本田財団レポート No. 94

持続可能な発展において応用するための

知識の学際的な統合

スロヴェニア共和国 リュブリャナ大学
国際化学研究センター 理事長
アレクサンドラ・コルンハウザー教授

Multidisciplinary Synthesis of Knowledge

for applications in sustainable development

Professor Aleksandra Kornhauser
Professor of University of Ljubljana, Slovenia
Director of International Center for Chemical Studies-ICCS

財団法人 本田財団

アレクサンドラ・コルンハウザー

リュブリャナ大学教授
国際化学研究センター理事長

Aleksandra Kornhauser

Professor, University of Ljubljana and Director, International Center for Chemical Studies-ICCS

■略歴

1926 年	スロヴェニア、スコフィア・ロカで生まれる
1945～54 年	学校教師、産業界での勤労
1955～65 年	働きながらリュブリャナ大学　定時制学生として化学を専攻、65 年化学博士号取得
1965～69 年	リュブリャナの教育アカデミーの化学教授、アカデミー学部長
1969 年～	リュブリャナ大学　化学教授
1974～78 年	スロヴェニア研究コミュニティ会長
1978～84 年	国際科学組織評議会 科学教育委員会 副会長
1980～82 年	欧州化学学会連盟 化学教育委員会 委員長
1980 年～	リュブリャナ大学　国際化学研究センターの理事長
1988～90 年	ユーゴスラビア科学促進協会　会長
1993～96 年	国連開発計画（UNDP）による環境と持続可能な開発に関する指導トレーナー
1998 年～	国連大学　評議会メンバー

■受賞歴

スロヴェニア共和国・国家科学賞（最高の国民栄誉賞）
米国化学学会（ワシントン）ロバート・ブラステッド記念賞
薬学アカデミー（パリ）ローラン・ラボワジエ賞
オーストラリア化学学会・デービット・メロール・メダル

■会員資格

アカデミア・ユーロペア創設会員
世界芸術科学アカデミー会員
第三世界科学アカデミー会員

●主な著書：

研究、教育の分野、および知識の製造工程や製品の清浄化
技術開発への応用などの分野で、200 以上の出版物

■Personal History

1926	Born in Skofja Loka, Slovenia
1945～54	Working in school and industry
1955～65	Employed and part-time student, University of Ljubljana, Doctorate in Chemistry, University of Ljubjana (1965)
1965～69	Professor of Chemistry and Dean, Academy of Education, Ljubljana
1969～	Professor of Chemistry, University of Ljubljana
1974～78	President, Research Community of Slovenia
1978～84	Vice-President, Science Education Committee, International Council of Scientific Unions
1980～82	Chairperson, Chemistry Education Committee, Federation of European Chemical Societies(Frankfurt)
1980～	Director, International Center for Chemical Studies University of Ljubljana
1988～90	President, Yugoslav Association for the Advancement of Science
1993～96	UNDP Lead-Trainer for Environment and Sustainable Development
1998～	Member, United Nations University Council

■Awards

State Award for Science, Republic of Slovenia (highest national award)
Robert Brasted Memorial Award, American Chemical Society, Washington
Laurent Laboisier Awards, Academie de Pharmacie, Paris
David Mellor Medal, Australian Chemical Society

■Memberships

Academia Europaea (Founding member)
World Academy of Art and Science
Third World Academy of Science

●Major Publications

Over two hundred publications on research, education and transfer of knowledge for development of cleaner processes and products

MULTIDISCIPLINARY SYNTHESIS OF KNOWLEDGE
for applications in sustainable development

Commemorative Lecture at the conferring ceremony of the Honda Prize
on the 17th November 1999 in Tokyo

Professor Aleksandra Kornhauser
University of Ljubljana, Slovenia

There are rare moments in one's life when memories are particularly clear, revealing pleasure and doubt about the work done, and triggering ambitions for the future - an urge to create, combined with strong feelings of responsibility.

Receiving the Honda Prize is such an occasion. Being honoured by this prestigious and globally highly respected award, brings me a great joy. At the same time, joining the brilliant Honda Laureates, fills me with deep humility.

I would like to express my sincere gratitude to the Honda Foundation, and especially to its President, Mr. Hiromori Kawashima and the members of the Jury. Allow me to thank also the excellent staff of the Honda Foundation, Mr. Hiromitsu Miyahara and Mr. Masaru Inoue, for their high level of professionalism in making all the arrangements for this ceremony.

"There are no limits to quality" was the *credo* of the creator of the Honda Foundation, Mr. Soichiro Honda. This quality principle, defining activities of the Foundation at its start a quarter of a century ago, is today widely recognized as the greatest hope for achieving sustainable development, for which the protection and improvement of the environment are pre-conditions. It is now time to apply this quality principle on a global scale. Receiving the Honda Prize alerts me to my increased responsibility.

To achieve sustainable development, women scientists need to take a strong lead in efforts to change the "global intolerables" into developmental opportunities: for turning population explosion into reproductive health, poverty and environmental degradation into sustainable development, and violence into peace and cooperation. As the first female Honda Laureate, I have an inner need to express my deep respect to Lady Honda for all that she stands for. I feel a strong obligation to cooperate in engaging the talent of women worldwide for the contribution to the development of science and eco-technology, and for humanistic understanding of their role - a belief of Lady and Soichiro Honda which obliges us all.

The whole world has learnt from the leadership of Japanese Government how to make science a most important driving force for development, and how to share the experience internationally. I am therefore deeply honoured by the congratulatory greeting of Mr. Hiroo Imura, representing here the Council for Science and Technology at the Prime Minister's Office. It is not accidental that the United Nations University, promoting the idea of linking basic and applied research with development for the benefit of the whole of mankind, has its centre in Tokyo, and enjoys intellectual and material support from Japan. I would like to express my joy that the Rector of the United Nations University, Professor Hans van Ginkel, is today among us.

And finally, a tree can only develop a lush crown if it is deeply rooted. Allow me therefore to mention my beautiful home country, represented here by his Excellency, the Ambassador of Slovenia to Japan, Mr. Janez Premoze. Slovenia, located on the sunny side of the Alps, is geographically so tiny that it hardly can be found on the map of the world. Far too small to be a power on its own; but with its openness and concern for development, Slovenia is very appropriate to serve as an efficient bridge between West and East. Our people deeply appreciate the combination of Japan's high technology with great environmental culture which led to the concept of eco-technology, and we wish to nurture closer cooperation. The Slovenian universities and research institutes, and particularly the International Centre for Chemical Studies (ICCS), where a large part of my work has been carried out in cooperation with my colleagues, will make all possible efforts to open new doors.

