled together a number of different practices. The question of whether and how reports of tree planting could represent experimental knowledge, which I considered in chapter eight, also shows a situation where models of yield were emerging from particular local situations, and feeding back into both discussions of public policy and (in some places) the practical management of plantation. This is precisely the kind of loop between public and experiment which Stewart describes, and it should be part of the historical picture.

Incorporating the agricultural experiments which were submitted to the Society changes the sense of public science not least because it belongs to a rather different public. This is much closer to the Banksian learned empire, and the ideology of improvement which we associate primarily with the landed interest, than the republican and subversive aspects of public science to which Stewart primarily attends. It would be a mistake, however, to see the Society simply as a representative of the landed interest. As we have seen, its contributors came from a relatively wide range of positions, and its committees made assiduous if often unsuccessful attempts to evaluate the merits of new inventions which were submitted to them. For this reason, I have insisted throughout that we should take the early Society's claims to coordinate a wide variety of different social ranks and interests seriously, despite its obvious practical shortcomings.

This encompassing idea of the public offers an almost direct inversion of what has usually been argued as a chief characteristic of eighteenth-century public science. Historians have emphasised that even the ostensibly universal claims of, say, Newtonian natural philosophy were promoted within a marketplace of ideas, in the service of specific visions of the social order. The knowledge

embodied in the Society's premiums also had a vision; but while it was thoroughly textured with aspirations to profit, presented in the forms of accounts, run past the standards of practitioners, in almost every case it remained curiously remote from direct involvement in any actual trade or industry. On many occasions, this was because the Society's contributors and committee chairs had more than private interest in view and sought to promote a public vision which included the market alongside other goals. Thus John Blake's fish scheme was meant to transform the market for fish supply in the capital entirely by widening the number of people who could purchase the commodity; thus the committee of manufactures so often referred its concerns to the possibilities of production in houses of industry; thus a device like Bowen's sand dredger from Corkbegg received its reward. All these rewards are significant because they suggest situations where the "public" use of inventions was more than a mask for private interest, but rather provided a more encompassing framework for invention and improvement than existing markets could provide.

While it is in the area of agricultural experiments that the Society's approach conflicts most with standard narratives of the development of experimental practice, similar issues can be raised with respect to other aspects of natural philosophy as well. As I argued in chapter six, this sense of chemistry being in dialogue with existing practice informed the ethos and even the structure of Dossie, Lewis' and Bancroft's published works. In that chapter, I argued that a similar view of the ambiguous relation between properties, materials, provenance, users and commerce – and the creative possibilities which substitution offered – was also widely present in papers in the *Philosophical Transactions* of the Royal Society. It would require further study to work out how widespread such interests were in the context of that Society's activities as a whole, but clearly they were not confined solely to the Society of Arts. Again, it might be argued that this arose from the attempt to apply natural knowledge directly to practice, a process which problematized distinctions between "empiricism" and "theory", and "natural philosophy" and "artisanal skill", because of the difficulty of determining which aspects of a material resulted from local factors, and which could be understood in more general terms.

At the Society, local factors were also often personal ones. More than one landowner received an award from the Society primarily because of the scale and extravagance of his improvements,

and the critic who noted the absurdity of the Society's recording the present of a pat of butter gave a more profound insight into its activities than he perhaps realised. Both the Society's social structure, and the form of its premiums encouraged a valourisation of the local and the particular. The certificates accompanying premium awards would speak not in terms of numerical accounts, proofs of numbers sold or money saved, but by describing an achievement which worked in a particular place which should be made more widely known. They documented local acts of patronage in the hope that they could be extended further, and expressed a wish to speak from experience, and make details of local – even relatively domestic – experience more publicly known. Again, this reliance on personal connection stands outside the mainstream of public science, if we understand this as a shift from gentlemanly conventions of trust and reputable witnessing, and towards legitimation in front of a wider audience. The personalisation connects, of course, to the Society's inclusive but hierarchical ethos. It is tempting to see in this a shift from one culture of knowledge, based primarily on personal ties, to another based on more impersonal publication. There is obviously a tension between this personalisation, and the Society's inclusive public ethos. In the next section, I attempt to tease out its implications.

6. The Society and Improvement

"Improvement" is now associated with some of the most destructive practices of the landed interest, as well as with British colonialism more generally. In the works of post-colonial and radical historians, the concept speaks of the will to treat the colonised world as if it was a landed estate, and to make all land pay, shattering customary economies, traditional practices and local values.[112] Even those who are sympathetic to elite culture recognise some degree of intensified exploitation during this period. Thus Simon Schaffer offers a judicious summary of Roy Porter's relatively rosy view that "[t]he enlightened notion of nature was that of a material resource legitimately to be exploited by its owners" within which "the proper model for humanity's relation with nature had

[112] See especially Richard Drayton, *Nature's Government: Science, Imperial Britain, and the 'Improvement' of the World*, (New Haven, London, 2000).

