Rationality in an Uncertain World
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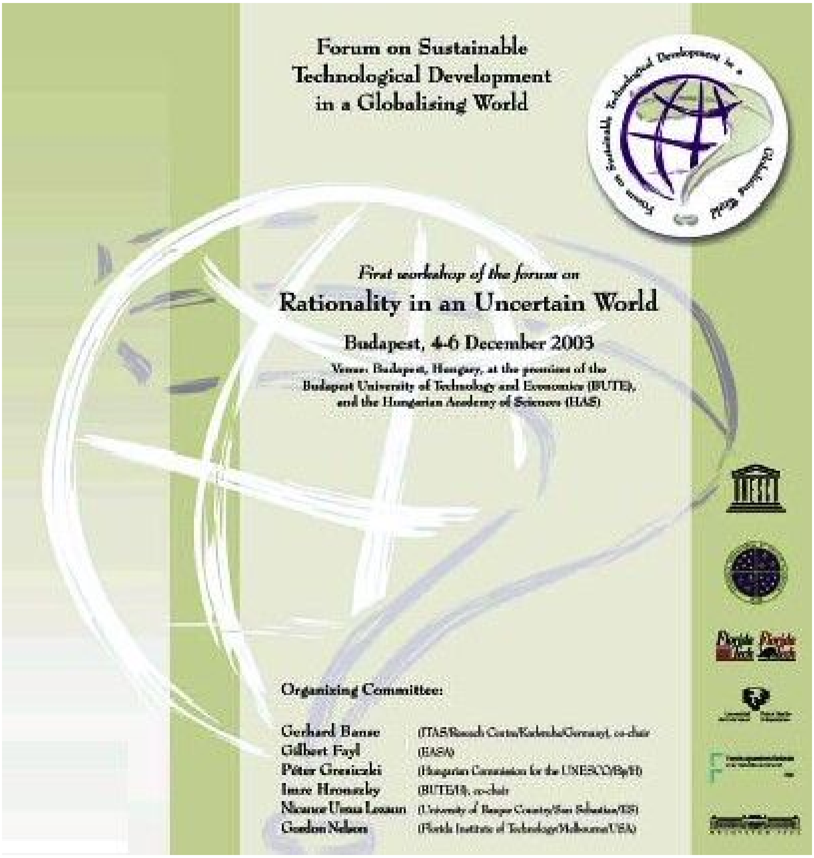

Rationality in an Uncertain World

A *consortium of Institutions* (see below) intends to develop a *Forum on Sustainable Technological Development in a Globalising World* (Keywords: humanities, social sciences, sustainable development, economics, sciences, legal and policy aspects) through a series of yearly workshops.
The *first workshop* is to be held in Budapest, 4-6 December, 2003.

1. Why do we need a forum on technological development?

Modern societies are engaged in innovation. A substantial part of innovative efforts is technological innovation. *So, we live more and more through technology. Developing any new technology, as any innovation, is also engaging in a semi-structured social experiment with its possible impacts. This "experimentation" leads to partly unforeseeable impacts that are realised through the interaction of technology with its natural and social environment. Hence we need profound accompanying reflection on (intended and non-intended) implications of those new technologies on society and the nature.* While this social experimentation through developing new technologies repeatedly opens evolutionary possibilities for society even to develop new social values, all these raise the problem of safety. But, by now, using or abusing technological development for mankind gets a new, shocking dimension by the threat of worldwide terrorism too. So, sustainable technological development for a sustainable society (including its nature dimension) needs balancing innovative efforts and anticipatory actions with safety and security on a global level. This balancing effort can only be realised through the co-operation of every actor in the "technological arena". Hence, all social agents, from individuals, through firms, movements, institutions, states, etc. should be called upon for conscious reflection and for ongoing co-operative discussion of the complexity of both strategic and tactical measures for sustainability.

The problem of sustainable relation to nature has proved to be and widened to the problem of sustainable societies. Among other things a deeper understanding of the problems of poverty is needed to the construction of these expected sustainable societies. Furthermore, quick technological progress brings with itself the new problem of inclusion and exclusion, on a worldwide, regional, and country level, down to individuals (i.e. the digital divide…). To repeat it, managing the recent problem of worldwide terrorism in relation to technological development constitutes an important element of this complex picture. The original problem of sustaining nature as basis of all social development is a problem to handle through a complexity of considerations of the most different types of social sustainabilities and becomes itself a part of it by now. Sustainability of the major social institutions, i.e. sustainable financing is to be realised and transition management should be found. Balanced technological development is a main element of successful transition toward sustainable societies. The realisation of balanced technological development needs the realisation of a controlled co-evolution of technology and society toward sustainable development and transdisciplinary research is also required which is often called as "prospective technology studies" by now. It unifies understanding of the technology – society relations with interest in its political regulation and policing.

We have learnt that sustainable development/growth can only be realised through an integrated approach to it. Our forum focuses on the role of the technology in this complex process. A global regard on balanced technological development seems to offer an important cognitive element to solve societal problems, provided a really holistic approach is realised, trying to properly assess the possible consequences from all the different perspectives, and to prepare through the possible anticipation for what is called "genuine surprises". Hence, the main perspective should be the deep-going simultaneous assessment of the possible consequences of new technologies and the objectives of the human societies in our globalised world.

2. What is the aim of the forum?

1. The proposed series of workshops is conceived to *set up a multi- and transdisciplinary forum developing a wide range discourse and special knowledge on the social role of technological development in the age of globalisation.* Assessing this development needs *multiple perspectives from science* to utilise them to find results with practical importance. Clearly, the forum is intended to be not only multi-and transdisciplinary but also *heterogeneous* in terms of participants. It will include not only university scholars and PhD students, but also stakeholders such as representatives of civil organisations, corporate representatives and policy makers, etc. from different countries. The forum is intended to become a continuous "market-place" of ideas and proposals by highly competent participants and the outcomes should be presented to a heterogeneous public.
2. Examining *possible actions based on widely shared consensus* is its main goal. It also tries to include social actors, less usual in earlier periods, working for sustainability. So, the first Budapest workshop will

also focus on the questions of *good corporate citizenship*, and of *long-term corporate responsibility.*

3. *Transatlantic discussion and consensus* is the most important in our time. The forum realises it in issues of sustainable technological development.
4. *Discussion and consensus* among the *technologically leading countries and European countries in transition.*
5. The *due follow-up of the outcomes* of the workshop is also absolutely dealt with and stressed.

