

Societies and cultures in the sustainable development

Research project

Phase 1: 1st - 24th month
in research-action

FROM THE LOCAL CONSTRUCTION OF THE ECO -INDUSTRIAL CONNECTIONS OF SUSTAINABILITY . . .

Conditions of emergence, obstacles, viability modes, perspectives and consequences on the values,
the technological trajectories of the societies, the governance modes and the cultural dynamics

. . . TO THE THINKING UP AND THE REDESIGN OF THE INDUSTRIAL SYSTEM IN SUSTAINABILITY

Phase 2: 25th - 36th month
in reflection-self execution

THE INTERDISCIPLINARY CONSTRUCTION OF A VIRTUAL ECO-POLE OF ACTIVITIES

Parameters, methods, principles, criteria, practical and conceptual challenges of an interdisciplinary and virtual
evaluation of the local and global industrial sustainability

- ACTEURS, PRATIQUES ET RECHERCHES EUROPEENNES & INTERNATIONALES POUR LA SOUTENABILITE (Véra Chiodi)
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Societies and cultures
in the sustainable development
Eco-industrial connections
of sustainability

Interdisciplinary
International
In network

Research-action
Comparative method
systemic approach
methodological holism
ethical norms
transverse analysis

Phase 1: 1st - 24th month
in research-action

FROM THE LOCAL CONSTRUCTION OF THE ECO-INDUSTRIAL CONNECTIONS OF SUSTAINABILITY ...

Scientific targets

- Conditions of emergence, obstacles, viability modes, perspectives of the local eco-industrial connections
- Consequences on the method of working (*the operating mode*) of the industrial system, the contents of labor, the values, the technological trajectories of the societies, the industrial policies, the designs, concepts and the strategies of development, the governance modes, the dynamics of culture, the acceptability of the environmental risk, the organization of the local autonomies, the globalizations

... TO THE THINKING UP AND THE REDESIGN OF THE INDUSTRIAL SYSTEM IN SUSTAINABILITY

Practical and scientific outcomes

- Design, conceptual and technical conditions of the sustainability
- Principles and mode of local functioning of the industrial system of the sustainability
- A strategic tool essential to the practical rigor, scientific and ethical of the sustainability

Phase 2: 25th - 36th month
in reflection-self execution

THE INTERDISCIPLINARY CONSTRUCTION OF A VIRTUAL ECO-POLE OF ACTIVITIES

Scientific targets

- Pertinence, fertility and limitations of the analogy between the industrial system and biological eco-system
- Parameters and criteria of virtual evaluation of the industrial sustainability and their local cultural declensions.

Practical and scientific outcomes

- Design of a virtual model well shaped to the principles of the local and global sustainability
- Methodological tool box
- Challenges for the local sustainability of the articulation between the numerical eco-networks of the territories and the analogical territories of the eco-networks.

1. The relevance of the choice of the axis of research and the investigation ground and the practical outcomes of the research
2. The issue and its advance, the relevance of the subject of research and the step and the scientific goals of the research
3. On the interdisciplinary construction of a virtual éco-pole of activities: theoretical richness and the local practical range of the reconceptualisation of the industrial system on a global scale
4. Methodology, principles and the implementation of interdisciplinary work
5. Originality of the project - kinds of collaborations - Valorization
6. On the program, the schedule and the articulation of all the steps of project
7. Brief selected bibliography
8. The Mobilized Competencies
9. The Partners of the project

1. The relevance of the choices of the axis of research and the background of the investigation ...

The industrial ecology which describes the industrial system as a configuration of dynamic connections of products and information, is an essential strategic tool for the practical, scientific and ethical rigor of the sustainability.

An industrial system separated from its **tropical** network and increasing the distance between extraction and evacuation, needs not only a huge energy consumption but it frees its social and technological **trajectory** from any territorialized sustainable constraint, every territory becoming a block of modifiable, movable or interchangeable inputs. . Putting itself outside the biosphere and globalizing the space, it desires to be able to become independent from the constraint of the local and create its customer but the global ecosystemic constraints and the social and cultural resistances limit locally its degree of freedom.

The sustainability is based upon its local **implementation** and the implication of the civil society as whole (sustainable community). The “**local**” (virtual or physical predetermined place) and the **civil society**, - *the government being reduced at controlling the environmental impacts of the industrial activity by regulating* - are that being the case in a position to become a field of fruitful questioning, micro experimentations and innovative achievement which needs to be analyzed and evaluated.

... and the major scientific aim of the research

The reconceptualization of the industrial system in the sustainability and its ranges, challenges and means of the interdisciplinarity, anthropological **challenge** for the industrialistic societies, economical and cultural stake in the North-South relationships, social and ecological issues for the globalization.

One of the conclusions of a research project on the «local labour markets, the labour content and the modeling of the sustainable development»¹the research sponsors' attention, the ministry of Ecology and Sustainable Development and the ministry of Employment, to the fact that «the industrial ecology, an economics of interactive connections, the economics of **sustainability**, is a strong condition for **the implementation of the sustainable development** in practice. The new design **and the new organization** of the industrial system which would be given rise to and the change of from a product economy to a service economy and from a society of production to a **functional** society which would be implied, would be essentially regional. In the context of this new social and technological **trajectory**, where a new globalization would emerged, it would give back to the cultures their own creativity and to the individuals their own responsibilities in the construction of the sustainability. It can consequently build up the system (network) of a local capable of bring up another **world**

The answer to the paper calls makes of those conclusions the axis of this research project

In fact, the sustainable development stirs up in practice the quantitative and qualitative question of the flows and stocks of the product or energy withdrawn or vanished and accompany it with a double ethical solidarity, horizontal to the poorest, and vertical between generations, own conditions of its scientific relevance and of its fulfilment.

¹ EPIC study (scientific management :Léo Dayan) .Reference MATE n°99118 and Research program “Centre d'études de l'Emploi CEE” #21, 3 volumes.