* * * * *

Understanding the concept of sustainable development

The concept of sustainable development is all too often vague. It is mostly understood as an urgent need to protect the environment by limiting the world's consumption, particularly of non-renewable resources. The developed world, in reality, is not very enthusiastic about this requirement, whilst developing countries oppose limitations with the well-justified statement that they have lived at the lower limits of consumption for long enough and have the right to take a greater share in future. Similar is the situation in the countries in transition where the collapse of the economy has caused a most severe social crisis and the problems of future development are overshadowed with the struggle for daily survival. A model of limits does not generate enthusiasm.

The difficulties in accepting the principles of sustainable development can be better understood in the light of "four global intolerables":

- *Population growth* is still exponential - on 11 October, it was reported that the world's population has reached six billion. This causes increasing demand for wealth.

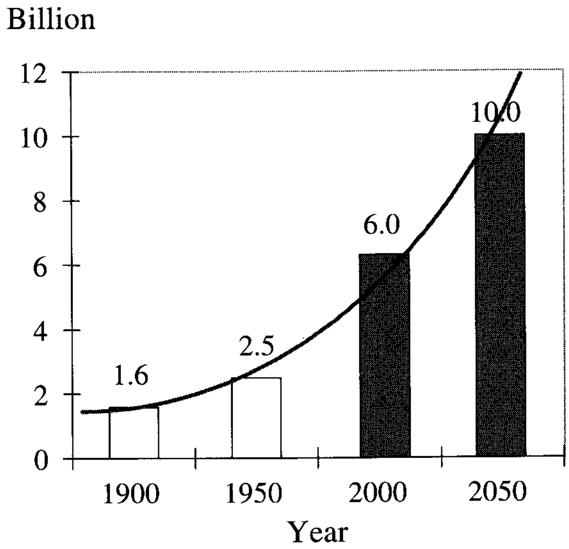

Figure 1. Our increasingly crowded planet

- *Poverty*, which is to a large extent the source of the third intolerable - *violence,* persists: less than 20 % of the global population belongs to the developed countries with GDP over 30,000 USD per capita. Another 20 % of the world's population form the poorest group with GDP well under 1,000 US$ per capita. Calls for much greater help to the poor countries are therefore more than justified, bearing in mind that global (international) aid represents less than 2 % of the global armament expenditure. However, the sometimes extreme calls for an egalitarian re-distribution of the global GDP are unrealistic; not only that this would not be easy to carry out, the result would be disappointing: poverty for everybody.

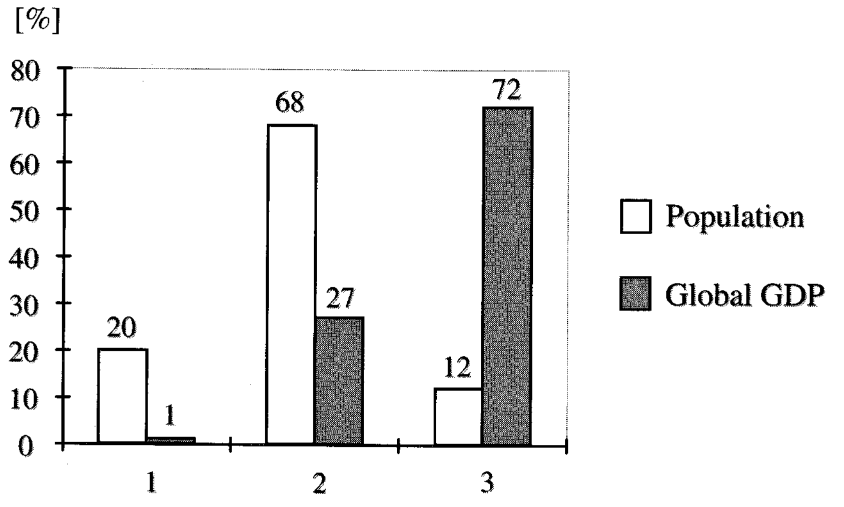

Figure 2. Global GDP distribution

- *Environmental degradation* caused by pollution and over-use of natural resources is in fact the consequence of the three previous "intolerables", worsened by human greed.

A different approach to sustainable human development is needed. *Development* must be an optimistic promise for a better life for all people. *Human* should mean another value system giving more weight to non-material richness, introducing a deeper respect for the environment and greater responsibility and solidarity among people. *Sustainable* should mean primarily *better*, i.e. quality of processes, products and human relations. This quality will allow a higher living level for everybody to be reached with lower consumption of non-renewable resources. Sustainable human development should therefore be understood as progress through quality in every human activity.

For achieving higher quality, we need better knowledge. We need achievements of science and technology, of social sciences and humanities. To recognize quality in humanistic terms, we need an improved value system, based on the best local, national and global cultural achievements. Only knowledge interwoven with values creates wisdom. Eco-technology - a crucial condition for sustainable development - has therefore to be widely understood in its scientific, technological, economic and humanistic dimensions.

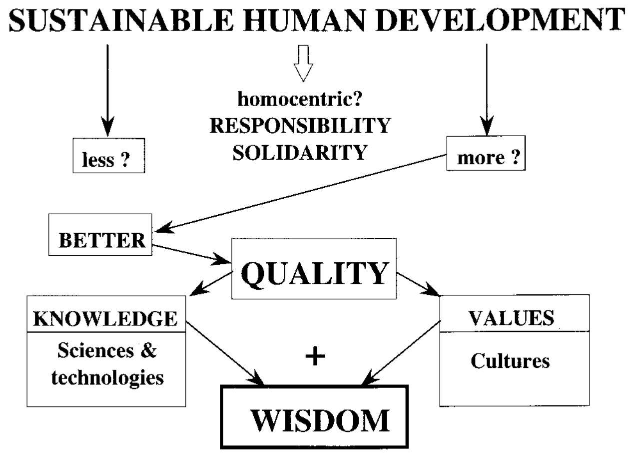

Figure 3. Concept of sustainable human development

Time to integrate research and education with innovation

Sustainability of development, which will define our future material and social living level, can be achieved only by creating a *knowledge society.* The main characteristic of this society is permanent innovation, a process of continuous change affecting every aspect of our life. Innovation which is usually defined as a successful application of knowledge or techniques in new ways or for new purposes, has a key role in new wealth creation.