3. The organising committee of the workshop is set up as follows

- *Prof. Dr. Imre Hronszky*, Budapest University of Technology and of Economics (BUTE/H), as co-chairperson
- *Prof. Dr. Gerhard Banse*, Forschungszentrum/Karlsruhe (FZK/ITAS/GER), as co-chairperson
- *Dr. Gilbert Fayl*, foreign secretary of the European Academy of Sciences and the Arts (EASA)
- *Mr. Peter Gresiczki*, Hungarian National Commission for UNESCO
- *Prof. Gordon Nelson*, Florida Institute of Technology (Florida Tech/USA)
- *Prof. Nicanor Ursua Lezaun*, University of Basque Country (ES)

RISK AND RATIONALITY IN AN INFINITE WORLD

Gotthard BECHMANN
Institute for Technology Assessment and Systems Analysis

The language of risk reflects a new uncertainty in society which takes the form of conscious perception of the future as contingent on the present. Seen in these sociological terms, risk means that possible damage is already attributed to decision-making attitudes although it is impossible to know the scale of the damage, the emergence of the damage and if there will be damage at all. This ignorance (unpredictability of the consequences of a decision) becomes part of the decision. The only thing that is certain is that a decision must be made, as there is no social entity which future damage can be attributed to, leaving only decision-making under conditions of uncertainty. The expansion of the potential for decision and the disappearance of any metasocial rules with the resulting pressure to choose options has resulted in society

The concept of risk further operates with a difference in time, namely with the difference between the assessment before and after the occurrence of the accident. Only such decisions are risky, that one would regret if the damage took place. In management science this is called post-decisional regret. It is not only the simple increases in costs which lead to one not regretting the decision itself. Instead the term focuses exactly on the paradox of contradictory judgements before and after the event. However one may view this paradox of synchronously opposite attitudes, the paradox unfolds, as logicians would say, through time itself. Thus it is dissolved by the difference in time so that there is only a *single* plausible judgement at each point in time. The concept of risk however neutralises this life technique of chronological succession. It collects the contradiction in the present, creates the paradox a new and solves it in a different way, namely by means of rational risk management. If the improbable happens, one can defend oneself against accusations by saying that one had decided correctly, namely according to the rationality of risk.

We thus recognise that the concept of risk embodies a multidimensional problem that is already complex in the logical sense and cannot be adequately handled with the relatively simple means of classical two-value logic, requiring instead logic richer in structure. The practical consequence is that risk can be observed very differently depending on how which differences are weighted in which way. The problem thus returns to the social dimensions, to society and thus ultimately to politics.

RATIONALITY IN AN UNCERTAIN WORLD

Armin GRÜNWALD
Institute for Technology Assessment and Systems Analysis

Uncertainty has become one of the key notions in diagnosing the current state of human civilisation as well as of specific societies. The notions of a "risk society" (Beck) or of the "Neue Unübersichtlichkeit" (Habermas) are demarcating a situation where it seems to be no longer possible to rely on unquestioned values or guaranteed truths. Several developments contribute to that diagnosis – the end of the Cold War, new geopolitical constellations, terrorism, migration, cultural differentiation but also developments in science and technology, above all in the fields of biotechnology, nanotechnology, information technology and the cognitive sciences – which, altogether, could provide – like envisaged in the NSF report on converging technologies – completely new capabilities for the "enhancement" of individuals or the entire humankind. Contributing also to the feeling of uncertainty, recent discussions in philosophy and sociology of science and knowledge have destroyed the last bastion of reliability and certainty: science itself. As many researchers claim, the main effect of research is no longer to increase certainty but to increase uncertainty.

However, we should be aware of the difference between increasing uncertainty and the increasing perception of uncertainty. Science and technology, in fact, do not only produce uncertainties but also provide capabilities for dealing with uncertainties – again in a way that their success is not guaranteed but due to uncertainty. It comes out that we are living in an inevitably experimental situation. Are there approaches or orientations available to deal "rationally" with this situation?

In order to explore what rationality could mean in an experimental situation I will use the pragmatic concept of rationality proposed by Nicolas Rescher, and I will expand this concept to the current situation. In my interpretation, the pragmatic concept of rationality consists of three dimensions

- a *procedural* dimension (in opposition to a substantial or ontological understanding of rationality)
- a *relational* dimension (in contrast to a universalistic approach), and
- a *reflective* dimension (which prevents rationality of becoming uncritically rationalistic).

From this point of departure I will sketch a pathway of rationally dealing with uncertainty in general. Following the umbrella topic of our conference series I will choose the imperative of sustainability as normative background. The imperative of sustainability aims at giving orientation in the above-mentioned experimental situation. Since we do not know what sustainability is in positive terms we have to explore it step by step. The integrative approach to sustainability, developed mainly at ITAS, will be used as conceptualisation and starting point for future clarification processes.

For the sake of further illustration I will concentrate on the social shaping of technology. Developing any new technology is also contributing to the "social experiment" mentioned above, with all its possible impacts including the increase of uncertainty. We need profound reflection on (intended and non-intended) social implications of those new technologies – knowing that even this knowledge will not prevent us from the necessity to act under uncertainty. The existential experimental situation is becoming the new *condition humana.*

Content

IMPACTS OF FUTURE INFORMATION AND COMMUNICATION TECHNOLOGIES ON SOCIETY AND ENVIRONMENT - DEALING WITH UNCERTAINTY IN PROSPECTIVE TECHNOLOGICAL STUDIES

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A vision of future ways of applying Information and Communication Technologies (ICT) to our daily lives is called 'Pervasive Computing' and widely discussed in the ICT field. It involves the miniaturization and embedding of microelectronics in non-ICT objects and wireless networking, making computers ubiquitous in the world around us. Unlike most of today's ICT products, Pervasive Computing components will be equipped with sensors enabling them to collect data from their surroundings without the user's active intervention.

If our daily life is to be pervaded in such ways by microelectronic components, running all the time with most of them wirelessly networked, one must ask whether these technologies might not have undesirable side-effects. The expected benefits need to be weighed against the potential risks involved in implementing such technological visions. A technology assessment study carried out on behalf of the Swiss Centre for Technology Assessment deals with this issue (Hilty et al. 2003).

When comparing opportunities with risks, we will have to answer the basic question of the ethics of technology: "Which technologies do we want in our lives, and what kind of a world would that be?".

The identification and assessment of opportunities and risks, though, require value judgements, which cannot be decided by science alone. The study is based on values derived from the principles of traditional ethics (respect of human dignity, non-maleficience, beneficience, and justice), supplemented by the precautionary principle and the paradigm of sustainable development. The core values found both in the precautionary principle and in sustainability expand the principle of justice to include explicitly future generations: Act today in such a way that you do not restrict others' scope to act in the future.

The main opportunities and risks associated with Pervasive Computing identified in the study can be summed up as follows.

The most significant opportunities come in the form of medical prevention, treatment and care, and in general on innovative services, all of them enabled by Pervasive Computing.

The increasing independence of activities from defined locations has various consequences. Among the environmental aspects, the effects on traffic are foremost, as the bottom line can turn out to be either positive or negative. As far as social aspects are concerned, an improved compatibility of professional and domestic activities (namely caring for children) may result in gains for persons of either gender.