The industrial ecology, which describes the industrial system as a configuration of dynamic connections of material and information inspires, by the local, the change of technological trajectories which would contribute to resolve the problems related to the impoverishment of the ecosystems, to the spatial and temporal aggravation of human inequalities and to the loss of cultural identity.

It reduces the dependence of the societies from a technological rut, the incremental progression and the technological resolution «end of pipe» of the problems (issues)of sustainability. The latter reinforce an industrial system which it likely improves to the detriment of an innovation which would modify the divided up and compartmentalized technological trajectories. The pillow of technological idleness which it forms, gives coercive and reactive strategies and translates into transfers of the perturbation across time, by their movements into space, into a stronger material and energetic dependence of the societies as a whole and into a stronger commercial and cultural pressure of the Northern societies over the Southern ones.

Crossroads of several disciplines, offering the conditions, the the procedures, the instruments and the techniques of the systemic dematerialization of the economic activity, meaning the substitutability of the productivity of resources by the productivity of labour, the industrial ecology allows at the same time the research of the environmental total quality, to give the technological conditions of the construction of the equity, the cultural genius of the populations and the entrepreneurial energy of the local.

The local development of the symbiotic exchanges between the firms, the mastering of the traceability «from cradle to cradle» of the components and the intensive use of the local resources, source of the exceptional decrease of the global costs and an optimal management of the local resources, challenges a conception of the individual efficiency and the world competitiveness which was translated into an increasing growth of the labour productivity, measured by the growth of the extraction (removal) of natural resources and wastes, and by the extension of the material loop cycle whose effect is the growth of its dissipations, its harmful spreading and the societies' vulnerability to social, environmental, and cultural risks.

In an economy organized according to loops of the reuse of resources, the development and the efficiency do not depend anymore on the wage costs and large scales of production. The eco-industrial connection modifies the content, the position and the role of the human labour in the wealth creation, a wealth use, which it decouples from material flows. It recomposes territorially the activities, into eco-territories of networks and into eco-networks of territories. Also, allowing the development of the industrial biocenosis into areas where urban civilization concentrates, whose it brings close the areas of supplying and the areas of removal, it draws, by the local projects, another globalization, a world into which the critical resource becomes the quality of information, the confidence, the entrepreneurial energies of the local, human intelligence and the know how.

The sustainability, which concerns a transversal and interdisciplinary field of technical and practical scientific studies: «Le lien - le lié - le liant»², invites to decompartmentalise time, energies and space and takes an interest into interrelations, interdependencies and interactions between all the areas and activities that some disciplinary, organizational cultural or institutional sharing separate.

It attempts to be an answer in construction to a range of practical, methodological and theoretical questions relative to the linking sentences between and within the terms of the whole series of couples which link intimately the intelligibility of the world, the human solidarities, the efficiency of the social activities and the unity of the biosphere.

² the link – the linked- the linking

The justification of this new way stands first into the prosaic and practical necessity to assemble the conditions of surviving of the species threatened by the fundamental antinomy which appears between the insular linear and reversible logic of the economics and the discontinuities, the weak resilience, the threshold effects and the irreversibility of the phenomena in the ecosystems.

But it also lies, faced with the chaos risk, into a share of seduction which the self imaginary of the sustainability holds, the reconciliation of what an dual, additive or subtractive economic rationality, the plan or the market, resulting from the debates about the industrial revolution, gives rise to compartmentalization by separating the industrial system from the biosphere. In this compartmentalized and sectional view, the worry of the sustainability would limit itself to be a technique intended to control, by government regulation means or to trade, through the market or the tax system, the negative impacts caused by a social system whose logic of functioning and the representation stays unchanged: on one side, industry, technology, city, «North hemisphere» and on the other side, Nature, human being, environment, «South hemisphere». The sustainability concept would reduce itself in practice to some techniques of marketing or to regulation policies allowing to minimize the environmental pollution of the industrial system on the «outside», on what surrounds it, on its environment.

The functioning of the industrial system as such would stay exterior to the analysis!

Although and because it is still polysemic (polysemous) in its definition, stammering in its implementation and nebulous in its content, the sustainability concept gives rise to a new way of thinking, evaluating, acting and doing. If this research process renews the debate on the relationship antinomies of economics and ecology, it also modifies the relations between and inside the terms of a whole series of couples which marks out the scientific and practical debates and specifically: growth-development, local-global, firm-territoriality, regional-planetary, North-South, organization-self interest, «hard» science-«soft» science, theorem-norm, moral –policy, etc.

The quantitative and qualitative debate of flows and stocks of material and energy extracted or dispersed does not split up, in the sustainability concept, from normative and ethical solidarity with the poorest and between generations.

The ethics and the norm are the very condition of its scientific achievement and of those of any development theory, of the intelligibility possibilities of the world and of the organizational system efficiency and human governance.

The holistic structure of the sustainability crosses and reconfigures qualitatively, on the systemic conciliation method, the scientific knowledge without separating, in their reconstitution, Science, Ethics and Normative project. That would distinguish, the conscientious human organization, able to endow itself with a project, those of the nature.

The integration clearly stated of Ethics and the norm distinguishes therefore this attempt of the claims to the pure scientific character of the terms in disciplines which thinks being able to slip from (escape from). Among those ones, the economic rationalities, the «robinsonades» of the market or the plan.

But if the concept of sustainability invites to take an interest in the systemic interrelationships and to inscribe them in the context of a holistic methodological structure in which the affirmation of the world unity constrains its diversity, it also requires, as regards human society, to understand the specificity and the degrees of freedom of this diversity and to develop from the solidarities, condition of its self-reproduction.

And if the concept, which induces a new area of study in the social sciences, «*Le lien – le lié – le liant*», is inspired by the theory of systems which it renews by getting out from its original naturalism, leads to a new universalism, it does not lapse at all into the elaboration of anti-freedom policies nor put the centralized planning on the agenda but it heads for decentralized and non-concentrated methods of cooperation.