Innovations are often proclaimed with great enthusiasm, however when it comes down to practice, they are - particularly in less developed environments - more often than not resisted. Usually, there are mainly barriers in the mind which prefer the existing, rather than new developmental strategies. The main task for sustainable development is therefore to prepare the mind for change and permanent striving for improvement. This includes continuous enrichment of knowledge and skills in every individual, and application of new knowledge to processes, products and services.

Universities, which were since ever centres of scholarship, have to take the lead. Today, they have to extend their function fully to integrate research, education and innovation, and to attract other centres of knowledge into cooperation. University - industry cooperation is of particular importance since the driving force in technological innovation is new scientific knowledge. The resulting new technologies drive development of new processes, products and services. More awareness needs to be created that these need to be successful at the market to trigger new investment into research and development. Industrial investment is proportional to the success of commercial activities.

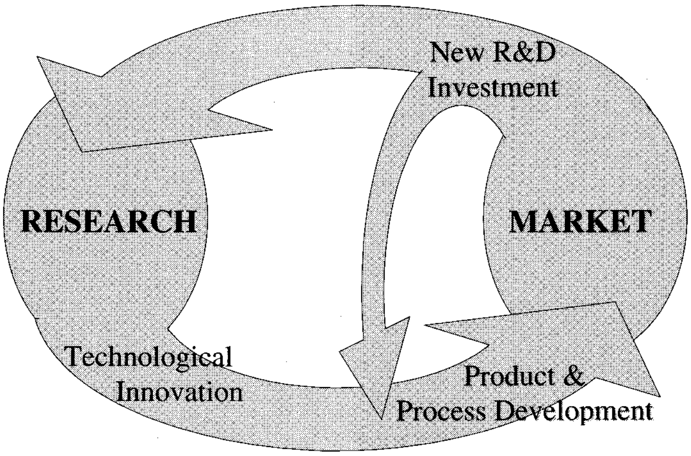

Figure 4. Cycle of innovation

Contemporary universities are therefore exposed to growing expectations for the abilities of graduates and postgraduates:

- development of critical thinking, a most characteristic goal of all university curricula, must be combined with solving problems in practice;

- innovative skills must be developed alongside entrepreneurial abilities, if research is to be used for creating national wealth and social harmony;

- communication skills, which are all too often neglected, must be carefully cultivated in all areas - written, oral, visual, electronic - with the aim to promote wider understanding, team work enabling development of group intelligence, and leadership;

- and last, but not least, knowledge has to be integrated with cultural values - local, national, global - which will result in wisdom needed for a wider transfer of scientific results into processes for enhancing the quality of life.

The needs of sustainable development offer great opportunities for development of universities' innovative potential: they challenge scientific creativity, economic entrepreneurship and realization of ethical norms. However, there is a requirement for a major change: deep knowledge in a specific discipline must be considered only as a partial view of a real problem. It must be combined with understanding and inclusion of the achievements of other disciplines to reach the level of multidisciplinary synthesis leading to synergetic results.

There are no "great solutions". Realization of sustainable development is like building a gigantic mosaic with very small stones - billions of efforts are needed, each one fulfilling the basic criterion of meeting human needs without endangering the future.

Some examples of such "small stones", built by the team of the International Centre for Chemical Studies in Ljubljana, Slovenia, are briefly described below. None of them could be achieved in a traditional monodisciplinary approach. Information methods supporting the multidisciplinary synthesis of knowledge were developed and applied in design of cleaner processes and products, as well as in toxic waste control, processing and prevention.

Introducing and promoting control of toxic waste

The global toxic waste problem is often underestimated. We are more concerned with the prospect of using up primary natural resources (even if many of them could be - and some already are - replaced with new materials), than with accumulation of toxic waste and its spreading causing dangerous pollution.

ZERI, i.e. Zero Emmission Research Initiative, a movement strongly supported by the United Nations University, is a promising eco-technological activity, with an important contribution from Japanese researchers and industrialists. However, great efforts and many years will be needed to develop it globally to the level at which toxic waste will cease to be a problem. Till then, we have to bear in mind that toxic waste, particularly in the countries with weak control over its generation and disposal, represents a major danger, causing most serious water pollution.

It is roughly estimated that, worldwide, over one million tonnes of hazardous (to a large part toxic) waste is generated every day (nuclear waste not included). Its quantities usually increase with the growth of energy generation, mining, foundries, metal manufacturing and finishing, electronic industry, chemical and pharmaceutical industries, paint production and use, soap and detergent production, porcelain manufacturing, pulp and paper production, textile mills, rubber processing, etc.

Figure 5. In many industries with no programme for management of toxic waste, the waste is deposited in the courtyards in drums which, as time goes by, corrode and start leaking

However, large industries are not the only generators of toxic waste. Pesticides in agriculture belong to the most toxic group of substances, many reaching the toxicity of chemical warfare agents; leather tanning and finishing can cause dangerous water pollution; small electroplating firms often do not properly dispose of their highly toxic waste; timber processing contributes to the pollution with toxic organic compounds; used batteries may cause serious environmental problems; hospital waste, if not properly treated and disposed, can endanger the population, particularly children who very often play on waste dumps.

Nobody knows what are the exact quantities of hazardous waste (often called *special waste* to avoid political problems) generated daily worldwide, or what are the quantities of already existing toxic waste deposits. Waste generators usually do not like to disclose this information to avoid public opposition and legal consequences. They also fear that clean-up will bring high costs which could increase prices of their products and decrease their competitiveness at the market. Even some governments, under pressure of economic problems, are often reluctant to take initiative for minimization and proper treatment of the toxic waste accumulated.

To mobilise governments and industry for toxic waste control as the first step towards its minimization and management, a *Register of Special Waste* was designed, tested and implemented. This is an integrated information systems consisting of a database on firms and their production potentially generating special waste, supported by databases on toxic substances, regulations, water pollution control, and waste processing technologies. The design of this integrated system was a multidisciplinary endeavour, bringing into cooperation chemists (technologies, analyses, photodegradation), biologists (toxicity, biodegradation), industrial experts (data on industries), statisticians (national and international statistical comparisons), legal advisers (regulations), civil servants (implementation of regulations), economists (economic consequences) and politicians ("art of possible").