Pervasive Computing becomes interesting for business and consumers when it is filled with local contents and services. The context sensitivity of Pervasive Computing favours locally differentiated products: Information is made available and services proposed according to one's precise position and individual preferences.

We used the following criteria to evaluate risks: *irreversibility*, *delay effect, conflict potential* and *negative impacts on posterity*, and identified the following issues as the most important:

- Non-ionized radiation: Average exposure is expected to increase. There is a conflict potential, as non-users of Pervasive Computing will see themselves exposed to impairments caused by others, such as in the case of passive smokers. It is imperative to do further research on the possible health risks.
- Stress: Pervasive Computing can generate stress for various reasons, such as poor usability, disturbance and distraction, the feeling of being under surveillance (privacy issues), possible misuse of the technology for criminal purposes as well as increased demands on individuals' productivity. Stress has a considerable impact on health.
- Restrictions on individual freedom: The trend toward Pervasive Computing may drive some consumers and patients into a situation in which they are compelled to use such technology (if, for instance, alternatives are no longer available) or to co-finance it against their will (as for example with rising mandatory contributions to health insurance).
- Ecological sustainability: Consumption of scarce raw materials for the production of electronics and the energy consumption of stationary infrastructure may increase sharply. Furthermore, if no adequate solution is found for the end-of-life treatment of the electronic waste generated by millions of very small components, precious raw materials will be lost and pollutants emitted to the environment.
- Causation principle: As a rule, it is not possible to isolate the cause of damages due to the combined effects of several components from computer hardware, programmes and data in networks, as no one can cope with the complexity of such distributed systems, neither mathematically nor legally. As society's dependence on systems of this kind will grow with Pervasive Computing, a net increase in the damage

derived from unmastered technical complexity has to be expected. As a consequence, a growing part of day-to-day life will, virtually, be removed from liability under the causation principle.

„DISCOURSIVE VARIABLES” IN CALCULATIONS

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By now, we acquired some basic knowledge of „risky situations”. They are systemic, of „natural-social ontological” type, different from different perspectives, only partially covered by quantitative risks (Uncertainty, not qR is the overarching category). A historical glance on scientific understanding of uncertainty shows a turn from the original overall expectation of transforming uncertainty into certainty of calculated risk toward the recent claim of rational managing of simultaneous production of uncertainty and safety (involving developments in qRA).

Modern societies try to realise two purposes, innovation and safety. They systematically reproduce a basic tension. This tension leads to the need for its rational management. This need is of political nature. The pragmatic question about production of uncertainty and knowledge of it is connected to the following question: In what type of society what sort of „knowledge order” exists, how this „knowledge order” fits with the practical life of society and what are the consequences of the „knowledge order” on practical life? According to Luhman's basic characterisation human history moves toward producing/reproducing radical contingency. Rationality of active, regulating relation to future, when our practice systematically /re/produces uncertainty as its basic feature, can only be evolutionary, a systematic regulationary trial, based on non-Bayesian learning during „walking” that manages living together with uncertainty production. Learning when „walking” should be overarching strategy to unify innovation with safety. Risk calculation can only be a part of this overall approach. A different type of supreme rationality in the world of radical contingency is needed. This rationality should be based on the radical turn from „emergency management” to „crisis management” /Lagadec 2000/. „Crisis management” is a trial to adequately reflect on and managing eco-social complexity. Because of the unavoidability of multiple perspectives it essentially needs networking and participation of stakeholders, both in successfully learning about and managing complexity. „Crisis management” types can be further differentiated according to the types of networking and participation. Projecting sustainable future is essential element of understanding and managing the evolution of complex systems. Realising precaution (learning and acting on the basis of precautionary principle, PP) is one way to approach and manage complex systems.

It is to differentiate bw PP as „paralysing perspective" vs as dynamic, evolutionary balancing of action possibilities. As A. Rip formulated, it is clever to avoid a „Dichotomy trap". As he pointed out, contrasting science with PP is based on a categorial mistake /Rip, 1999/: cognition context realises contrasting science – non-science, while contrasting narrow and wide, comprehensive regulation (based on PP) is made on the regulatory level. Reformulating PP in a form that avoids the categorial mistake makes PP understood as comprehensive regulatory approach based on the widest science possible.

Accounting for complexities needs a narrative. What gives science, if any, a special place in telling a story about complexity? This question should be put together with systematically put others such as what gives a special place to stakeholders' perspectives, including the public? These questions should be answered on the basis of knowledge of "distributed intelligence", on rethinking division of labour and cognition under conditions of complexity and the possibility of different political perspectives. These considerations lead to a paradox: We need more and more experts / specialists of new types/ meanwhile, through this need more and more participation is also needed and vice versa, a co-evolutionary approach is emerging. A systematic cooperation is to realise through the emerging medium of the recently scarcely existing „technological citizenship".

WHICH SUSTAINABILITY? EUROPEAN POLICY DILEMMAS OVER GM CROPS

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'Sustainability' discourses have been widely adopted and promoted. Their meanings have become more contested, especially in Europe. The term encompasses divergent accounts of the problem to be solved. Such accounts underlie European conflicts over genetically modified (GM) crops. Questions:

- How to characterise divergent accounts of sustainability?
- How do regulatory conflicts relate to those accounts?
- What policy dilemmas arise?

Sustainability debate: analytical perspectives

Conflicts over sustainability feature different scenarios for socio-natural futures. Each view is both discursive and material; language constitutes practices. Each view has its own concept of society, economy and environment. A three-part taxonomy can help to analyse their role in policy debates: environmental management mediates between neoliberal and community views.

Agricultural futures debated

Environmental mgt view has dual role of promotion and mediation. Brundtland report:

- GM crops as double-edged
- intensive methods cause adverse environmental effects;
- ag-biotech offers benefits but may aggravate farmers' dependence.

Neoliberal view: GM crops as high-yield sustainable agriculture

Critics: GM crops as ‘genetic treadmill’, intensive monoculture, precluding beneficial alternatives.

European policy on sustainable development

Agenda 2000: aims to enhance rural livelihoods, food quality, and 'environmental friendliness'. But CAP reform generates conflict between neoliberal versus community views.

'Sustainable agriculture' has become central to debate over GM crops

Each national debate features a type of common resources to be protected.

- Germany: less-intensive weed-control options versus herbicide-tolerant crops
- Denmark: drinking-water quality vs pesticide usage

- Austria: organic agriculture as norm for export products and tourism
- UK: biodiversity around agriculture as ‘the environment’
- France: *produits de terroir*, high-quality local products versus industrial methods

Alternatives stimulated

- Integrated Crop Management (and organic) methods for reducing pesticide usage;
- Seeds R&D for pest- and disease-resistant varieties; polygenetic tolerance;
- Green supply chains in retail industry promote those options.

