Grassroots science – an ISYP Ideal?

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This article argues that a mix of different values guides contemporary scientists and engineers in their work. The conventional dichotomy between academic science and technological research and development is hereby transcended. However, on the analytical level distinctions between different kinds of research activities are considered helpful. Three sets of norms that define different categories of research activities are presented: The CUDOS ethos that defines academic science, the PLACE set of norms that defines industrial and military technological research, and the 'ISYP Ideal' that defines 'grassroots science' – a scientific endeavour that explicitly addresses the problems facing humanity. This analytical tool (i.e. the three sets of norms) is used to analyse the activities of International Student/Young Pugwash.

In this article the concept of 'grassroots science' is introduced. It covers and refers to techno-scientific activities that explicitly address the problems facing humanity. Reorientation of science and research activities is currently being debated both in society and in scholarly journals. Hence, the present seems like an appropriate time for launching a concept that suggests that the problems facing humanity should be on the research agendas, thereby legitimising such endeavours by categorising them as scientific. Grassroots science is not thought of as a substitution for either academic science or technological research and development. Rather, the idea is to complement our understanding of techno-science, and add something qualitatively new to it: ethical reasoning at the structural level.

Norms of different types of research activities

At present it is not clear to me to whether grassroots science is actually an existing category capturing a certain type of research activity or whether it primarily is an idea after which future research activities can be modelled. This question is an important one. However, it needs a thorough empirical answer, one which is not presented in this article. Here my motives are more explanatory and normative. If academic science and technological research (or any mix of

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the two) cannot alone solve many of the serious problems facing humanity, can we then imagine a third form of knowledge production that is more successful in promoting this aim?

Sociologically, one can distinguish between different forms of research activities by referring to the set of norms that the practitioners are expected to follow [1]. In table 1, I have summarised in three columns the norms for different types of research activities: 'academic science', 'technological research', and 'grassroots science'.

The purpose of table 1 is not to reduce contemporary research activities to, or categorise them as, academic science, technological research or grassroots science. The purpose is rather to set up an analytical tool that can be used to analyse concrete research activities in a 'both ... and' manner – not in an 'either … or' fashion.

The ethos that guides academic science is known under the abbreviation 'CUDOS' ('communism', 'universality', 'disinterestedness', and 'organised scepticism') [4], the set of norms describing technological research being 'PLACE' ('proprietary', 'local', 'authority', 'commissioned', and 'expert') [5]. In the third column of table 1, I have sketched the ethos defining a third type of knowledge production: 'Grassroots science'. This ethos I abbreviate as the 'ISYP Ideal' ('interdisciplinary', 'social responsibility', '¡Ya basta!', 'public opinion', and 'idealism').

As the CUDOS and PLACE sets of norms are well described in the literature, I now directly proceed to explore the ISYP Ideal.

The ethos of grassroots science: the ISYP Ideal

In this section I expand on the set of norms I have called the ISYP Ideal, which constitutes the ethos of grassroots science. I will do so by describing each of the norms one by one, simultaneously relating them to some of the CUDOS and PLACE norms:

Interdisciplinary: In one punch line one can say that grassroots science is the systematic and non-commercial attempt to solve the problems facing humanity, and its results are analysis of and strategies for solving these problems. As technological research, grassroots science is a problem-solving enterprise (cf. the norm of being an expert). Grassroots scientists should be experts – but experts on what? Conventionally an expert is seen as a person who, on the basis of objective scientific knowledge, can solve technical problems. However this perception of the expert does not apply to the complex problems facing humanity. Within the sphere of grassroots science experts also focus on risks, uncertainties, potential problems et cetera.

Grassroots science differs from industrial research by not being driven by proprietary/commercial aims. Hence the results of grassroots science should not be considered as private property, but as the property of humanity. In this regard grassroots science resembles academic science. An important task for groups of grassroots scientists is to develop carriers of these results – i.e. write books, reports, and articles, establish journals and websites, develop literature lists et cetera.