Waste generators have to report annually by answering a questionnaire which is designed as a "birth certificate" for the control of toxic waste generation, processing and disposal, following toxic waste "from cradle to grave".

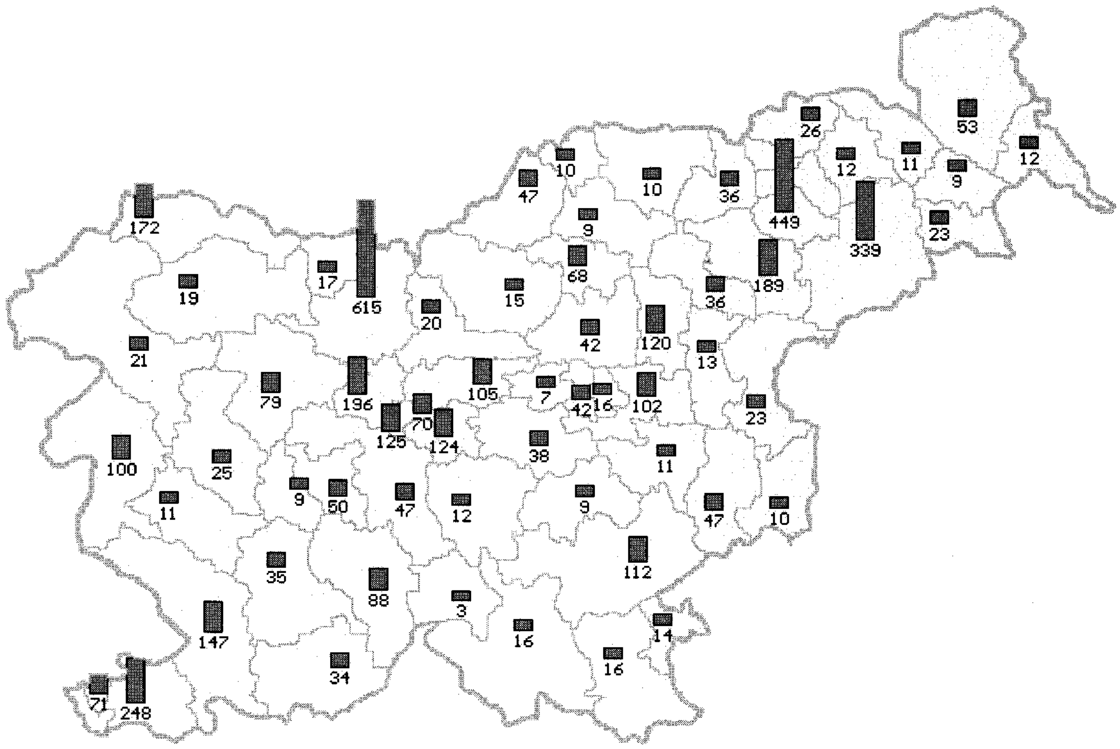

Figure 6. Results of special waste control are accessible from the Register database in numeric and graphic presentations An example from Slovenia

The answers to questionnaires are analysed in comparison with the production (type of technology, yearly production), and the verified data included into the database which serves local and national governments and waste generators for:

- control of special (toxic) waste, its generation and disposal,

- orientation for design of legislation and application of regulations,
- planning waste minimization and processing,
- decision making for introducing clean(er) technologies, or closing down highly polluting processes.

The data which are not consistent with expectations, and the missing data, attract special attention. They are verified or completed by comparison with similar production in countries with efficient toxic waste control and management.

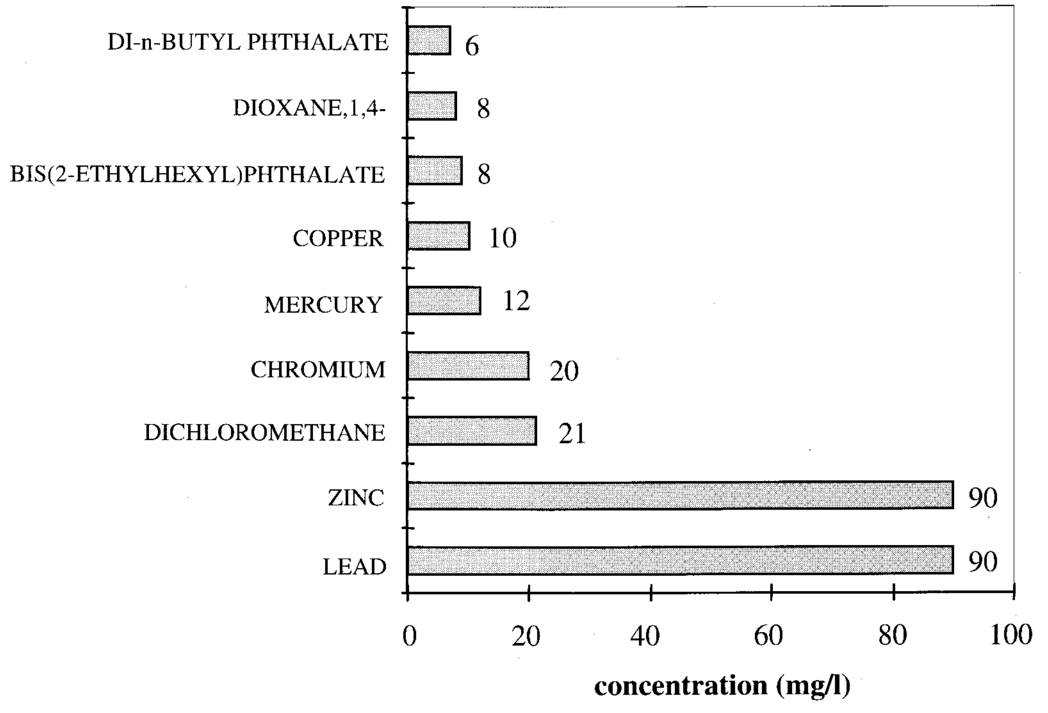

Figure 7. Expected pollutants from an industrial process (paint industries) in wastewater before treatment

For water pollution control and prevention, a relational database on river water pollution was developed. The specific goal was to support the rapid identification of toxic pollutants and their possible damaging effects in rivers, and - in broader terms - to provide automatic classification of water quality. The procedures in the building of this database include the methodology of (1) how a problem can be defined, (2) how a targeted search for data can be carried out, (3) how a conceptual structure for the organization of information can be designed for enabling recognition of relations between causes and consequences, and (4) how an information system can be built, tested, optimized, regularly updated and applied. These could be achieved only by multidisciplinary cooperation of chemists, biologists, hydrologists, computer scientists and, last but not least, experts from industry.