Regulatory procedures: mediating the conflicts

- Deliberate Release Directive links environmental protection with market integration.
- EU approval of GM products: initially accepted 'genetic treadmill' of herbicide/insecticide-resistance.
- Public protest re-opened safety assumptions from the late 1990s onwards.
- UK farm-scale evaluations compare GM crops various farming methods and environmental norms.
- Extra bodies deliberate policy issues, e.g. accounts of sustainable agriculture, monitoring methods, etc.

Conclusions

Regulatory conflicts are driven by divergent views of sustainability.
GM crops have become a focus of debate around sustainable agriculture, e.g.

- how to sustain or supersede intensive agriculture;
- how to enhance quality of food, farmland and rural environments;
- what environment should be protected, sustained or even created.

Risk regulation faces the implicit task of accommodating or adjudicating those divergent views.
Policy dilemmas ensue:

- Meaning of scientific evidence depends upon one's normative framework.
- As less-intensive cultivation methods are developed, they provide more stringent norms for evaluating the environmental effects of GM crops.
- Norms are subject to debate about 'sustainable development'.
- These value-laden issues are deliberated in a publicly accountable way, thus undermining the official pretence of 'science-based policy'.
- Yet this process remains an essential basis for government eventually to take responsibility for decisions.

Social-science too frames the sustainability debate for its own tasks.

Our research questions are value-laden. Implicitly, what political role do we play?

ENVIRONMENTAL CONSERVATION AND RESTORATION

(Theoretical and Practical Aspects for a Sustainable Development)

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The human being has a large capability to technologically *interfere* with the *World.* That causes serious problems, since human being is capable to transform technologically every thing. Today we know that the survival of mankind depends on vegetable production, biosphere regulation processes like water cycles, oxygen production, carbon dioxide of the air, thus it depends on rural and natural landscape configuration. It's well known that without the good health of the planet it is not possible to have future chances and perspectives for our, and for our children's survival. Ecosystem "Earth" is a group of interconnected systems in which all processes and components are related to each other. Restoration and Conservation face one of their greatest challenges: It is about *justification* of the need to preserve biodiversity. It will be argued about Economics, Sciences and Ethics. We are going to focus on ethical arguments. This raises the issue that if it's right or wrong the human behaviour related to environment and nature then that implies an alteration to these media and put danger on life of several numbers of processes and species in turn. Technologies appear in society as inherent benefit. However technological process is in need of ethical reflection. The need to set upon with an ethical reflection is what human beings think about it. Technological change does not only approach a problem for moral reflection problem, but ethical decisions influence the *way we live and use our technologies. Experts* by themselves - whether they are technologists or scientists - cannot solve our problems. We do not live in order to make and use new technologies, we make and use new technologies in order to live in a much better way. (C. Mitcham)

SUSTAINABILITY AND CATCHING-UP

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Czech Academy of Sciences

Transitional countries follow generally a strategy of catching-up the advanced Western countries in terms of aiming at closing the gap in economic performance and standard of living. This task is generally accepted by the public. At the same time, sustainability is considered being of highest relevance.

The questions arise: are catching-up strategy and that of sustainability rather compatible (mutually fostering) than conflicting in the conditions of transitional societies? Is a win-win rationality successful only in the favourable conditions of the most advanced countries whereas in the less developed countries the contradiction between economic dynamics and sustainability requirements still persists?

Even if we generally acknowledge compatibility of these two strategies – conceptually under the notion of modernization for example, it is still left a problem of where putting stress or that of timing (phasing). Catching-up makes use the concept of imitation, but what should be imitated: the presence or historical process? Should identity also be imitated?

Overall societal rationality is usually in a relevant way determined by the conflict of interests that is simultaneously learning process. This applies for the Czech Republic either: then in the public discourse the different accounts of the concepts of sustainability, modernization and imitation appear and clash.

SUSTAINABLE INNOVATION. CONDITIONS, EMERGENCE, AND POLICY

Helge MAJER
University of Stuttgart

This paper develops some basic ideas as regards the definition, conditions and implementation of sustainable innovations. The approach is normative in many respects, but there are quite many links of implementation.

First some definitions. Sustainable development or sustainability is often defined with the „three bottom line". The triangle implied contains economic efficiency, environmental excellence and social responsibility. On a more general level and integrating the large number of definitions at hand, I suggest a suatainability-triangle comprising of the edges 1. Long term, 2. Justice, and 3. Holistic. With these notions, it becomes possible to use sustainability as a tool for solving complex problems. Complex problems are characterized by interdependency, contingency and uncertainty. They can be described in sustainability projects, which bear a set of particular criteria. The process of solving such sustainability projects is at the heart of sustainable innovations.

The problem solving process is working through the interaction of agents (actors). These agents comprise experts (scientists), those involved by the problem and those carrying responsibility as regards aspects of the problem. In a learning process, the project group utilizes a range of solutions, that are marked by a matrix of targets (EESIC) and measures (tbi). Targets are economic efficiency, environmental excellence, social resonsibility, international conformity, and cultural variety. Measures comprise technical, behavioural and institutional innovations. When the matrix is worked through completely, the resulting solution can be called sustainable. Thus, sustainable innovations are new or significantly better ways of doing things, resulting from the interaction of a number of agents with inter- and transdisciplinary competence as regards the creation of new knowledge as well as the consequences of implementation. The results of the problem solving process can be (technical) products and/or productions processes and/or services and/or behavioural changes and/or rules, etc.

Sustainable innovations emerge from cooperative learning processes. They emerge from the productive and creative interaction of different agents (actors). The process implies a number of conditions: 1. A joint (shared) vision. 2. A potential of cooperation and interacting (cultural aspect). 3. The willingness and ability to cooperate and to communicate (behavioural aspect). 4. Qualification for T-learning (H.-P. Dürr). 5. Embeddedness in a learning society. 6. Institutions and organisations of learning and experimenting. 7. Basic trust within the societies.

Implementation of such institutions and organisations needs networking and self-organisation. Thus the national innovation system should be fundamentally reorganised to meet the reqiurements of sustainability projects and their solution.

LESSONS FROM THE WESTERN AUSTRALIAN STATE SUSTAINABILITY STRATEGY: APPROACH AND PROCESS

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Dora MARINOVA
Murdoch University

The global discourse on sustainability encapsulates a different approach to government and requires a long-term commitment, which is often in conflict with the short-term political goals of the government of the day. According to Patsy Healy (1999), there are three levels of policy change with increasing depth: (i) changing language, (ii) changing thinking and (iii) changing culture. A shift towards sustainability entails a change in culture that is not simple to achieve. However, the vision, approach and processes put in place in the development of a government sustainability strategy can trigger a deep-seated commitment to sustainability that transcends the imperatives of political life. The Western Australian State Sustainability Strategy offers an example of this.