Grassroots science transcends the conventional disciplinary boundaries, thereby differing from normal academic science (cf. Kuhn's philosophy of science). The problems facing humanity are not given by established paradigms, so no single scientific community possesses the power to evaluate grassroots scientific results. Grassroots science is an interdisciplinary and sometimes even transdisciplinary activity, as it confronts the problems facing humanity with insights from many scientific disciplines. The process of formulating the standards used for

Table 1. The norms of different types of research activities

Academic science (CUDOS)	**Technological research** (PLACE)	**Grassroots science** (ISYP Ideal)
Communism. This norm requires that scientific findings be openly published in scientific journals, and hence in principle available for everybody. Academic scientific knowledge is the property of humankind.	*Proprietary*. This norm states that knowledge produced in an industrial or military laboratory is the property of an industry or of a state (cf. the fact that inventions can be patented).	*Interdisciplinary*. This norm states that grassroots science takes on an interdisciplinary approach in its attempts to solve the problems facing humanity.
Universality. This norm states that no scientific result should be excluded because of the finder's nationality, religion, social status etc. Academic knowledge claims must be evaluated against impersonal standards.	*Local*. Industrial and military research is aimed at solving local technical problems.	*Social responsibility*. Grassroots science is a socially responsible enterprise. The problems addressed are related to the betterment of humanity.
Disinterestedness. This norm warns us against trusting knowledge claims that come from a tainted source, such as the research laboratory of a tobacco company or of a racist government.	*Authority*. Industrial and military researchers work under managerial authority. For example in industries it is the board of directors that decide on which research projects are launched.	*¡Ya basta!* This slogan represents the idea that current practices cannot continue, and must be changed fundamentally. Grassroots science is a revolutionary activity, as it tries to develop radically new lines of thinking.
Organised Scepticism. Scientific claims should be systematically and critically tested with regard to consistency and reliability (cf. the peer review system of scientific journals)	*Commissioned*. Industrial and military research et cetera is commissioned to achieve practical goals – not universal knowledge.	*Public opinion*. When addressing the problems facing humanity, grassroots scientists often need the support from public opinion to put the key-questions on the research and political agendas.
	Expert. Industrial and military researchers are hired as expert problem-solvers – they are not supposed to be 'organic intellectuals'	*Idealism*. Grassroots scientists are idealists. They get involved in grassroots science, because they consider it the right thing to do.

evaluating the activities of grassroots science is also an inter- or transdisciplinary endeavour, and a task for grassroots scientists. Hence they should (also) ask: how do we evaluate the outcomes of grassroots scientific projects? Are the attempts to solve the problems facing humanity beneficial?

The emergence of new 'mixed' disciplines, such as nanoscience and technology, biochemistry, physics and technology, and social pharmacy and medicine, shows that also academic science and technological research are becoming increasingly interdisciplinary.

Social responsibility: The problems that grassroots science tries to solve are those that concern humanity, such as achieving world peace, a nuclear weapon-free world, global environmental sustainability, a world free of hunger, and improving world health. Many of these issues have conventionally been pursued by grassroots organisations such as the Pugwash Conferences on Science and World Affairs (nuclear weapon-free world), Medecins sans frontières (universal access to essential medicines), and Greenpeace (prevention of environmental degradation).

In which settings do grassroots scientists carry out their endeavours? The paragraph above hints at a potential answer: Grassroots scientists are organised in networks, and are not associated with any particular category of workplace. Hereby grassroots science differs from academic science, as academic scientists primarily work at universities, and from technological research, as developers of new technology usually work in closed research settings.

How can one more explicitly define the problems that deserve the attention of grassroots scientists? This is a difficult question and I find it hard to formulate a clear-cut answer. Pieces to an answer were given at the exhibition conceived by the French philosopher Paul Virilio: 'Ce qui arrive' (English: 'Unknown Quantities') that took place at the 'Foundation Cartier pour l'art contemporain' in Paris, November 29, 2002 to March 30, 2003. In the introduction to the exhibition Virilio states:

> 'Progress and catastrophe are the opposite faces of the same coin', observed Hannah Arendt… The twentieth century, the century of liberation, the century of the emancipation from Earth's gravity and of the acquisition of escape velocity, also unleashed atrocities on the world and fostered the exponential growth of major catastrophes, such as Bhopal, Chernobyl or, more recently, Toulouse.
>
> The qualitative achievements of discoveries that have benefited humanity has stealthily come to be conjoined with the quantitative, harmful depredations of progress.
>
> Local accidents of the past (the Titanic or Seveso disaster) and global accidents of the present (the Chernobyl meltdown or the threat of weapons of mass destruction) provide many reasons for opening, alongside war museums, the first 'Museum of Major Accidents'. The museum's purpose would not be to 'spread fear', but to confront what is no longer a chance event. There is an increasingly present cumulative reality related to a sudden globalisation in which accidents and terrorist attacks have merged to become an anonymous undeclared war. We shall not be able to uphold the imperative of responsibility or the precautionary principle for long if we do not remember the disasters that have plunged history into mourning. [6]

Hence Virilio argues that in modern cultures we need to increase our attention to the backside of techno-scientific progress. I agree with Virilio in this regard. But simultaneously with organising such enlightenment projects, new knowledge needs to be produced about, for example, human induced catastrophes [7].

Hans Jonas has formulated what he calls 'the imperative of responsibility', which I find applies to the socially responsible scientist (even though Jonas states that the 'imperative ad-

dresses itself to public policy rather than private conduct, which is not the causal dimension to which that imperative applies') [8]:

> Act so that the effects of your action are compatible with the permanence of genuine human life'; or expressed negatively: 'Act so that the effects of your action are not destructive of the future possibility of such life'; or simply: 'Do not compromise the conditions for an indefinite continuation of humanity on earth'; or, again turned positive: 'In your present choices, include the future wholeness of Man among the objects of your will [9].

In other words, the grassroots scientist is socially responsible. By this phrase I refer to an individual quality possessed by the grassroots scientist that guides his or her choices of research problems in the direction of what he or she thinks is beneficial to humankind.

One can say that the results that grassroots science is trying to achieve are universal. Not because the results are universally applicable or valid, as academic scientific knowledge is said to be, but because of the universal interest humans have in the solutions of the problems grassroots science pursue. Grassroots science is also local. The way towards for example a nuclear weapon-free world is characterised by the solutions of many local problems.

¡Ya basta! was a slogan used by Los Zapatistas (EZNL) in Mexico when on January 1, 1994 they declared 'war' against the Mexican government and its inability to prevent racism and oppression of the indigenous Mexicans in the province of Chiapas [10]. Los Zapatistas felt that the conditions of indigenous people of Mexico were so oppressive and unjust that they needed to be changed radically. I also use this slogan to characterise grassroots science. In that context it represents the idea that current practices, power relations, social structures, et cetera cannot continue, and must be changed fundamentally [11]. Hence grassroots science is a revolutionary activity in the sense that – by developing radical new lines of thinking – it tries to break problem-causing prejudice, unequal power relations, rigid social structures etc. But just as Los Zapatistas in Mexico are using the word as their weapon, so are grassroots scientists [12].

In other words, grassroots science is not disinterested as academic science tries to be. Grassroots science is actively promoting the interests of humanity. Neither is grassroots science practiced under managerial authority as industrial and technological research conventionally is. It is the individual grassroots scientist that chooses the problems with which he or she wants to work (cf. the norm of social responsibility dealt with above).

Public opinion: Trying to solve the problems facing humanity needs the support of public opinion. One of the reasons is that such endeavours might be in conflict with special interests (including commercial, cultural, military, political, and others). Hence, grassroots scientists can easily encounter powerful opponents to their work. (Opponents' weapons might be marginalisation, lack of funding, or, in extreme cases, psychological and physical violence.) Consequently, grassroots science only stands a chance if it is supported by public opinion, which is a prerequisite for political action and allocation of resources.

One crucial question that needs to be addressed by grassroots scientists is how is the support of public opinion won? Personally I consider clarity and transparency regarding objectives, underlying values, assumptions and methods important in the process of gaining the support of public opinion.