Its new universalism, which is distinguished clearly from individualistic or totalitarian universalisms inherited the era of the lights, does not dissociate science, politics, art, technique and practice. It challenges the common human being as well as the thinker and the decision maker, the technician as well as the designer, present generations as well as the future generations, the worlds from here and of over there and connect them in the same need, in the same challenge: to explore collectively new ways of development, to release civil energies and the entrepreneurs of the local, to initiate new technological trajectories more sparing in resources and richer in value of use: to create new imaginary positive.

On the basis of the observation that to arrive to a given goal, a system can use, according to a given situation, several different paths, capacity known as of «equifinality», a system is sustainable only if it ensures a determining role at the local. And the autonomy of the local would be all the more large as it would be made able, within the framework of a shared standard and an ethics, of elasticity, impact strength and dynamism facing the global and external constraints.

The holistic approach of the sustainability is accompanied thus by the individual objective of eco-efficiency, like means and tool to stimulate the companies to be integrated, in a voluntary way, in their organization and their management, of the co-operative local steps and to create between them the eco-industrial connections which would allow the setting in loop of matter, energy and waste and the production and the exchange of the information required by the dematerialization of the economic activity considered in the whole of its expressions and functions.

The industrial ecology, which gets rid of the vision according to which the preoccupation with a sustainability would amount creating activities intended to attenuate or repair the damage of the environment (pollution damage) caused by a social system whose logic of operation would remain unchanged, shifts the usual prospect. It origins from the idea according to which the activities related to sustainability are a product and means of implementing new economic and social practices.

Sustainability is thus not an addition of local, economic, social, ecological, territorial and cultural components. It is the organization of the elements which, in a transverse way, bring, in these fields, the answers which are complementary the ones the others on each one of these fields and prove, in last authority, respectful of the cultures, socially equitable and compatible with the local valorization of "the environment" and the planetary safeguarding of the ecosystem.

It thus orders to integrate, in the construction of its object and its progression, the narrow interdependence between grounds, techniques and theories and the interdisciplinary connections.

At the junction of very many disciplines, the industrial ecology², which takes as a starting point the knowledge on the ecosystems and the Biosphere, while trying to determine the transformations likely to make the industrial system compatible with a "normal" operation of the biological ecosystems, offers an exploratory, concrete and practical way which constrains to renew the visions of the world borrowed from the classical economics and a compartmentalized organization of sciences. It is one of the major and impossible to circumvent conditions of putting into practice the sustainable development.

The practice of sustainability will thus find in the local construction of eco-industrial connections a strategic tool essential with the scientific rigor of durability, a functional base with its industrial component, an approach of optimization on a territorial scale and economic system as a whole and finally an operational instrument (eco-efficiency) for the management of the firms.

² I thank Sören ERkman of the ICAST (Geneva), late Ed Cohen Rosenthal of the University of Cornell (Ithaca, NY, USA) and Raymond Côté of the University of Dalhousie (Halifax, Canada) to which I owe my initiation and my explorations in this field

2. The issue and its advance

From the incompatibility of the industrial system with the Biosphere and from the «end of pipe» approach to the design of the productivity and the wealth, while passing by the increasing economic needs for a human population in increase, unequally satisfied but rich of its cultural diversity.

The relevance of the object of research and the step ...

The economy of the eco-industrial connections operates a slip of the centre of gravity of the production towards the local management of information and the services and the swing of the capacity of the producer to the profit of the user of the territories and the goods. It is primarily regional.

The eco-industrial connections require the implementation of the principles of reciprocity, confidence and social responsibility and support the creativities of vicinities ("virtual" or "physical"). They order to escape from individualism methodology, the economic insularisms, the institutional territorialisms and the disciplinary summations to explore, in the interdisciplinary one, the concept of development and to integrate in the same cognitive and functional unit the researcher and the expert, ethics and science, politics and the citizen, industry and ecology, the city and nature, economics and the culture, North and the South.

. . . The practical expectations of the research

To define the local methods of the industrial system of sustainability, to produce an operational, culturally generalizable and socially equitable conceptualization, of mundiality, sustainability and local autonomy, to build a local model of virtual industrial culturally declinable ecosystem, to deepen and make known the experiments of existing local eco-connections, to stimulate theoretical research and dynamic energies of the local, to help with the public and private decision and to cause new experiments of local industrial ecology.

How the societies can be organized, the individuals to undertake locally and the cultures to express their creativity in the sustainable development?

Which globalization requires the implementation of the sustainability for which global world through the globalization of the field of deployment of the strategies of development, is itself, one of its conditions?

Economic globalization was not accompanied by the research of the control of the speed and volume of flows of material, energy and waste, in constant increase. The development of the society of communication in the North, thanks to the components, the wage-earning and the cultures of the South, increases the speed and flows of information, but far from being used for the dematerialization of the activities and allowing the dialogue between the cultures, accentuates the ruptures of the eco-systemic loops of the material cycles without reducing the political, cultural and social distances between and even inside the societies, on the contrary which it worsens them up.

How thus to make compatible the industrial system with the Biosphere, while meeting the increasing economic needs for a human population in increase satisfied unequally but rich of its cultural diversity ?

Which practical strategies of development would make it possible to answer a human population requiring a greater equity in the world share of the fruits and the loads of growth and eager of a greater participation in the definition of the possible ways of development, the values and the criteria of the well being?

Which productive system, which design of the wealth, which functioning of the industrial system, can allow the practical implementation of a sustainable development and which indicators can allow the development and the evaluation of the strategies of sustainability?

The most economical and least polluting economic activity is that which is materially not produced. All repaired damage, the person without employment is that who degrades less the environment. In addition a developed local resource and locally put in loop energy and creates local job. These reports which really make sense, can be regarded as a conceptual reference mark of the sustainable development, with "strong sustainability".

It follows that the conciliation between the economy and the ecology, the economy and the social, the economy and the local culture, is only possible by the questioning of the prevalence granted in the economic decision making to the economic criteria captive of the short term and the unique individual calculation: market price, labour productivity, comparative advantage, monetary cost, market wages, etc....