The Western Australian government manages an area of land the size of Western Europe yet with a population of only 1.8 million. The state has huge mineral, gas and agricultural resources and is the only developed country area to have one of the top 25 biodiversity hotspots. In February 2001 the Gallop government was elected in Western Australia with a mandate to stop the logging of old growth forests (the only place in the world to do this with substantial ancient forests remaining) and a commitment to develop a State Sustainability Strategy. The Strategy is now finalised (Government of Western Australia, 2003), and only a few state or sub-national governments have yet completed such a sustainability strategy with nations and local governments being more than a decade ahead on these matters (OECD, 2002).

The definition of sustainability adopted in the Western Australia State Strategy is: “Sustainability is meeting the needs of present and future generations through an integration of environmental protection, social advancement and economic prosperity”. The important word is ‘integration’ – as governments generally don’t bring environmental and social factors into the mainstream of economic development. The integration of all three areas is a challenge which was put before the West Australian public and government over a 2 year process from mid 2001. Work on the Strategy begun first by developing a series of 18 public seminars and a set of Case

Studies and Background Papers using students and academics. This unique partnership between universities and government was symbolic of the value that can be gained when a common cause can be identified. Numerous meetings in the city of Perth and the regions follow which encouraged and enabled values-based discussion on future issues rather than just expert opinion. At no stage did the discussion become party political. It developed new language and new way of thinking but only after the sustainability principles are institutionalised and partnerships established will the embracement of the sustainability culture become a reality. Until then it remains the politics of hope.

TRANSDISCIPLINARITY IN TEACHING AND LEARNING SUSTAINABILITY

Dora MARINOVA
Natalie MCGRATH
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The era of globalisation is creating unprecedented challenges which are being equally matched with new opportunities and possibilities for the future unforeseen by previous generations. Change in this new era is rapid, and appears to be ever accelerating as new technologies allow for faster communication and information flow. This is resulting in the deepening of divisions in wealth and wellbeing but also in the creation of new partnerships and expanding coalitions across and within government, markets, universities and civil societies. These coalitions are uniting cultures around the world and are forming a counter power to the divisive forces of capitalism.

The decade of UNESCO's Education for Sustainable Development emphasises the increased significance of sustainability in the higher educational system and requires a concerted and committed focus within universities. It is the place of the university in society to discern truth, impart values and to prepare students to contribute to social progress and the advancement of knowledge, in which to achieve a sustainable world (Calder and Clugston, 2003). The report to UNESCO of the International Commission on Education for the Twenty-first Century, chaired by Jacques Delors recommends four pillars of an educational system which include: learning to know, learning to do, learning to live together and learning to be. Transdisciplinarity provides a framework in which this may be achieved and includes the participation of society as a whole, with universities as one actor. The complexities and contradictions of today's global challenges require transdisciplinary skills that cross disciplines, cultures and institutions, to be utilised by the citizens and professionals of today and tomorrow.

The quality of learning is inseparable from the quality of teaching within a higher education system, and the pillars of education for sustainability are equally applicable to any field of education. The current "silo" division within the university environment constrains the development of the united culture necessary to achieve sustainability. The formation of partnerships is often more difficult internally and nationally than in the global environment. Dialogical, critical and active learning as described by Friere (1972) in a process of ‘conscientizacao’ requires a pedagogy in which teachers and students learn, reflect and act together, and by doing so transform themselves and the world around them. The universities also need to transform to be in a position to change the language, thinking and culture of the society for the ongoing achievement of sustainability.

Transdisciplinarity in universities is necessary for the realisation of global sustainability. An education system built upon the approaches of the previous century, confined solely to the boundaries of a disciplinary perspective, will not be able to meet the requirements of sustainability. Nicolescu (1997) recommends that universities should have one transdisciplinary department and then every other department devote 10% of time to transdisciplinary work. This is particularly relevant to sustainability. This one transdisciplinary department could act as a centre in a network of disciplines whose understanding of transdisciplinarity for sustainability would be enhanced by this 10% loading. This would mean that teaching and learning sustainability would rise above the disciplinary framework, a transition that is very much required, but would be fed and would also feed individual disciplines. The Institute for Sustainability and Technology Policy is a case-study to demonstrate excellence in teaching and learning for sustainability as a centre of transdisciplinarity at Murdoch University, Western Australia.

TECHNOLOGICAL STRENGTHS IN THE DEVELOPMENT OF SUSTAINABLE TECHNOLOGIES

Dora MARINOVA
Murdoch University

Irrespectively of whether we agree with Engels (1844) about the third element, namely science, in the land–labour relationship and its power and limitless progress, it is widely accepted that sustainable development requires new technologies. The environmental behaviour of individuals, companies and countries, how much they pollute and what resources they consume, is of paramount importance and a major role in it plays what technologies are being used. The issues of cleaner production have become a major concern in the attempts to rectify the damages caused to the natural environment by industrial development. Renewable energy technologies are considered to be an alternative to fossil fuels in terms of preventing resource depletion and as a way of reducing air pollution. New ecological technologies are expected to help decrease the human pressure on the environment while providing or keeping the desired standard of living. Nanotechnologies, which are at the frontier of today's knowledge, are not only considered to be inherently green but are also expected to help deal with waste decomposition and treatment.

How are the various countries placed to address the challenges of globalization and the imperatives of sustainability? This paper examines a technological strengths model based on US patent statistics applied to three classes of technologies which are expected to have a major impact for a more sustainable development, namely: (1) environmental technologies; (2) anti-pollution technologies as a special case of environmental technologies; and (3) nanotechnologies. The adopted approach uses patents in the USA registered by the top twelve developed countries between 1975 and 2002 in order to analyse the patterns in the development of the above technologies.

The development of green technologies is the currently emerging technological and socio-economic paradigm. Although the absolute number of patented environmental technologies has been increasing, the annual shares of patents which address ecological issues and their implications remain very small The empirical findings demonstrate that the expertise and strength in environmental technologies are concentrated in a relatively small number of countries, namely Germany, Canada and Japan, with Australia close behind the leaders. Nevertheless, these countries show different priorities, being more successful in some aspects of technological strengths than in others. All of them, however, are currently establishing the foundations for the future significant impact of this important group of technologies.

After strong levels in the 1970s, the interest in anti-pollution technologies has diminished in the 1980s and has again resurrected in the 1990s to level off in the late 1990s. The overall best performing countries in the area of anti-pollution technologies are Japan, France and Germany. These three countries also seem to have the bulk of technological knowledge and capacity in this area. There are, however, more similarities between Japan and France where the prevention and abatement of pollution appear to be a national priority. Nanotechnology is an area of significant patent activity in the mid- to late-1990s, in terms of absolute numbers and as share of total US patents. In comparison with the other sustainable technologies, the expertise and strengths in nanotechnology are also not evenly distributed among the most technologically advanced economies (Marinova and McAleer, 2003). These countries approach these developments with different national strategies and priorities. Although the top three countries are France, Japan and Canada, some countries are clearly more successful than others according to different indicators, and are currently establishing the foundations for the future impact of this new group of technologies.