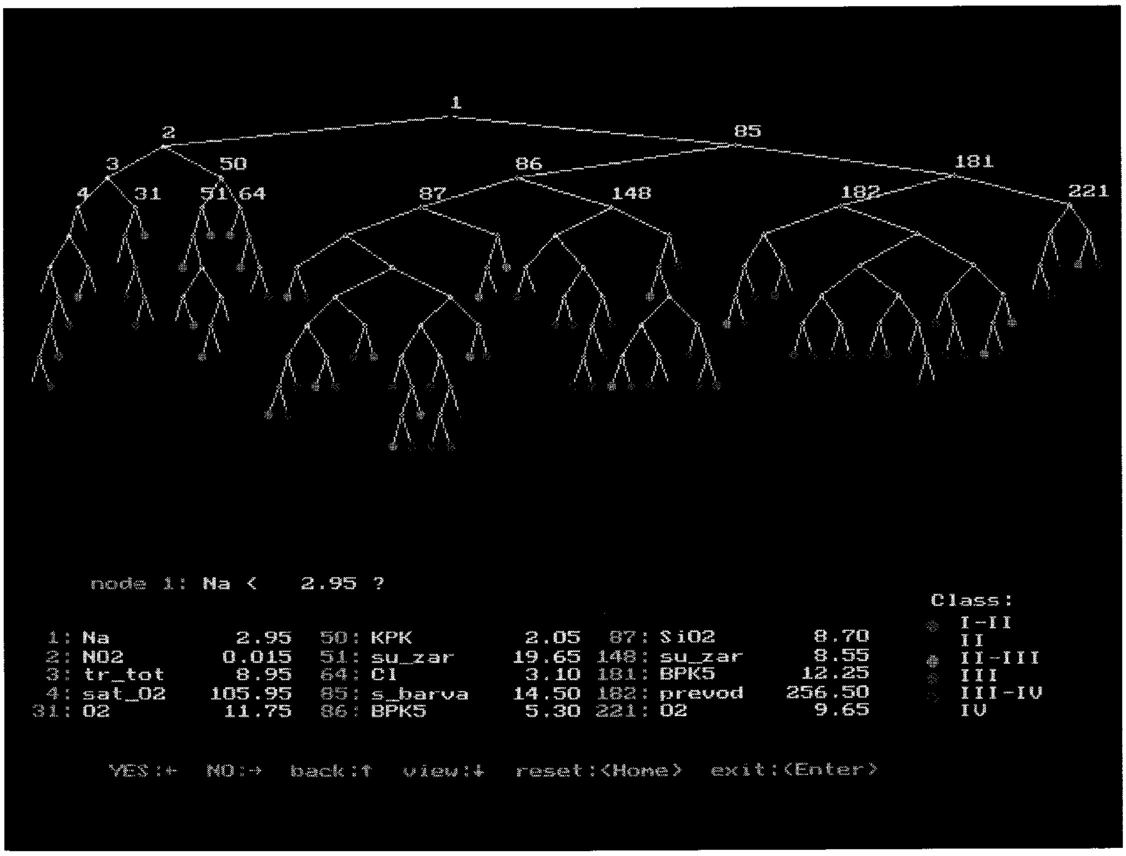

Figure 8. Classification tree for water pollution control

As long as eco-technologies are not prevailing globally, we have to push the toxic waste management from *ignore* via *control* and *clean-up* towards *prevent* to reach *eliminate.*

The *Register of Special Waste* was - through workshops and postgraduate training programmes in cooperation with UNDP, UNESCO and The World Bank - introduced for initiation of toxic waste registration in 42 countries (17 European countries in transition, 11 Asian and 14 African countries).

Supporting efficient toxic waste incineration

Once the dangers of toxic waste have been recognized, and the problem defined by waste registration and regular control, practical solutions have to be found for specific socio-economic conditions in different countries. For developing countries and countries in transition, where the economic conditions are very harsh, ambitions to introduce capital-intensive toxic waste processing technologies have no realistic basis (a specialized incinerator costs between 50 and 100 million USD). The main effort must be the mobilization of people, producers and consumers alike, for prevention of toxic waste generation, or at least for its minimization. However, even in the most positive circumstances, there is still some toxic waste remaining to be treated. Besides, many countries have large amounts of toxic waste which has been accumulated over decades.

A relatively new and efficient technology is incineration of toxic waste in cement kilns. It has been developed and applied in many industrialized countries, requiring relatively small investment of 1.5 - 2 million USD for adaptation of the rotary kiln. There are many advantages in using this technology, e.g.: cement industries are available in most countries, kilns operate at high temperatures up to 1500 degrees Celsius and enable efficient destruction of toxic waste, gas retention time is 4 - 5 times longer than in commercial kilns, acid components are neutralized by alkaline clinker, most inorganic components are bound in the cement, and organic waste incinerated enables a considerable saving of fossil fuels needed for cement production. Relatively small limitations are substances from waste which could harm equipment (e.g. those with high chlorine content), or disturb the final product (some metals disturb the structure of cement). The main limitation, however, is the mistrust of the local community, fearing that toxic emissions will endanger their health.

A sound analytical system for the control of toxic waste incineration in cement kilns has to be applied. However, complex analyses are usually expensive (I heard industrialists saying : *These analyses will drive us into bankruptcy)* and not easily understood by non-specialized local representatives which often demand to be a part of the supervising body.