The implementation of the sustainable development passes by an optimal use of the extracted resources and must result in putting an end to the ancient idea of economics which is always harping on the same string : regulate the growth on labour and labour on the measure of its direct or indirect contribution to the increase (monetary or not, merchant or not) in material flows. The market is not the exclusive place of the efficient economic exchange and the monetary market price cannot be the only selection criterion of the economic decision making.

Government regulation, when it privileges control and substitutes itself by the project, a market of the rights to pollute or an internalization of the social costs of pollution, through in particular the polluter-pays principle, can be certainly of a certain effect but are overall lures. They cultivate an approach end of pipe of sustainability.

The industrial ecology, which should not merge with environmental industries nor even with green or cleaner technologies, is interested in the long run evolution of the industrial system as a whole. It considers the economic sphere like a particular case of eco-system and pays attention to the evolution of the human society as a whole and on a long run range and in its interrelationships with the Biosphere and not only to the environment which constitutes only one aspect of its object. The issue of the impacts of the human activities does thus not boiled down, "end of pipe", to the problems of pollution and waste.

Approach "end of pipe" of Sustainability

Sectional Rationality... global inconsistency and inequity

In France, the share of a water invoice devoted to the royalties and taxes of protection reaches on average 60 %. Each new technology of purification improves the system... But does the clean up of water leads to the air and ground pollution then again water pollution.... indeed, what do the filters of the stations of purification become full of harmful substances? Should cleaning up of pollution be useful for polluting again? Which true innovation other than the development of a lucrative market of cleaning up of pollution? Which consequence other than to pass on to the poorest the financial effects of their own access to a vital right?

If the urban households are certainly the first propagators of the water pollution, its first producers are industry and a mode of organization of the habitat and space which the automobile dependence authorizes. Should it be concluded that the sufficient answer consists in directing the investments in the improvement of the environmental performances of the car?

However an example, the effect named "take back" by the American and Canadian researchers, discovers the perversions of measurements "end of pipe" of reduction of the harmful dissipative emissions. An environmental technology which increases the environmental performance of a vehicle increases the traveled total distance and trip demand by car. Although there is reduction of the fuel consumption and the dissipative emissions, the increase in mileage can raise other welfare expenditures, congestion of traffic, road infrastructures and parking, accidents, urban spreading out and new pollution or, by volume effect, raise the emissions which technology was intended to reduce. This example shows in particular and also clearly the limits of the strategies of sustainability being based on the government regulation as well as the technological rut in which the approach end of pipe inserts a society. They make increasingly more difficult the exit to gears without end. The measurements taken are certainly rational by sectors but overall in a disordered way, without overall prospects.

Recycling is still another example. Registered in an approach "end of pipe", it is relatively polluting and disseminating multiple substances in the environment. It reduces neither the speed nor volume of material and energy but on the contrary increases them. Thus the plastics require at the time of the operations of recycling of the chemical additives and, which more is, to dubious harmlessness.

Finally when in Niger, the law forces to build a permanent structure all the public buildings and thus bans the use of local material, clay, considered as less "hard", it results by the cement importation, the increase in the cost of construction and flows of material, energy and waste, by the dissemination of pollutants, the depreciation of the local knowledge, the confusion in the representations of what is sustainable and non-sustainable and reconciles economy, culture, ecology and social life and finally by the relativization of the Tuareg cultures and the women who are the bearers ones.

The approach "end of pipe" in the technological resolution of the problems of sustainability, partitioned and sectional resolution, is incremental, expensive, pernicious and inequitable, it moves the effect locally, defers the expiry, prevents the diversity of the local solutions and depreciate the cultures.

Inspired by the initial intuition of E.G. Hutchinson, expressed in a study published in 1948 on the geochemical cycles bio and in which the industrial system was presented in the form of a subsystem of the Biosphere, the expression of industrial ecology, a oxymore which is useful of simple biological analogy, appears in the specialized literature of the physicists, chemists and biologists of years 60-70 then spreads themselves at the beginning of the Nineties in mediums of engineers of industry with the United States. By regarding the industrial system as a particular case of the Biosphere, Robert Frosch of the University of Harvard and Nicolas Gallopoulos, persons in charge for research on the General Motors engines, start again in 1989 this way of research and renew the debate on the relational discrepancies of the economy and the environment.

The leitmotiv of these pioneers ³ was simple. The industrial system could aim, more and the best possible, to put overall (globally) in loop the cycles of material and energy and to limit the dissipative emissions and the discharges: waste is consequently regarded as resources and the accumulation of the emissions and discharges like a loss and a threat.

Industrial ecology is not an abstract idea. In spite of its youth, it makes locally and experimentally its way but meets obstacles and limits, especially within the framework of the projects of the "sustainable communities". Practical and significant examples translate already the territorial steps, methods, applications, the results and the range of industrial ecology. Here a non-exhaustive but varied sample:

- The construction, in a sector of the town of Minneapolis, in the United States, of the "Phillips Eco-Enterprise Center ", in which 15 firms try to exchange in loop their waste, materializes an innovation transposable which replaced the project of installation of a factory of storage and of transfer of waste.
- Transposable attempts and projections of "Eco-Efficiency Centre" of development of the eco-industrial connections in an already existing vast industrial park, "Burnside Industrial Park" in Halifax in Canada. Result of a multidisciplinary research-action and multi institutional associated to an educational project and an university education
- The symbiotic industrial model of Kalundborg in Denmark, gradually worked out and in an unintentional way, between friendly knowledge around a flow of energy and heat.
- Under development, the virtual eco-industrial park of Brownsville in the south of Texas. Based on a regional approach and on a data base which uses an analysis of the metabolisms of the industrial and agricultural processes, it makes it possible to identify virtual links between existing and potential firms. Specimen owing to the fact that the partners are not brought together physically in the same site but are held jointly together by the composition of their flows of waste which constitutes their reciprocal inputs and the key of their profitability. Specimen of significances also because the city, located in the Large valley of Rio, joins together populations of which the poverty, rate of unemployment and impacts of environmental problems on their health are among the more serious of the northern hemisphere.
- The integrated management of mobility and accessibility combined with a center of commercial activities at Portland, in Oregon in the USA led by "The Lloyd District Transportation Management Association.
- The association of fight against waste, which employs more than 90 people in the Jura (France), which achieves a social and ecological work (benefit) meeting the local population needs, by developing the channels of the reuse in aid of the social integration.
- A specialized firm in disassembling, in repair and in remaking of worn computer equipment, "New Generation Software Systems Incorporated", created in 1995 in the United States by a French guy, old executive officer of the public sector, which succeeded in 5 years having 12 % of the market in this industry in New York city. It contributes to a more rational management of the computer equipment of the firms.