KNOWLEDGE, COMPUTER-MEDIATED COMMUNICATION AND SUSTAINABLE DEVELOPMENT

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Any of the terms in the title of this contribution could be the subject of a paper in their own right. Nonetheless, this paper concentrates less on explications and much more on the connections that allow these phenomena to interact with one another. The dynamics behind them are on the one hand – on the ideational level – based on models, and on the other hand – on the material level – based on developmental paths. To what extent the "sustainable society" or the "information society" diverge or converge depends above all on how the cycle of knowledge formation, conveying of knowledge and knowledge exploitation is formed in society. As the use of information and communication technologies can fundamentally change the requirements for the course and development of this cycle, it is time to give some thought as to how this challenge can be met. To this aim, a series of reflections, hypotheses and suggestions will be put forward for discussion.

ENVIRONMENTAL ETHICS AND ENGINEERING ETHICS COURSES AT THE BUTE

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The engineering ethics course is intended to make engineering students conscious of moral aspects of their professional roles. Engineers work as employees, entrepreneurs, managers and civil servants, too. The conflicts of these roles are presented by case studies and analyses during the course. By these presentations the would-be engineers will be capable of evaluating ethical aspects of their work. The reason of it is that by presenting case studies and theoretical analyses the implicit moral assumptions of engineering (and other types of) activity will be made explicit for them.

The teaching of these ethics subjects has been based on the concept that moral values and models are integrated in our decisions even if we are not conscious of them. For example weighing of risks and benefits of a technological project is structurally similar to the evaluating method of utilitarian ethics. For example setting environmental standards is to set levels of socially acceptable, that is morally justifiable level of risks. Most of the cases of these regulations are based on utilitarian considerations but, in certain cases - if it is about zero risk standards - we can speak of regulations based on duty ethics.

The environmental ethics course is intended to present the main problems and issues of environmental ethics. According to the conception of the course ethical problems are presented in connection to environmental issues and policies. (environmental-, technology and economic policy) The main intention of the course is that we can cope with environmental problems with a new attitude of partnership, in accepting that nature (environment) has intrinsic value. (value in itself), only. The course is intended to contribute to a change in attitude of engineering students toward this conception.

On the whole both subjects are oriented towards promoting the idea of sustainable development.

So environmental and engineering ethics should be integrated into policies, especially to technology, and economic policy.

The following table shows stages of development of engineering ethics and technology policy. So you can see correspondences between them.

TYPE OF ENGINEERING ETHICS	MODEL OF TECHNOLOGY POLICY

ETHICS OF ENGINEERING "ORDER" (Public good is not yet of concern to engineering)	MARKET-PARADIGM (There is no need of technology policy because market in itself solves the problems of technological development)
ETHICS OF "ORDER" + UNIVERSAL ETHICS = MODERN ANTHROPOCENTRIC ENGINEERING ETHICS (Engineers "hold paramount the safety, health and welfare of the public")	TRADITIONAL TECHNOLOGY POLICY (State interferes with technological development directly because market underinvests in it.)
ANTHROPOCENTRIC ENGINEERING ETHICS + ENVIRONMENTAL ETHICS = ETHICS OF SUSTAINABLE DEVELOPMENT (Moral considerations are extended to future generations and environment as intrinsic value)	TECHNOLOGY POLICY OF SUSTAINABLE DEVELOPMENT (State promotes and creates conditions for sustainable technological development)

NEED FOR COMPREHENSIVE SCIENCE IN SUSTAINABILITY ASSESSMENT

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„Sustainability” is a word often used. But how do we know whether a set of human activities is sustainable or not? Multiple activities with multiple impacts are occurring simultaneously. Changes are occurring both natural and man-made, one overlayed on the other. Those changes may occur over many hundreds of years. This paper will explore three different examples related to sustainability assessment.

Some scientists have said that the present time has the highest temperatures in the last thousand years. A recent paper has analyzed the work from 140 papers dealing with climate change from around the world. The workers looked at proxy indicators as an ensemble of individual indicators of long term climate change in the context of the „Little Ice Age” (1350 – 1850) and the „Medieval Warm Period” (700 – 1350). To the extent that such proxy records show a climate anomalie, what do such records say about the present period? Their analysis reveals that the 20th century is probably not a unique extreme climatic period, all be it a period of global warming. The work is controversial. However, those who are disturbed by the analysis have failed to provide an explanation for the climate in Viking times in the North Atlantic. Temperatures at 1000 AD were substantially warmer than at present, which permitted the Greenland colony of 6000 people to exist for over 400 years. As human impacts are assessed, what do we really know? How may that affect public policy?

The US has one of the highest rates of fire (including death) due to building fires in the world. As a result it uses some 45% of flame retardants in the world. One class of flame retardants, those containing bromine, have been identified as having potential environmental impacts. Some specific compounds have been found in nature. One result is that in Europe, „eco-labels” have included a bromine compound exclusion. Manufacturers of some products, such as televisions, have complied by removal of bromine containing flame retardants but without replacement by other flame retardants. Over time the net result has been that across Europe some 300 people are now dying from TV fires per year, a rate 10 times higher than the US. An environmental benefit, difficult to assess, has been shown to have a negative product safety impact with calculable human harm. Groups interested in one aspect are not in clear communication with those involved in studying other aspects of technological impact.

The third example deals with „precaution”. Can one truly take action „when there is no scientific evidence to prove a crucial link between emissions and effects”? A specific industrial hygiene example will be discussed. In the absence of some level of causal link one can make a meaningless or simply wrong decision. The US and European approaches to risk management have thus taken different courses with regard to the „precautionary principle”, although in practice their actions may actually be similar.

The three examples argue for the need for the best science, comprehensive science in sustainability assessment. In its absence the potential to make public policy which itself has a long term negative impact is clear. Scientific societies argue that regulation, e.g., environmental regulation, should only be made on the basis of sound science. True substantiality rests on an understanding of all those forces at work, both natural and human impact, over long periods of time. Nature is not constant. Human impact is not simple.

ECO-21: DEVELOPMENT OF A COMPLEX ENVIRONMENTAL PERFORMANCE INDICATOR FOR HUNGARY

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Aggregated (macro) indicators are widely use to describe the economic and social circumstances both at regional and international dimensions. Nevertheless, the development of complex environmental indicators has significant barriers in data availability and representativeness. The overall aim of the development of ECO-21 is to monitor the environmental pressures and the response policies in Hungary. The origin of ECO-21 is in the PSR model introduced by the OECD. The table below shows the indexes chosen to calculate the *P, S* and *R* macro indicators. It should be noted that the indexes (i.e. every single elements of the matrix) may be replaced by a more useful indexes.)