become the carefully husbanded farm."[113]

Elsewhere Schaffer describes what this implied: it was an "assault on the moral economy and its displacement by a new programme of calculation, surveillance and soil chemistry."[114] In this view, farms were made to be knowable, practices increasingly controlled, with commensurate reduction in the autonomy of labourers. Field trials were a significant part of this redefinition:

> [t]o know nature's agency in agricultural systems agronomists had to manage and transform those systems, then naturalize them. Farms had to be changed to make them knowable; then it was argued these changes revealed, rather than disrupted, natural principles. […] Crops had to become commodities and in this process persuasion and transplantation, experiment and computation all counted. We might think of this in the terms of the enlightened political economy set forth by Adam Smith in 1776 – commodity formation required the disentanglement of local plants and people from local settings, and their successful displacement and recomposition in a new frame of experiment.[115]

Schaffer is charting a shift in overall discourse, and how land could be conceptualised, under the banner of improvement. In the process, what it meant for knowledge to be local changed. At the same time, however, a wish to bring farms under surveillance does not entail that they were, in fact, more visible; propagandists like Arthur Young insisted on the difficulty of obtaining reliable knowledge, and the need to multiply and repeat trials and experiments. This experimental urge was not entirely the same as the other practices – such as enclosure, changes in tenure – associated with improvement, precisely because it was unproven and hence potentially wasteful, if judged in straightforwardly economic terms. This was not exactly the same thing as the more rationalising aspects of improvement, because it was motivated by philanthropic goals, a vision of social harmony and various schemes of the material means by which it might be brought about. That does not mean, of course, that it was the pure benevolence which some of the Society's official

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[113] Simon Schaffer, "Enlightenment Brought Down to Earth", *History of Science,* 2003, **41**: 257-268, at 257.
[114] Simon Schaffer, "The earth's fertility as a social fact in early modern Britain", in Roy Porter and Mikuláš Teich, eds., *Nature and society in historical context*, (Cambridge, 1997), 124-47, at 140.
[115] Schaffer, "Enlightenment Brought down to Earth", 260.

historians have ascribed to it. Sarah Tarlow captures some of the complexities of these non-economic questions. Qualifying a broadly Marxist view of the historical archaeology of capitalism she claims that her account

> confronts phenomena that do not sit comfortably in Marxist explanatory frameworks: philanthropy, aspiration and collective activity. All these three could, of course, be explained as manifestations of 'false consciousness', or as ideological strategies for masking the 'bottom line', but I argue here that such analysis necessitates subscription to a very cynical understanding of human culture, and some contortions of analysis. […] Improvement was an aesthetic and an ideology as much as a rational response to perceived problems. It did have a strong moral and philosophical grounding and much genuine philanthropy was motivated by a desire to bring about improvement.[116]

I am less interested in the claim about how cynical different historical approaches are, and more in Tarlow's implicit assumption that "much genuine philanthropy" can be separated from ideologies of rationalisation and exploitation. The wish to regard philanthropy – benevolence – as something which slipped the net of the general economic system, fits with the picture of the Society of Arts which I have given here. One unifying theme among all the activities which were conducted beneath the Society's auspices was the recurrent hope that *this* way of doing things – whether this was growing an alternative crop such as rhubarb or madder, or producing silk in England, growing grass for straw-plaiting – might go against the normal run of things and allow for different productive possibilities. This was perhaps clearest in the Society's attempted dealings with the Colonies. In chapter three, I emphasised the way that during the Society's early years its example appeared to offer a different model of sociability and less exploitative productive relations. A letter from Joshua Steele in Barbados to the Society from 1785 captures the queasy sense of experimental thrill, in which utility, improvement, the entertainment of experiment were all entangled:

[116] Jean Tarlow, *The Archaeology of Improvement in Britain 1750-1850*, (Cambridge, 2007), 9 and 192.

> The novelty of everything here, Plants, Vegetation, seasons, slaves, Brutality of my species, the endeavours of our infant Society to open the Eyes of the people of Capacity & Feeling to amend many things that are amiss, and the attention I give to model the government of my own Estates, so as to add to the happiness of my Slaves, without injury to myself, have so completely amused me, by finding constant occupation for me, that 5 years have passed over, in this eternal Summer Country, like only one.[117]

Steele's efforts in Barbados were to end in failure, although his example was later much-cited among anti-slavery campaigners.[118] Again, this does not mean that we should see "improvement" as an unequivocal positive, but it is important to note that for those who participated in it, the possibilities of improved practices were neither entirely foreseeable, nor altogether foreclosed. It did not simply involve the reduction of farms, plantations and other sites, to surveillance and soil chemistry, but seemed to promise participation from a wider public, the opportunity to "open the Eyes of the people of Capacity & Feeling".