In his speech at a conference on nuclear policy and proliferation organised in London on January 8, 2003 by The Guardian, the Royal United Services Institute for Defence Studies and the US Physicians for Social Responsibility, Sir Joseph Rotblat called for the support of public opinion in the struggle for avoiding nuclear war:

> How can we prevent such catastrophes [nuclear war]? The traditional method of dealing with such situations – by partial agreements, damage-limitation treaties, confidence-building measures – does not seem to work any more. In its determination to maintain world dominance, particularly on the nuclear issue, the present administration [in the US] will pay no attention to reasoned and sophisticated arguments. Arms control is as good as dead. As I see it, the only way is to go back to basics, to put the goal of total nuclear disarmament back on the agenda. The only way to compel the current decision-makers to change their minds is by pressure of public opinion. For this purpose, the public must be awakened to the danger. The general public is not sufficiently informed about the recent changes in military doctrine, and the perils arising from them. We have to convince the public that the continuation of current policies, in which security of the world is maintained by the indefinite retention of nuclear weapons, is not realistic in the long run because it is bound eventually to result in a nuclear holocaust in which the future of the human race would be at stake. We must convince public opinion that the only alternative is the total elimination of nuclear weapons [13].

One can say that grassroots science is commissioned by humanity to solve the serious problems facing all of us. In this regard one can view grassroots science as technological research and development applied to worldwide problems.

Idealistic: Many might criticise grassroots science for being idealistic and naïve. Indeed grassroots scientists are idealistic people, as they believe that a better world is possible. However, I consider this to be a question of ethics rather than of naïvety: do we want to live in a peaceful and sustainable world based on compassion, not on greed; on generosity, not jealousy; on persuasion, not force; on equity, not oppression [14]? And if we do, are we not committed to do something about? (Though, I admit that it is problematic if or when the idealistic character of grassroots scientists contradicts the norm of organised scepticism that also applies to grassroots science.)

The antithesis to the norm of being idealistic is that of being pragmatic and opportunistic. Hence, I consider the idealistic character of grassroots science as the motor that drives this activity forward. People get involved in grassroots activities because they consider it the morally right thing to do, not because they gain from it personally (in a narrow sense) or because they are following orders.

* * *

Let me sum up: I have in this section drafted a set of norms which I envision guide grassroots scientists working on problems facing humanity. The set of norms shall not be seen as a complete list of norms – meaning that new norms can be added, and the ones I include in the ISYP

Ideal can be modified or removed. Neither shall the ISYP Ideal be seen as isolated from the CUDOS nor the PLACE set of norms. Grassroots science is in some aspects situated in between academic science and technological research, as the norms of communism and organised scepticism as well as those of work being commissioned and people being expert also apply to grassroots science.

Is the name grassroots science a good one? Personally, I like it as it directs the attention towards the focus areas of grassroots organisations which is identical to that of grassroots science (constructing a culture of peace, eradication of hunger and deceases, sustainability et cetera) Furthermore, the name might facilitate collaboration between scientists and the so-called 'New Social Movement'.

The problem of techno-science

Before I use the analytical tool presented above, I will discuss the question of whether academic science and technological research (or any mix of the two) can on themselves solve many of the serious problems facing humanity.

According to Thomas Kuhn, normal science, which is the most predominant form of academic science, is about riddle-solving. Scientists compete in solving the riddles defined by the disciplinary matrix under which they work. This has (at least) two consequences. The first one is that it is the scientists' fascination of solving scientific riddles that drives academic science forward [15]. The second consequence is that normal research does not aim to solve the really pressing problems, e.g. a cure for cancer or the design for a lasting peace, are often not puzzles at all, largely because they may not have any solution [16].

Also technological research has been exposed to criticism, in particular the consequences of its commercial affiliation. For example Vandana Shiva argues that technological development – which only has a proprietary agenda – cannot solve many of the problems facing the poor majority of the earth's population (as they have few economic resources). Shiva writes: Over the past two decades every issue I have been engaged in as an ecological activist and organic intellectual has revealed that what the industrial economy calls 'growth' is really a form of theft from nature and people [3]. This rather strong claim is supported by examples from the Third World, especially from India [17].