To help increase the analytical reliability and decrease the costs, ICCS developed a computerized analytical support for incineration of toxic waste in cement kilns, with the segments shown in Figure 9:

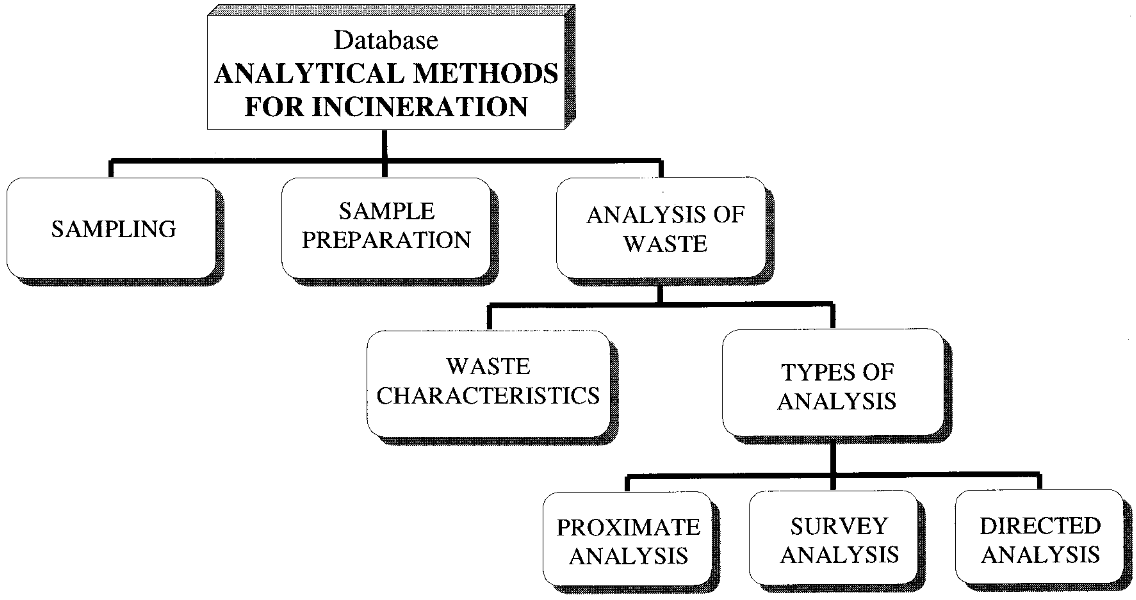

Figure 9. Structure of the database on analytical methods for incineration of toxic waste in cement kilns

The analytical methods are foreseen not only for the determination of dangerous compounds in waste and stack gas, but also for the control of parameters which could have an impact on the environment and product quality.

Defining the analyses needed, and their hierarchical order, for each phase of the production process, was the most demanding task. The result is a computerized analytical support system, including sampling and sample preparation, with the main part including analyses for raw materials, primary fuel, secondary fuel (waste), incineration products and final product - cement. Joint chemical, biological, technological, environmental, legal and economic consideration resulted in an optimized system with three levels according to their sequence, relevance and accuracy:

- obligatory procedures to be executed for every charge of waste at its incineration (fingerprint analyses),
- optional procedures to be implemented when obligatory procedures show the need for additional control,
- additional procedures to follow specific parameters.

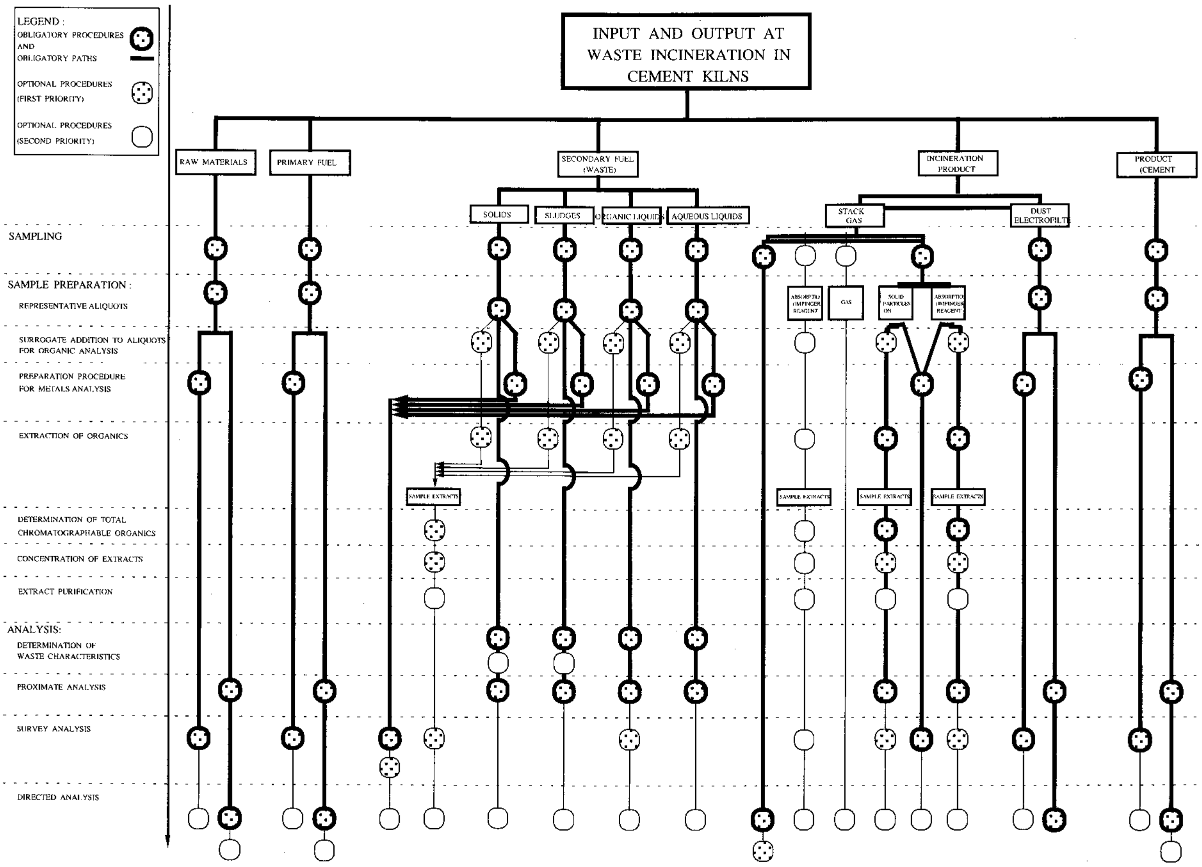

Figure 10. Scheme of the analytical system for waste incineration in cement kilns

Reducing toxicity of agrochemicals

Agrochemicals, particularly highly toxic chemical pesticides polluting water, soil, air, and even agricultural products themselves, are a major environmental problem. It is reported that less than half of the quantities used reach the target plants, and less than 1 % hit the target pests themselves. The rest of the pesticides is carried away by wind, evaporation, leaching, rainwashing, degradation, or lost on non-target areas. A threatening consequence is pollution of ground waters endangering drinking water supplies. Human health and biodiversity are at stake. Eco-technology approaches are greatly needed.