One can also quote firms, such as 3M, which identify the repair and re-use the raw materials not used, the obsolete products, the useless or too old machines and valuable waste, such as Dell which sells by correspondence made to measure computers or Xerox which gave up producing "new" photocopiers replacing it by dismantling, remaking, recirculation and maintenance of the existing machines, designed by flexible

³ to re-use, repair, recover, refabriquer, to recycle products and by-products on a very great scale (Frosch and Gallopoulos 1989; Allenby and Richards 1994; Graedel and Allenby 1995; Garner and Keoleian 1995; Ayres 1996; reduction of the use of virgin materials; reduction of pollution; increase in the energy effectiveness; reduction of the volume of the residues;. such are the permanent leitmotivs

segments and which trains its technical staff to visit its customers or finally such as Electrolux, world leader of the white, which tries out in Sweden the "pay per wash" in residence by proposing the long run hiring. One will notice the dematerialization of the activity of Dell and the relocalization of the jobs of Xeros and Electrolux by the increase of the local tasks of maintenance, monitoring technological development and maintenance.

All these instructive cases describe the main contribution of industrial ecology with the implementation of the sustainable development. They show the singularity and the plurality of the forms of the eco-industrial connections, the territorial and cultural proximities, territories of eco-networks and eco-networks of territories, but also can highlight the conditions of their transposability, their implementation and their development. They make it possible to illustrate the systemic articulations between the activities, the local forms of the organization of industrial ecology, the local recombining of the tasks and jobs, the social functions and the joint strategies which the territorial practical implementation of the sustainable development requires.

One will choose to bring back a summary but concrete outline of two examples of innovations whose practical and conceptual range for the industrial system is considerable:

- the beautiful realization of social engineering of downtown sustainability, "Phillips Eco-Enterprise Center", on behalf of a disinherited population and a non-profit association, "The Green Institute", in Minnesota in the United States. It harmonizes industrial ecology, economy, revitalization and the eco-reorganization, employment, the social integration and the protection of natural resources.
- a masterly realization of technological engineering: the industrial symbiosis of Kalundborg in Denmark

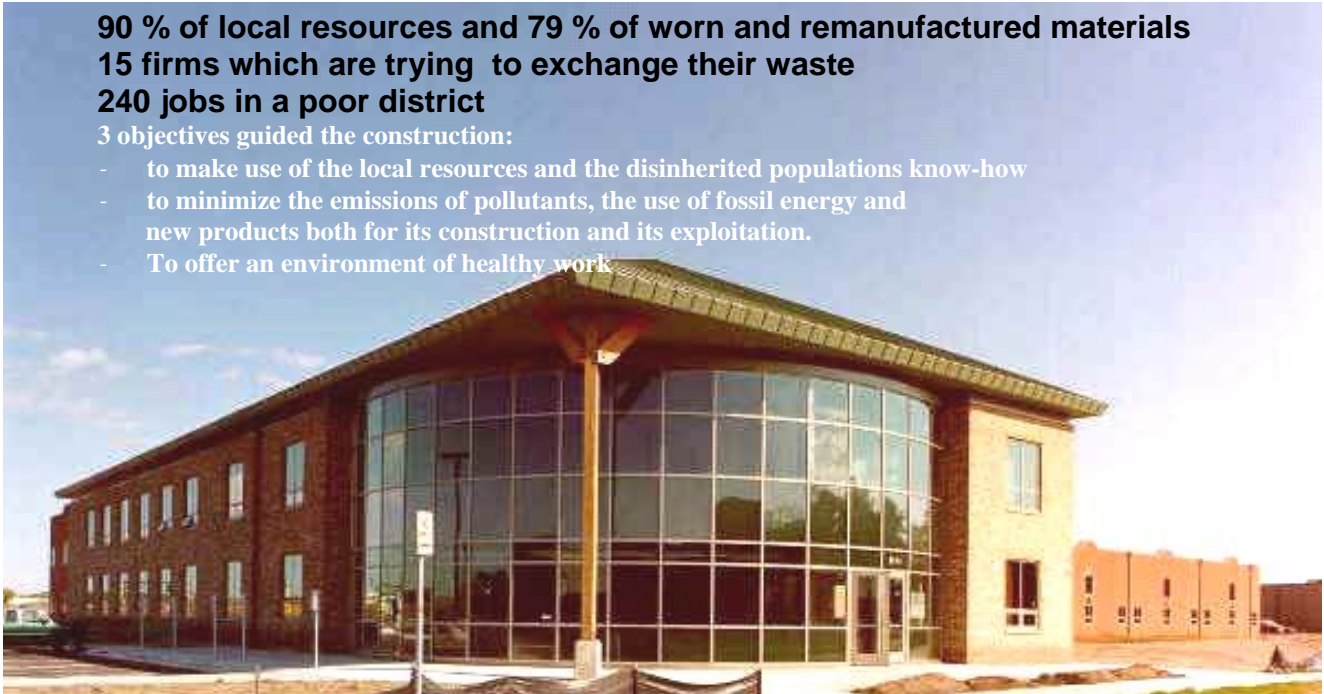
**AN ECO-POLE OF ECO-ACTIVITES,
"PHILLIPS ECO-ENTERPRISE CENTER"
MINNEAPOLIS, MINNESOTA, UNITED STATES**

In substituting the productivity of the resources to the labour productivity, it built one of the most sparing and efficient centers of the activities in the world as regards to stock management and energy and a remarkable example of integrated and crossed connections of industrial ecology, of urban revitalization and social integration

**90 % of local resources and 79 % of worn and remanufactured materials
15 firms which are trying to exchange their waste
240 jobs in a poor district**

3 objectives guided the construction:

- to make use of the local resources and the disinherited populations know-how
- to minimize the emissions of pollutants, the use of fossil energy and new products both for its construction and its exploitation.
- To offer an environment of healthy work



Alternative to the mechanized demolition: the disassembling and remaking of the structures of the buildings doomed to demolition for their re-use

The "*Green Institute*", a non-profit and non governmental organization, is founded in 1993 by inhabitants of Minneapolis and entrepreneurial local energies, in a poor area of the city, Phillips, crossed by social motorways, factories, foundries and social distresses, on a site initially destined by the County to install a station of storage of waste.