The criticism of contemporary science and technology I am addressing in this article mirrors the claim that the major problems facing humanity do not appear on the agendas of contemporary science and technology. It is doubtful that contemporary CUDOS science and PLACE technological research alone are capable of solving the majority of the problems facing humanity.

Science and research as we know it are under pressure and as a result transforming. John Ziman states, 'academic' science and 'industrial' science are merging into a new societal form – 'post-academic science'. This is obvious for example, in the way that university scientists are being directly funded by the private sector, or are expected to patent their findings and exploit them commercially [18].

John Ziman is not the only sociologist of science claiming such transformation. Also John Gibbons, Helga Nowotny, Peter Scott and others argue that a novel understanding of contemporary science and research is needed (on the descriptive level). They argue that knowledge production is changing from primary being an academic endeavour (they use the concept

'mode 1' to denote the conventional academic knowledge production), to becoming more interdisciplinary and problem-oriented ('mode 2' research) [19].

Henry Etzkowitz and Loet Leydesdorff believe that a clear-cut division of research institutions in three sectors (universities, industrial research laboratories, and governmental institutions) can no longer be upheld, as they interact and collaborate to a high degree ('Triple Helix' activities) [20].

One can argue that the 'new' forms of scientific and research activities (post-academic science, mode 2 research, and triple helix activities) are not affected by the criticism posed towards academic science and technological research. Or to be more specific, that these new forms of techno-science will put the problems facing humanity on their research agendas.

I perceive the 'new' forms of research activities as primarily being mixtures of CUDOS-science and PLACE-research [21]. Or said in the words of John Ziman: What were previously quite distinct social practices are being performed almost simultaneously, day by day, by the same individuals. On Mondays, Wednesdays and Fridays, in my 'academic' role, I write an article for a learned journal: On Tuesdays, Thursdays and Saturdays, I prepare a secret report on certain aspects of the same research for my industrial supporters [22].

I see no reason why mixed CUDOS-PLACE forms of research would put the problems facing humanity high on their research agendas.

An ISYP Ideal?

In this section I use the analytical tool presented in table 1 to analyse the activities of the organisation 'International Student/Young Pugwash' (ISYP).

ISYP consists of concerned students and young professionals from all over the world. The organisation is a superstructure of national Student/Young Pugwash groups located on five continents. ISYP is, according to its homepage (http://www.student-pugwash.org), committed to seeking alternative and viable solutions to critical global challenges at the intersection of science, technology, and society. International Student/Young Pugwash is the student/young affiliate of the Pugwash Conferences on Science and World Affairs (Pugwash).

The activities of ISYP are, at the moment, centred on:

- Maintaining a website that coordinates and distributes information about ISYP initiatives as well as national groups' activities.
- Organising yearly conferences for students and young professionals, who afterwards participate in the annual Pugwash Conference on Science and World Affairs.
- Promoting student and young participation in Pugwash workshops.
- Issuing a peer reviewed journal entitled 'ISYP Journal on Science and World Affairs'.
- Setting up an e-based course 'The Duality of Science and the Social Responsibility of Scientists'.

I will end by returning to the question posed in the headline of this article: Is 'the ISYP Ideal' really an ISYP ideal?

Let me start by the norm of social responsibility, which regards the selection of problems potentially addressed by ISYP. As the student/young affiliate of Pugwash, the questions dealt with by ISYP are to be found within the Pugwash programme areas: Nuclear Weapons, Chemi-

cal & Biological Weapons, Regional Conflict & Global Security (i.e. Regional Conflicts; Terrorism; and World Governance), Space Security, and Science & Society (i.e. Impact of Biotechnology on Environment and Food Security; Economic & Social Inequality; Security Aspects of HIV/AIDS; and Science, Ethics & Society).

The Pugwash issues do focus on the problems facing humanity. However, the activities of ISYP seem to be process oriented rather than product oriented. One can say that ISYP has accumulated the power to identify the new key questions for Pugwash. This might be due to the fact that ISYP was formed in 2000, and hence is a very young organisation. With ISYP's process focus the two CUDOS norms communism and organised scepticism co-form ISYP activities.