The efforts of researchers are particularly oriented towards higher effectiveness on pests, improved selectivity towards target pests and reduced toxicity towards non-target organisms, and better biodegradability.

A major project of the ICCS research team is microencapsulation of pesticides and other agrochemicals for the preparation of controlled-release formulations which enable the same effect on pests with much smaller doses of a toxic substance.

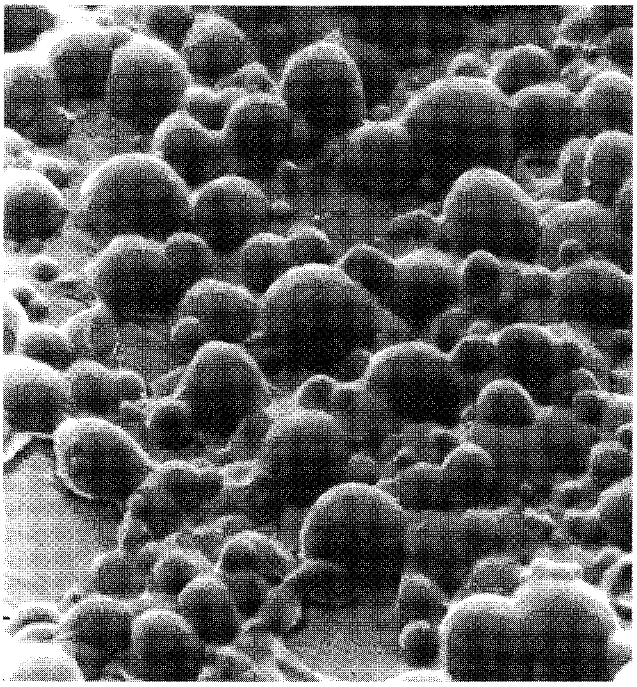

Figure 11. Microcapsules (ICCS, scanning electron micrograph, 630x)

The active substance - a pesticide or other agrochemical - is dispersed into small nuclei which are coated with protective spherical membranes by polymerisation or coacervation methods. These membranes are permeable enabling prolonged controlled release of the active substance into the environment, and much longer lasting effect with considerably smaller quantities of toxic compounds. They are released from microcapsules on plants by evaporation or dissolution. Microcapsules need first to stick to the plants, enabling targeting of pests , less rainwashing and prevention of premature photodecomposition. After a defined period, the active substance has to be used up and the remaining capsule wall material washed off the plants.

Development and applications of microencapsulation technology, which is not capital-intensive, is also a very promising field for innovative approaches in university-industry-agriculture cooperation. It offers a very wide range of opportunities for development in agriculture, food industry, chemical and pharmaceutical industry, cosmetics, graphics and printing, textile industry, increasingly also in biotechnology. Solving problems of permeability of microcapsule wall materials, composition and decomposition of core materials, design and efficiency of microencapsulation processes, and targeting applications with special care for protection of non-target organisms, offer many challenges to university students and teachers for research and development in which multidisciplinary synthesis is a *conditio sine qua non.*

Strong information support is needed for such an approach. ICCS has therefore developed, in cooperation with industry, an integrated information system on microencapsulation.

Figure 12. ICCS information system on microencapsulation: an example of applications in agriculture

To help the development of original production processes, information support for the comparative analysis of existing procedures has been developed by ICCS. It is based on structuring information of single patents, with comparison of their structures to find out the common backbones of already patented procedures, and identification of hypothetical niches for new developments. It is aimed at helping universities, particularly in developing countries, in their efforts to integrate research and education with innovation.

Developing non-toxic pesticides

Chemical pesticides, particularly insecticides, acaricides and fungicides, are widely used because of their strong effects on pests, and their low price. However, in addition to dangerous environmental pollution, they cause development of pest resistance which results in the use of ever increasing quantities of the same, or development of new, usually more toxic pesticides.

Biological (microbial) pesticides, mostly selected natural parasites of pests - fungi, bacteria and viruses - are more environmentally friendly and selective to target pests. However, their action is usually slow and sensitive to climatic changes, and they require well educated users.

The least known group are the pesticides with physical action. In the past, mineral and selected plant oils have been used. They act by physical suffocation of pests which does not allow development of resistance. However, they leave a persistent oily film which sticks to the plant surface, and reduces evaporation and transpiration.

A non-toxic pesticide has been developed by the ICCS team. It is based on potato starch dextrin produced by precisely controlled acid hydrolysis of starch. This part of the process was developed by chemists, resulting in low viscosity, high solubility in water (over 97%), and strong film forming capacity of the end product. The pesticidal effects of aqueous dextrin formulations were tested on numerous plants *in vivo* in laboratory by biologists, and in the field by agricultural experts.

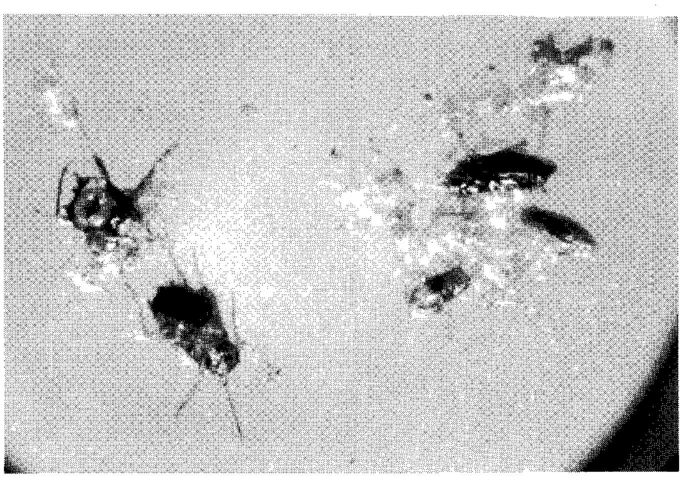

Figure 13. Testing pesticidal activity in laboratory conditions

All groups interacted during the whole development, reporting on problems which demanded further applied, and also basic research. Examples were drying and cracking off the dextrin films followed by peeling off from plants together with the dead pests, potential effects of dextrin film on plant physiology, and particularly scaling up the process to the pilot plant production level.