If the county had achieved its plan, this station would have absorbed more than 4 hectares of land, makes circulate 720 waste collecting vehicles per day and worsened pollution and waste.

Unemployment reached more than 15 % of the working population, that is to say three times and half more than the national average in the United States. About hundred social programs in the sector overlapped to help its 18000 inhabitants and several organizations provided the food, shelter and clothing. But all the distributed social funds were spent without any effect on employment and the local wealth.

In October 1995, the «*Green Institute*» opens the "Re Use Center", a store which retails salvaged materials of buildings.

15 inhabitants operate the store (7/7), earning barely a living wage, to which benefits and a quarterly proportional to the sales bonus are added.

In October 1997, the Institute extends its activities while engaging in a new firm which has an alternative to the mechanized demolition: the disassembling and the remanufacturing of the structures of the buildings doomed to the demolition for their re-use.

It develops new markets for these recovered and remanufactured structures and opens a wholesale warehouse and materials direct sale on site ("Deconstruction Warehouse"). The personnel has a training in the use of the tools, the techniques of construction, the terminology of building and the safety standards.

The Institute also lavishes with its program "*Green ED*" classes, forums and projects to make it possible for the citizens to play a major role in the implementation of the eco-effectiveness and the eco-behaviors

In Minnesota, approximately 40 % of the volume of the buried waste is materials and building machinery. When the teams of "Green Institute" dismantle a building, approximately 60 % of the materials are sold on site, 30 % go to the warehouse for inventory and 10% are to be buried with an environmentally responsible way.

These activities not only preserve virgin resources like the forests and the soils, but save also the resources and the energy which would have been used in the manufacture and the transport of new final products. They reduce the costs of supplying and the burden of the environmental regulation

These activities, which intensify the use of the materials, substitute the productivity of the resources for the labour productivity, dematerialize the economy, relocate jobs and reassert the value of the local cultures.

In October 1999, The "Phillips Eco-Enterprise Center" is built with 79 % of worn and remanufactured materials on the old site designed for the garbage dump.

In June 2001, the eco-center of eco-activities joins together 15 firms of the environment and the green energy of which some exchange their waste and created 240 local jobs.

The design, the construction, the exploitation of 6000 square meters of offices and commercial and pro-industrial green activities make of this center one of the most sparing and efficient in the world as regards to resources and energy management and an outstanding example of integrated and crossed connections of industrial ecology, urban revitalization and social integration.

With the 15 resident firms, "Phillips Eco-Enterprise Center" does not reach the size of the other American "industrial eco-parks" nor even less the size of Kalundborg but its potential growth is very high and it is above all of a different nature.

With the firms joined together in this same center, the «Green Institute» works in collaboration with its partners, to develop other local projects of industrial ecology and to help to incorporate eco-industrial connections in comparable projects, the center acting thus like a catalyst for the revitalization of the urban areas. The local decompartmentalization of the firms, the decentralized co-operation, the cross flows of information, the mutualization of infrastructures and the interactivity of the links, the exchanges between the firms and the local population and the firms, that the new center stimulates, allow the Institute, not only to develop a joint chain of local sustainable activities and to form networks of new exchanges, but also to spread and to develop the social local capital, of which that of the poor populations: the transfer of "green" social technologies, eco-construction, the urban strategies of practical sustainability, the re-engineering of the urban industrial base, the techniques of energy saving, the social and eco-efficient strategies and devote the success of an anchored association in the territory of the city and cultural know-how of the poor populations.

A ECO-INDUSTRIAL PARK CENTERED ON THE USE OF A COMMON ENERGY FLOW AND ITS UNDER-PRODUCTS

The industrial symbiosis of Kalundborg (Denmark)

A park eco-industrial could, technically, be described like a community of production firms centered locally around the mutual management of local material flows, waste and information in order to simultaneously increase the environmental and economic, individual and collective, local and global performance. Purified form of a park eco-industrial, of which the origin is unintentional, the symbiosis of Kalundborg was worked out, between friendly acquaintances, around the use of a common energy flow and of its under-products. The management of all the transits of material is the subject of a bilateral and private negotiation, respects the laws of the market and integrates the environmental regulation. It is an example of local industrial collaborations at commercial and financial purposes but with a pro-environmental and pro-territorial effect.

PERFORMANCES

(tons / year, data bracket obtained by crossing of several sources 1998)