It is my impression that ISYP is interdisciplinary when it comes to the disciplinary background of the participants in ISYP's conferences. This impression is based on my personal participation in five student/young pre-conferences [23]. The distribution between young natural and social scientists is approximately one to one. Few persons with a disciplinary background in the humanities participate in the ISYP pre-conferences.

It is also my impression that ISYP members are idealistic. They get and stay involved in ISYP as they consider it the right thing to do – not only because it benefits their carriers.

According to ISYP's website the ISYP community cherishes the slogan 'Thinking in new ways' (cf. note [11]). Hence, the norm ¡Ya basta! also applies to ISYP activities.

ISYP's activities are targeted towards students and young professionals rather than towards public opinion. These two target groups are not necessarily contradictory.

To sum up: ISYP activities are located in between the categories: Academic science and grassroots science, as the norms communism, organised scepticism, interdisciplinary, social responsibility, ¡Ya basta!, and idealism constitute the ethos of ISYP.

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Notes

1. It is not my intention to imply that sociological analysis of norms is more important than other kinds of categorisation. Philosophical distinctions, focussing on the metaphysical assumptions underlying institutionalised activities, and categorisation of research products (for example knowledge claims) is also important.
2. John Ziman, Is science losing its objectivity?, Nature 382 (1996) 751-754. John Ziman splits up Merton's norm 'organised scepticism' into two distinct norms: 'scepticism', which is identical to Merton's norm 'organised scepticism' and 'originality' that commits scientific investigations to discover fundamentally new and original knowledge.

3. The term 'organic intellectual' is used in Vandana Shiva, Stolen Harvest: The Hijacking of the Global Food Supply, South End Press, Cambridge, MA, 2000.
4. The sociologist of science Robert Merton originally formulated the CUDOS set of norms in an article of 1942, reprinted in Robert Merton, The Sociology of Science, University of Chicago Press, Chicago, 1973. A contemporary interpretation of the CUDOS ethos is found in [2].
5. The set of norms abbreviated as PLACE, is taken from John Ziman, Real Science: What It Is and What It Means, Cambridge University Press, Cambridge, 2000, pp. 78-79. The documentary 'Dreams with deadlines' directed by Pola Bonfils gives the spectator an impression of how technological research is performed at 'Novo Nordisk' – a large Danish pharmaceutical company.
6. Press Brochure: Unknown Quantities – An exhibition conceived by Paul Virilio, Foundation Cartier pour l'art contemporain, Paris, 2002, p. 3.
7. I would like to mention two additional examples of such enlightenment projects. One is entitled 'Science Friction. Accidents – waiting to happen? Hazards revisited' organised by Learning Lab Denmark. This project has developed an electronic card game, where one can 'play with' techno-scientific disasters and hazards. Also thorough background material, describing the catastrophes addressed by the card game, has been developed (http:// www.hazardcards.com). The other project is a planned e-learning university course with the title 'The Duality of Science and the Social Responsibility of Scientists', initiated by International Student/Young Pugwash. The course will focus on the two faces of science and technology – on examples where science and technology have had beneficial respectively harmful consequences.
8. Hans Jonas, The Imperative of Responsibility: In Search of an Ethics for the Technological Age, University of Chicago Press, Chicago, 1984, p. 12. (The German edition is from 1979.)
9. Ibid., p. 11.
10. I quote from the declaration of war: Pero nosotros HOY DECIMOS ¡BASTA!, somos los herederos de los verdaderos forjadores de nuestra nacionalidad, los desposeídos somo millones y llamamos a todos nuestros hermanos a que se sumen a este llamado como el único camino para no morir de hambre ante la ambición insaciable de una dictadura de más de 70 años encabezada por una camarilla de traidores que representan a los grupos más conservadores y vendepatrias. (http://www.ezln.org/documentos/1994/199312xx.es.htm).
11. Cf. the ISYP slogan thinking in new ways (http://www.student-pugwash.org) that is based on the following quotation from the Russell-Einstein Manifesto: We have to learn to think in a new way. We have to learn to ask ourselves, not what steps can be taken to give military victory to whatever group we prefer, for there no longer are such steps; the question we have to ask ourselves is: what steps can be taken to prevent a military contest of which the issue must be disastrous to all parties? (http://www.pugwash.org/about/manifesto.htm).
12. Daniel Barrón Pastor (Ed.), La Guerra por la palabra – A siete años de luchar Zapatista, Rizoma, 2001.
13. Rotblat's speech is available at http://www.guardian.co.uk/nuclear/article/0,2763,870939,00.html.
14. Ibid.
15. Hans Primas presents a similar point of view: Why are scientists fascinated by their research work? Of course, there are people in science who are doing very important work for science, but who are not involved in creative research work. In the following, I will consider only the genuine creative work by scientists. There are many research scientists who over many years work sixty or eighty or even more hours a week. There are scientists so fascinated by their work that they neglect their families. What is the point - for the welfare of mankind? Perhaps in some very rare cases. If one asks