Part of this involved the question of local knowledge, in very significant ways. Schaffer notes that the "enlightening" aspects of improvement tended to lead "local" knowledge to be configured in multiple ways, allowing for the "judging the worth and status of local knowledge and expertise," of "the colonized authors of local projects": "[t]heir cunning could be seen positively, judged natural genius, possessed of ineffable and incommunicably autochthonous skill and experience; or their very localism might be seen as fragility, to be tried, assayed and corrected by metropolitan expertise; or, finally, they might be seen as threatening to good order, challenging the very basis of society and of nature alike."[119] This captures many important aspects of the ways in which "indigenous" knowledge was represented, but is less attentive to the local aspects of improving cultures and practices themselves. In the controversies which I discussed in chapters seven and eight (and to an extent in chapter six as well) ideas of "natural place" – Steuart's phylogenetic affinity – were repeatedly revived to claim that disruptive practices should not be employed, and

[117] J. Steele to London Society of Arts, 24 May 1785, A12/32, quoted in David Lambert, *White Creole Culture, Politics and Identity During the Age of Abolition,* (Cambridge, 2005), 45.
[118] Lambert, *White Creole Culture,* chapter 2.
[119] Schaffer, "Enlightenment Brought down to earth", 263.

that there would be something shabby about wood grown on soils to which it was not suited. In other words, multiple views of the earth coexisted under improving views, and plants were too wayward to submit to straightforward regimes of surveillance.

In this context, the local was not only "traditional" or "indigenous" – it was also the near at hand, and personal. This again was part of how improvement operated, on a local level. In her study of eighteenth-century epistolary exchange about botany, Stephanie Volmer argues that despite the clear imperial and economic goals of eighteenth-century botany, we should not write its history solely in terms of domination. Volmer writes, botanical letters "suggest that the economic investment in the colonies was less driven by a general ideology of empire or conquest than by concrete goals, connected locally to soil, to plants, to 'testimony,' to hypotheses, and to the reading and writing of letters."[120] Like Tarlow's account of improvement, this is an attempt to make sense of how local interactions do not always seem to serve larger exploitative purposes. If it is not entirely convincing as a global statement, (the botanists may not have been motivated by an ideology of conquest, but they will still caught up in the larger goals) it is still a reminder of how local practices do not always seem to mesh with larger ideological currents, even if they were in some sense ultimately prompted by them. Thus the excitement which Eliot felt in proving that sand-iron could be forged, and that his neighbours were wrong, and it was appropriate to take risks; or the hopes which Alexander Garden countenanced for learned associations in the colonies; or John Blake's repeatedly renewed promise of a philanthropic fish supply; or William Withers' claim that quick-growing timber could transform the nation's wood reserves – or many other examples in the preceding pages – all pointed towards the Society of Arts' vision of public improvement. This was not only about rationalisation or exploitation, even if it was entangled in the same general tendencies.

In the end, this was the reason that I gave this thesis the title *Sentimental Industry,* drawing on a different aspect of Adam Smith than the celebrant of disembedded commodities. In my introduction, I quoted Smith's claim that " [a]s we have no immediate experience of what other men feel, we can form no idea of the manner in which they are affected, but by conceiving what we

[120] Stephanie Volmer, *Planting a New World: Letters and Languages of Transatlantic Botanical Exchange, 1733-1777*, (unpublished PhD Dissertation, Rutgers University, 2008), 126

ourselves should feel in the like situation".[121] That idea of projective sympathy, imagining the improvement of the world according to one's immediate surroundings, ran through the Society's projects, capturing both their condescending blindness and their odd vulnerability. It was the reason that they thought shoemakers would pass on their improved tools to each other in the manner of gentlemen recommending techniques of estate improvement. It was why local achievements continued to be valourised even in claims which sought to expose them public scrutiny. It was the way some of the tree-planters came to the practice with such delight and ignorance, moving from their scantling crops to national supply, high profits, naval timber. Ann Williams' 'little family' of silk-worms seemed to fill her world, and connect to grander things. She was one of the Society's improvers, and its public, too.

[121] Adam Smith, *The Theory of Moral Sentiments,* (London and Edinburgh, 1767), 2.

Bibliography

The main sources for this thesis are published sources, including ephemera: details for these are given below. In this I have been helped immeasurably by various digitisation projects, and particularly the availability of the Burney Collection of seventeenth and eighteenth century newspapers, available through the British Library, and the ECCO database of eighteenth century collections.

The analysis in chapter three is based on a database of the Society of Arts' premium awards, compiled from the *Transactions* and the *Register of Premiums and Bounties Given by the Society instituted at London for the Encouragement of Arts, Manfuactures, and Commerce, from the original institution in the year MDCCLIV, to the year MDCCLXXVI, inclusive* (London: James Phillips 1778).

By kind permission of Eve Watson, head of archive at the RSA, I also consulted the Society of Arts committee minute books, and other letters in the archives.

In addition, I consulted archival sources at the Bedfordshire and Luton archives for material from Woburn Abbey in chapters five and six, and in the Caird library of the National Maritime museum for chapter eight.

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