Reduction of the consumption of resources

Oil: from 19 000 to 45 000

Coal: from 15 000 to 30 000

Water: 1 200 000

Reduction of the emissions of pollutants

CO₂: from 175 000 to 200 000

SO₂: 10 200

Waste recycling

Fly-ashes: from 130 000 to 135 000
to 90 000

Nitrogen: 1440

Sulfur: 25 000 (including 3500 T of pure sulfur) Gypsum: 80 000

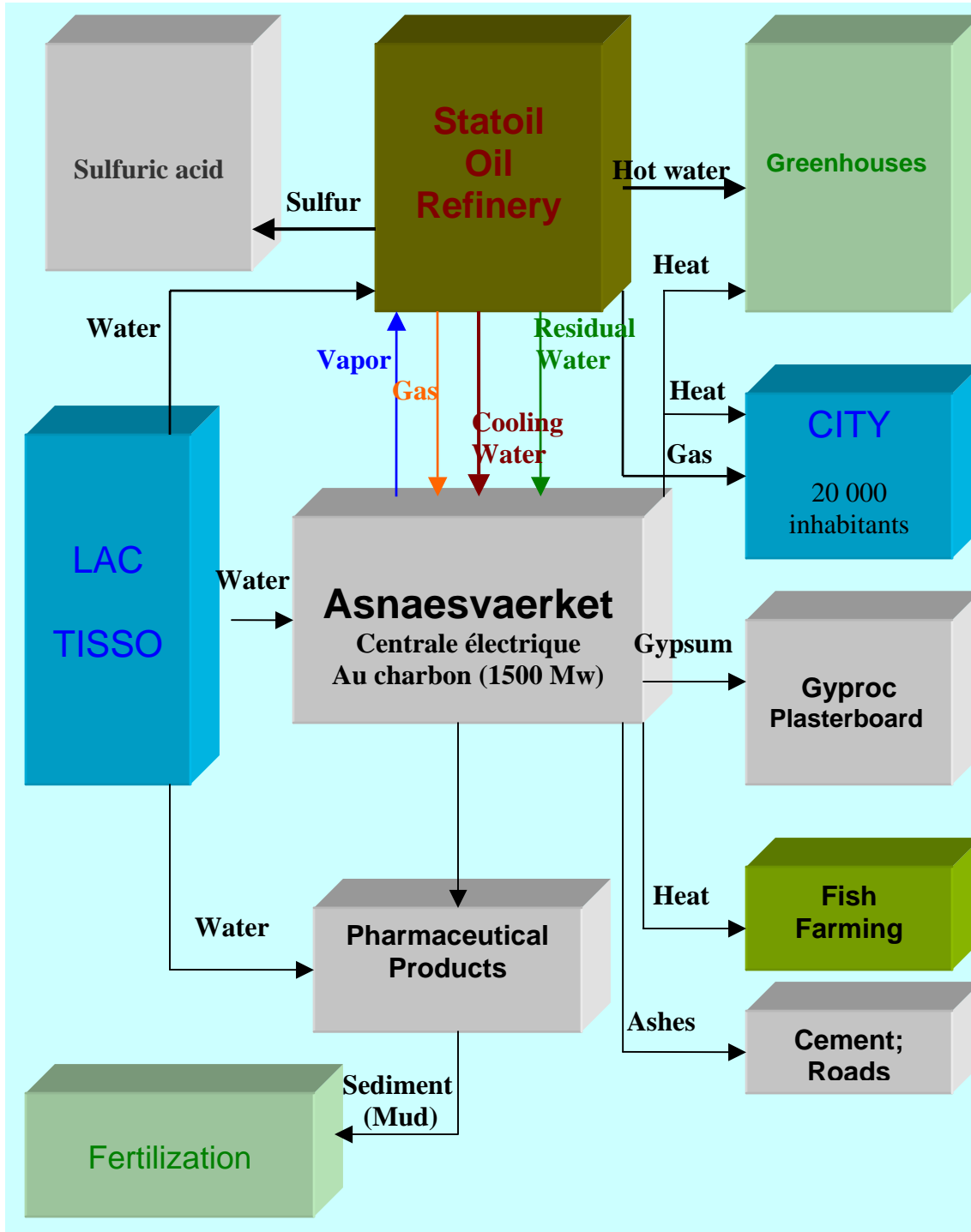
Nitrogen (in the form of sediment): 800 000

Phosphorus: 600

Annual economy: approximately 15 million dollars.

Return on investments ("pay back") < to 5 years

THE INDUSTRIAL SYMBIOSIS OF KALUNDBORG



The implementation of a global and integrated model of industrial ecology, which subordinates the approach "end of pipe" to a vaster prospect and develops methods of production whose risk of environmental impact would be of an acceptable level, allows an optimal management of the resources.

Producing more wealth, value of use, with the same quantity of material and energy, the eco-industrial connections reduce the global cost and make it possible to socially control the manufacturing, circulation and consumption processes of the products. They force to conceive the ways and the methods of re-use of material flows and the conservation of their properties during the operations of recycling, to know the accumulated doses of the ultimate residues and to predetermine the production of pollutants according to the conditions of their setting in tightness.

The industrial metabolism of the components of a product or flows of products of an organization is the technical tool of industrial ecology. It is based on the principle of the conservation of the mass and aims at translating the qualitative and quantitative characteristics of flows and stocks of material and energy.

Document

BEHIND THE PRICE AND THE COMPARATIVE ADVANTAGE ... THE ECOLOGICAL PRINT

1 liter of orange juice from concentrated juice

! = !

1 000 liters of water and a minimum of 25 Kilograms of material

THE INDUSTRIAL METABOLISME OF THE ORANGE JUICE

55 millions tons of orange juice, almost all consumed in Europe, in Japan and in the United States are annually produced in the world. More than 80% of the orange juice consumed in Europe come from Brazil and travel 12 000 kilometers on average to get to the consumers' table.

According to a study of the Wuppertal Institute, by cumulating the steam necessary to the process of concentration (up to 8% of its initial mass), transport and freezing (-18° Celcius), each ton of juice coming from Brazil requires nearly 100 kilograms of oil and each orange juice glass requires 22 glasses of water only for the concentration and the dilution for which it would be necessary to add the volume of water required for the refining of the diesel (between 0,5 and 20 liters of water per kilogram) used for the material and energy production (of which pesticides and packaging) related to the production of orange juice.

The American orange juice, as such, is even more voracious in consumption of material and energy: one liter of American orange juice from concentrate requires 1000 liters of water of irrigation and two liters of oil (in Florida, the use of pumps of irrigation and heating systems is generalized, which is not the case of Brazil which, in surplus, which use bagasse for half of energy).

On the whole, and without the "Rucksack"* minimum of 25 kilograms of material are required to manufacture and distribute 1 liter of juice of orange.