The significance of various indexes should not be equal, therefore a matrix of weights (weight factors of environmental significance and relevance) has also been introduced. Using an appropriate mathematical procedure, the *P, S* and *R* macro indicators are calculated as weighted averages.

Based on the time series of the indexes, the macro indicators were calculated for the period of 1990-2000. Finally, the time series of the macro indicators are shown and briefly analyzed. The major conclusion is that both the pressure and state macro indicators were the best at the mid 1990s and until a slight declining tendency may be identified.

	Environmental media						Responses
	Air	Water	Soil	Nature	Heal	Sector al footpr int"	

Pressures	Energy	Fossil fuel use	Water use in power gen..	Radioactive waste	Acid rain	-		Renewable energy resources
	Industry	Particle materials	Industrial water use	Dangerous waste	Open surface mining	Index industr. production		Companies with ISO 14000
	Agriculture	Methane from animal farms	Animal waste	Fertilizer use	Cultivated lands	Use of pesticides		Area of bio-farming
	Transport	Vehicle fuel use	-	Length of roads	Length of highways	Number of cars		Ratio of rail freights
	Households	Residential energy use	Sewage treatment	Household waste	Urban/rural index	Consumption index		bioproducts
	external	Global Warming Pot.	Quality of income water	-	International tourism	Ozone loss		
	Use of media						$P_{ECO\text{-}21}$	$R_{ECO\text{-}21}$
State		Dust Concentration	Nitrogen In lakes	Precipiation’s ph	Loss of leaves	Asthamatic illness	$S_{ECO\text{-}21}$	

POLICY RECOMMENDATIONS FOR SUSTAINABILITY RESEARCH PROGRAMMES

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A set of research programmes on sustainability research in Europe and elsewhere have been analysed through the Project AIRP – SD (STPA-2001-00007) deploying quality assurance procedures. The projects were analysed according to a methodology developed within the project that comprised an extensive list of criteria, and in general related to sustainability principles compliance.

Based on this evaluation, not only a refined methodology for evaluation of research programmes was established but also, policy recommendations for future sustainability research programmes were derived. Recommendations have been structured according to their relevance, requirements, and context-dependency elements.

The presentation will briefly browse the principles of evaluation, the main results and eventually policy recommendations.

WHAT KNOWLEDGE MANAGEMENT CAN DO FOR SUSTAINABLE TECHNOLOGICAL INNOVATIONS?

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Within the new paradigm of the “knowledge driven economy” (OECD 1999, EU 2000), knowledge turns out to be the dominating resource for the production added value. In this context Knowledge Management seems to be able to magnify the effective and efficient generation and use of knowledge as well as the transfer of knowledge into successful innovations. The March 1st 2002 started case study “Creation of Innovation by Knowledge Management” (CIKM research project funded by the EC’s IST program) is one of the first activities in this field. On the other hand and in the connotation with sustainability we find (of course very rarely) first approaches to Risk Management (FAR03), Experience Management (MIN02) und Competence Management (DIT03) as special kinds of Knowledge Management.

So Knowledge Management these days has become an entrepreneurial activity as well as an established academic discipline. Knowledge Management is enjoying a high profile and shaping the image of the information society to a large extent. “Ontology“, a term taken from philosophy, has provided major contributions to the progress of this discipline.

The success story of ontology within research on Artificial Intelligence and Knowledge Management, however, must not be over estimated. In many respects the current KM views are still too limited. The concept of knowledge is itself giving way, in ever wider areas, to the fashionable grip of Knowledge Management. However, knowledge management practices are often really just data management applications, and there is a considerable gap between formal models and real life business processes. Fundamentals of Knowledge Management are still lacking, as is a theoretical framework for the overall process.

Will we be able to build the fundaments auf a Basic Theory of Knowledge Management? Perhaps, images can help; Schrödinger considers them the main goal of science, Kuhn considers them able to organize paradigms. Thus, if I turn back to Plato (with some thesis), then only because of the expressiveness of his images. Hence, Plato is not my point, but a draft of a prototypical image for a discussion about the management of knowledge in a world of Sustainable Technological Innovations.

Plato's "Parable of the cave" is not a metaphor for the presumptuous-ness and the fictitiousness of any knowledge. It is the picture for the true position of the knowledge problem in sustainable technological development. There is a premonition of that it yields an idea of the contours of a yet missing theory of Knowledge Management (FRE03).

INTRODUCING ENERGY INNOVATIONS: STRATEGIES TO SUPPORT SOCIO-TECHNICAL TRANSFORMATION

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Energy systems in Europe (and many other parts of the world) are currently in a process of change. While energy markets are increasingly liberalised and at the same time new, decentral energy technologies are introduced, the role of users is in a process of change, too. With new energy service concepts the provision of energy can be customized to the specific needs and wants of users instead of just supplying a standardised product. Similarly, the implementation of decentral energy generation technologies directly at the site of the user, changes customers' roles within the energy system. Many of these new technical and organisational changes enable and promote innovations which also imply changes at a system level. The ensuing complex requirements of system adaptation are not possible without comprehensive social learning processes.

What does this mean for a support of the market introduction of sustainable energy innovations in such a changing environment? The paper will argue for a concept of the market introduction of innovations (i.e. not only new technologies but also 'social innovations' such as new energy services), which does not put its stakes on the marketing of a finished product, but which understands technology diffusion as a social learning process, which encompanies the co-evolution of technology and its social context. Introducing new energy technologies or new services in most cases means transforming socio-technical systems – expectations of users and other actors, social practices evolving around technologies, new meanings and changes required in the institutional context of technologies.

The paper will compare a number of strategies and methods to organise and improve learning processes shaping the introduction of new technologies in the energy sector: strategic niche management, the management of transition processes in the energy sector, 'serial' focus groups (as applied in a project on green electricity labels in Switzerland), the societal embedding of technologies or consumer constructive technology assessment (a format developed in the Netherlands and e.g. used for the assessment of the energy-efficiency of smart homes in Austria). All of these strategies aim at social learning processes and socio-technical experiments, i.e. at decision making in an uncertain context and at more flexible, adaptive and reflexive forms of policy making.

FROM THE PURSUIT OF HAPPINESS TO THE PURSUIT OF SUSTAINABILITY

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In this foresight working paper, I outline the advantages and limits of the two conventional regulatory societal conflict resolution mechanisms, e.g. market-regulation and national governmental regulatory capacities with a view on how to achieve sustainable development. After clarifying how we should understand the objective of sustainable development, we make the case for a third international arena of long-term planning which could overcome the current contradiction between the demands of democratic decision making and long-term planning and would complement the arena of the market and of national governmental regulation. Subsequently I will elaborate on 6 constitutional elements of such an arena, among others, international public debate, constitutional changes at national an international treaty level, science for sustainability, technology assessment and foresight strategies and system innovations. Finally I list a range of research topics which could underpin the emergence of the postulated third arena.