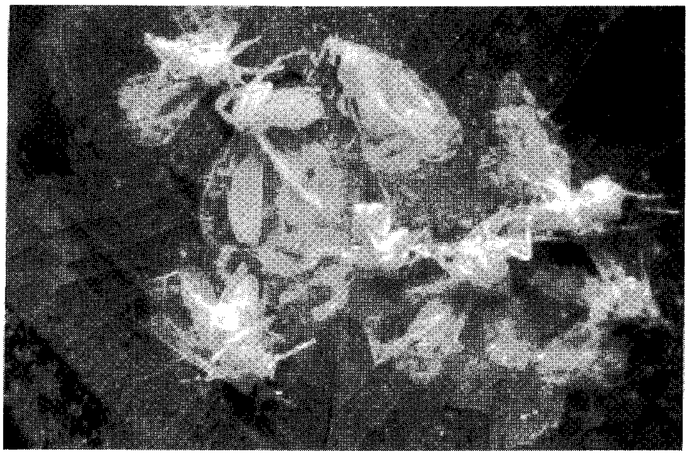

Figure 14. Dried and cracked pesticide film with dead pests

Once the production process was optimized, applications were developed, e.g. for vegetables, ornamental plants, fruit trees, vine, and even mushroom production.

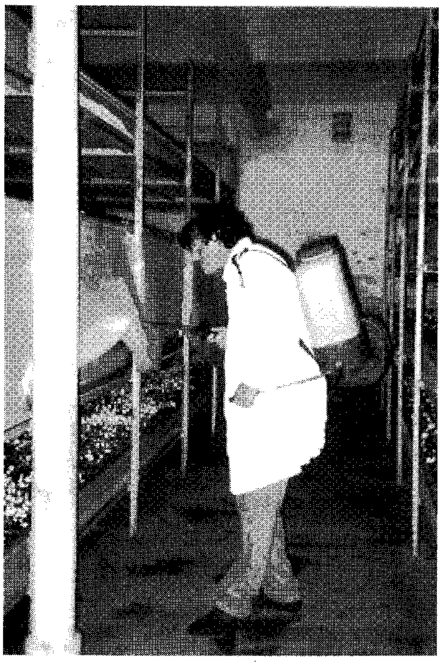

Figure 15. Non-toxic pesticide in mushroom cultivation

The results were not only published: advice was offered, and training provided, for colleagues in many universities, particularly in Africa, and a joint protocol for testing of the non-toxic pesticide with physical action was agreed.

The problems of the production of the non-toxic pesticide, which can be carried out in modest conditions, have been solved in cooperation with industrial technologists. The problems of use, however, remain. They require changing of the routine with chemical pesticides to environmentally sound, but more labour-intensive, use of the non-toxic pesticide. The university contribution has in this case been successful in research and innovation. Education of end-users, however, has still to be achieved.

Conclusion

Environmental protection and development of eco-technologies always require a synthesis of deep knowledge of a number of scientific disciplines. Multidisciplinarity has therefore to be understood as an efficient cooperation of experts from different fields. The very first condition for this is that we return to the natural language in science. This does not mean that the specific scientific terminology of disciplines, which is in itself a scientific endeavour, should be at risk. But jargon, which is making science less comprehensible not only to the laymen, but also to other scientists, should be considered as science pollution. To give knowledge the character of a developmental force, linguists have to help natural scientists, technologists and social scientists to speak to each other.

Computer-supported multidisciplinary information systems and application of modern information methods can considerably contribute to the efficiency of basic and applied research, and become unavoidable when knowledge is transferred into production and environmental protection. They help setting hypotheses for research and development and evaluating their probability, recognizing research results which promise industrial applications, identification of potential partners, understanding the role of the market, and making results public - either as a contribution to the global treasury of knowledge, or as a part of industrial intellectual property.

Multidisciplinary synthesis in research and education oriented towards development and application of eco-technologies offers great opportunities for implementation of ethics and social responsibility. Simultaneous consideration of scientific, technological, economic and social parameters involved leads to synergetic effects which enrich knowledge with values resulting in wisdom. And it is wisdom which the world needs now more than ever. The efforts of the Honda Foundation, following the vision of its founder, Soichiro Honda, are an inspiration for us all.

References

Developing Information Support for Research and Education in Toxic Waste Management, Ed. A. Kornhauser, UNESCO-ICCS, 1996 (234 pp.)

The Integrating Triangle: Research - Education - Development, Eds. A. Kornhauser, E. DaSilva, UNESCO-ICCS, 1996 (189 pp.)

Kornhauser, A., Vrtacnik, M., DaSilva, E., Information Support for Toxic Waste Management, Natural Resources (Paris), 1997, Vol. 33, No. 3-4, pp. 2 - 17.

D. Tierney, Science & Technology Investment: Priority in the Development of Strategy of the Nation, in Tempus/Phare: University-Industry Cooperation - Teaching Strategies, ICCS, 1998, pp. 47 - 60.

A. Kornhauser, University-Industry Cooperation - a Synthesis of Approaches Worldwide, Ed. M. Vrtacnik, UNESCO-ICCS, 1999 (85 pp.)

ICCS project teams (cooperation of university and industry)

Analytical control system for waste incineration in cement kilns:
S. A. Glazar, A. Kornhauser, A. Musar

Integrated information system for waste management:
A. Cizerle Belcic, P. Cok, D. Dolnicar, S.A.Glazar, M. Hafner, D. Kardos, A. Kornhauser, D. Krnel, A. Musar, R. Olbina, J. Radinja, M. Vrtacnik

Microencapsulation eco-technology development:
B. Boh, D. Dolnicar, D. Kardos, E. Knez, A. Kornhauser, I. Kosir, M. Kovacevic, M. Kukovic, V.Pipal, T. Pozek Novak, V. Skerlavaj, A. Skvarc, G. Urek, N. Zupancic Brouwer

Non-toxic dextrin pesticide:
B. Boh, A. Kornhauser, A. Krumpak, A. Musar, M. Novosel, M. Pokorny, I. Radez, V. Skerlavaj