a research scientist for his own motives, one gets usually an evasive answer like intellectual curiosity, potential usefulness of the research, a sense of duty towards the institution where one happens to work, or the desire for promotion, fame, financial gain, power or even vanity. All of these factors may play a role, but they do not strike at the core of the matter. Intellectual curiosity is certainly an important point. But there are much easier ways to satisfy the thirst for knowledge than to conduct research work. Reading the incredibly rich and interesting scientific literature leads quickly and conveniently to new insights. So why should anyone engage in tedious research work? I would like to encourage you to deliberate about the deeper motives for your own research work. The truth pursues the researcher. I think that many scientists are not content with the role of a spectator. They want to participate actively in the disclosure of the mysteries of nature and to experience the thrill of following out a chain of reasoning for themselves. If instead of 'intellectual curiosity' we speak of a 'Faustian striving for knowledge', then we move gradually to the point. Quotation taken from Hans Primas, Fascination and inflation in science, in: Tom Børsen Hansen (Ed.), The Role of Philosophy of Science and Ethics in University Science Education, NSU Press, Göteborg, 2002.

16. Thomas Kuhn, The Structure of Scientific Revolutions, 2nd enlarged edition, University of Chicago Press, Chicago, 1970, p. 37.
17. A similar critique is presented in the Institute of Science in Society – Scientists for Global Responsibility – Trans World Network's discussion paper 'Towards A Convention on Knowledge', found at http://www.i-sis.org.uk/conventiononknowledge.php.
18. The quotation is taken from John Ziman, Getting scientists to think about what they are doing, in: Tom Børsen Hansen (Ed.), The Role of Philosophy of Science and Ethics in University Science Education, NSU Press, Göteborg, 2002, p. 40. See also [5].
19. Michael Gibbons, Camille Ligomges, Helga Nowotny, Simon Schwartzman, Peter Scott, Martin Trow, The New Production of Knowledge – The Dynasty of Science and Research in Contemporary Societies, Sage Publications, London, 1994 and Helga Nowotny, Peter Scott, Michael Gibbons, Re-thinking Science – Knowledge and the Public in an Age of Uncertainty, Polity Press, Cambridge, 2001.
20. Henry Etzkowitz and Loet Leydesdorff (Eds.), Universities and the Global Knowledge Economy: A Triple Helix of University-industry-government (Science, Technology and the International Political Economy), Continuum International Publishing Group – Pinter, 1997.
21. A look at website of the 4th Triple Helix conference – that took place in Copenhagen, Denmark, November 2002 – qualifies this impression (http:// www.triplehelix.dk).
22. John Ziman, Getting scientists to think about what they are doing, in: Tom Børsen Hansen (Ed.), The Role of Philosophy of Science and Ethics in University Science Education, NSU Press, Göteborg, 2002, p. 40.
23. I participated in my first student/young pre-conference in Lillehammer, 1997, which was the first formal student/young pre-conferences to an annual Pugwash Conference. I also participated in the pre-conferences in Jurica 1998, in Cambridge 2000, in La Jolla 2002, and in Halifax 2003.