KNOWLEDGE SYSTEMS IN SUSTAINABILITY TRANSITIONS

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How do long-term global trends affect a transition to sustainability? We emphasize the "multitrend" nature of trajectories, which makes them complex, contradictory, and often poorly understood. Each cluster of them includes trends that make a sustainability transition more feasible as well as trends that make it more difficult. Taken in their entirety, they serve as a checklist for the consideration of global trends that impact place-based sustainability studies. Some long-term trends in nature and society serve as currents along which we can navigate directions toward this century's sustainability transition. This transition is seen as one where a stabilizing population of the region meets its needs and reduces poverty while maintaining the regional [and the planet's] life support systems and living resources. "Bending the curve," accelerating favorable trends, slowing harmful trends, understanding complex trends, and noting changes in direction and inflection that constitute significant departures are among the grand challenges of sustainability science. A core question of sustainability science for regional environmental planners asks, "How are long-term trends in environment and development, including consumption and population, reshaping nature–society interactions in ways relevant to sustainability for one nation for of a group of nations?"

Thus a central task of sustainable development will be to accelerate the trends that favor a transition and slow the trends thatimpede them. Because sustainable development takes place locally rather than globally, an important task for a place-based sustainability science is to identify the specific trends most relevant to such places and the ways in which local populations can contribute to altering the trendsthat affect them.

Given the tendency of participants in contentious public dialogues to selectively note only the specific trends that support theirpoint of view, it is the responsibility of sustainability science to map the broad, inclusive, and contradictory currents that social actors will need to navigate toward a just and sustainable future.

Earlier work on the determinants of effective scientific advice in the environmental arena has established three points ofdeparture for the work reported here. The first is based on historical analyses of environmental issues that trace their emergence from initial scientific discoveries to high-level policy agendas. This work suggests that the "effectiveness" of scientific inputs needs to be gauged in terms of impacts on how issues are defined and framed, and on which options for dealing with issues are considered, rather than only in terms of what actions are taken to address environmental problems. The same work shows that perspectives of a decade or more may be necessary to reliably evaluate the impact of science, technology and ideas on issue evolution.

Our second point of departure is based on evaluations of scientific advice in general, and environmental assessments in particular. It suggests that scientific information is likely to be effective in influencing the evolution of social responses to public issues to the extent that the information is perceived by relevant stakeholders to be not only *credible*, but also *salient* and *legitimate*. In the sense used here, *credibility* involves the scientific adequacy of the technical evidence and arguments. *Salience* deals with the relevance of the assessment to the needs of decision makers. *Legitimacy* reflects the perception that the production of information and technology has been respectful of stakeholders' divergent values and beliefs, unbiased in its conduct, and fair in its treatment of opposing views and interests. Our work shows these attributes are tightly coupled, such that efforts to enhance any one normally incur a cost to the others.

Finally, some of our preliminary studies have identified the importance to effective science advising of "boundary work" carried out at the interface between communities of experts and communities of decision makers. This work highlights the prevalence of different norms and expectations regarding such crucial concepts as what constitutes reliable evidence, convincing argument, procedural fairness, and appropriate characterization of uncertainty. It points out the difficulty in effective communication between the communities that results from these differences, and stresses the importance for effective advising of explicit development of boundary-spanning institutions or procedures.

SUSTAINABILITY IN ONE COUNTRY- RATIONAL APPROACH OR COMPROMISE OF NECESSITY

The Hungarian Case

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"There is still great uncertainty, however, about what a sustainable future must be like and what kind of changes are needed in the industrial nations to reach it." (Olson 1995, p. 20). Olson's vision is not too reassuring, though I find it quite realistic. We cannot deny that attempts have been made recently to incorporate the concept of sustainability in policy planning at both national and international levels, yet they are often based on far too vague criteria.

Despite the uncountable attempts of defining it, 'sustainability' still remains a vague term, which is used in very different circumstances to mean many different things. According to the underlying assumptions, diverse constraints will in fact have to be respected in order to satisfy appropriate sustainability criteria. The specification of the necessary conditions to achieve sustainability in various situations is therefore of more use than the definition of the term itself.

In contrast, the incorporation of sustainability on political agendas often seems to lack a precise theoretical framework, as proved here by means of analysing national strategies for Sustainable Development of in different European countries. Issues like intergenerational equity and capital and/or resource substitutability, which are of fundamental importance in the 'theory' of sustainability do not find any resemblance in the 'practice' of it. As a result, *sustainability* policies do not significantly differ from traditionally established *environmental* policies.

By analysing national strategies of single countries, we shall be able to identify problems and contradictions encountered by policy makers in the attempt of incorporating sustainability in their programmes. We should thus see whether in these official documents theoretical principles are better integrated with idealised principles, whether policies for sustainable development have really given a new imprint to traditional environmental policies and, if so, what the rationale behind such imprint is.

The completion of national strategies for sustainable development has in fact certainly had the positive effect of stimulating the implementation of more systematic approaches for the solution of environmental problems. Nonetheless, issues of intergenerational equity and substitutability, which are the core essence of sustainability, have not been formally dealt with in the design of policies for sustainable development. As a result, those policies do reflect an increasing concern for environmental protection and careful development, but they are not built on any new criteria.

The distinction between environmental and sustainability concerns is not made clear on the political agenda and as a consequence the realisation of sustainable development does often correspond simply with efforts towards the internalization of environmental costs, resource conservation and some kind of 'respect' for future generations.

The question that remains open though is whether problems and contradictions related to the concept of sustainability and its accomplishment derive from conceptual confusion, operational difficulties (like for example the determination of sustainability indicators) or people hypocrisy and cynicism.

TEACHING SUSTAINABILITY

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Currant university philosophy requires that the instruction it provides be highly focused and specialized. Our students, however, live and work in a world where information from several disciplines must be integrated. Finding solutions to complex problems related to living sustainability requires today's student to be exposed to techniques of teaching that directly involves them in diverse, interdisciplinary collaboration. Professional as well as lay persons need to be prepared to function in a multi-disciplinary framework where sound problem-solving and decision-making skills are a priority. Such an approach enables graduates to apply their learning to the needs of real world problems and real people. Cross-disciplinary education increases the students' awareness of issues and methods beyond their own disciplinary inquiry, enabling them to explore the interrelationships of these issues and methods. Florida Institute of Technology has developed curricula to emphasize the connectivity among scientific, social, economic, technological, and cultural experiences, demonstrating the relationships between high quality environments and the other aspects of people's lives. Through this approach, students become more aware of and sensitive to the obstacles to a sustainable future for our global society with comprehensive science as the base and then applying it in real life and real problems scenarios. The curricula for "Ecology of a Changing Planet" is discussed.

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