And if all the inhabitants of the Earth consumed on average the 21 liters per year of orange juice which a German drinks on the 24 square meters land required for produce it, one would need 3 times the surface of a country like Switzerland (130 000 km²) and it takes millions of tons of material.

Why thus develop and finance the orange groves of Florida to the detriment of those of Brazil? Is the principle of the comparative advantage, taking into account only monetary costs, globally and ecologically relevant?

For comparison: taking into account the essential volumes at each stage of the production, from the step of irrigation to the delivery, the production of four tires of car requires 9400 liters of water and the one of one kilogram of bread, 1000 liters.

* : the back bag

The inventory of the symbiotic groups of activities, the industrial biocenosis and the artificial trophic networks, that this tool allows, can encourage the firms to connect their material flows on the same territory (analogical) or to integrate them in network (analogical or numerical) and to encourage them to organize the efficiency of the industrial system around the most powerful among the strategies of the dematerialization and the preventive environmental protection: the intensive use of the resources, the value of use, the lengthening of the lifespan and the durability of the goods, the bringing together of the zones of supplying and unstocking of the cities and local employment.

The development of the eco-industrial connections would lead to increase the dematerialization of the manufacturing processes, the products and the organizations, to develop wastes as resources, to buckle the cycles of the material to minimize the dissipative emissions and "to decarbonize" energy. The research for the productivity of the physical resources (more value of use with the same quantity of resources) and for information (more quality with the same quantity of information) and its substitution for the productivity of labour would lead to an economy of the human intelligence and abundance of use, the functional economy, the systemic dematerialization of the economy.

By privileging a careful management of resources and energy, the local re-use of the materials and the setting in tightness of the pollutants, it limits the ecological print, preserves ecotoxicological risks and develops the inimitability of the cultural inheritances and the environmental landscapes.

In the use society ("functional economy"), the productivity gains being measurable by the increase in flows of rendered services for the same quantity of used material and energy, the real wealth growth, the *richness of use*, and the productivity gains can be uncoupled: the use and the lengthening of the lifespan of a good, the modularity of the products and the re-use of the components become the determining factors of the innovation, the economic growth, the eco-efficiency of the organizations and the social and environmental quality of the supply.

The firm does not sell any more a good but a service, substitutes the production and the exchange of rights of use of goods for the production and the exchange of the products, prevents the imperfection costs of the products for which the owner developer of the good would become responsible from cradle to cradle, does not privilege the internalization of the environmental costs but prevents from the start the environmental impacts and reduces the individual and global environmental costs.

The consumer changes both its statute and its function, he becomes the user of a service and a producer of value, his wastes of consumption.

His demand is not about the purchase of all the equipment goods and short lifespan durable products but on the acquisition of a right of user. Qualities, environmental safety, the functionality, the capacity of evolution and adaptability and the design of a good become paramount.

The qualitative control and the quantitative reduction of material flows, that these interactive connections would authorize, require informational upward and downward synergies, internal and external and thus the co-operation between the organizations and the decompartmentalization of the functions in the firm.

The productivity of the resources being privileged compared to that of labour, the nature of labour and the contents of the tasks must in parallel be changed.

A service not being storable, industrial ecology thus increases, in a use society, the quality of work and the transversality of the tasks, of which it develops the direction of the social responsibility, the local inter-individual relation and the personal initiative.

The tasks of organization, coordination, prevention, control, design, re-use of the products, recycling of materials, repair, maintenance become dominating. And numbers of jobs are relocated and requalified technically and socially.

By allowing an optimal management of the resources (systemic dematerialization), by drawing aside the purely competing strategies, by requiring the co-operation and by developing informational synergies, industrial ecology makes prevail informational energy and social engineering on the technological machinery and requalifies work like value, means and social product of sustainability.

It consequently implies the decentralization of the sources of information and the operations of technological development, the slip of the centre of gravity of the production towards the local management of information and the services and the swing of the producer's power to the profit of the user of the goods, consumer and producer of clean waste and thus of guaranteed resources.

The new field of study and the new object of science, «Le lien-le lié-le liant», introduced by the concept of sustainability, thus submits conditions and gives trajectories to the development, those which the maintenance of the link organizes and requires. The information, *the knowledge put in loops*, whose price would be only one of the components, the organization and the local innovation, the strategic partnership in research and the decentralized co-operation would become key factors of the modes of management, production and socially efficient development.

The industrial ecology which requires the implementation of the principles of reciprocity, confidence and social responsibility, supports the vicinities ("virtual" or "physical"), the local creativity and the «deterritorialisation» of information. It can thus contribute to rebalance the two dominant poles of economic rationality, the constraint of the plan and free market, to support undertaking local energies and to promote social engineering and the citizenship.

Thus industrial ecology, organization economics, local partnerships of projects economics, ethical economics of the reciprocity, interactive economics of the link, makes it possible to associate the eco-efficiency of the firms, the cultural creativities and the global and local viability of the ecosystems and to provide the technological conditions of the equity and the strategies of integrated local development.

The industrial ecology, which introduces co-operations "over the fence" within the strategies of competition, holds a key of sustainability and it shows of it the relevance, feasibility and the effectiveness.

But it invites to challenge the disciplinary shares, the dominant idea of the specialization of labour, the bulk-headings of information and the decision and the prevalence of organisational verticalities, ascending or downward,.

It orders to deviate from methodological individualism, the economic insularisms, the institutional territorialisms and the disciplinary summations to explore, in the interdisciplinary one, the concept of development and to integrate in the same cognitive and functional unit the researcher and the expert, ethics and science, politics and the citizen, industry and ecology, the city and nature, economics and culture, the North and the South.

It offers to the project of sustainability a global design of the industrial system and a qualitative technological base. It melts the articulation between the global and the local and regional economic autonomy on the decentralized co-operation. It makes to proof neither of technological catastrophism nor of big optimism. And, by introducing a new design of the wealth, the wealth of use, it reconciles the opposites and gets rid of the summing alternative offered by the couples State-Market, growth-development, world-nation, cultural tradition - technician modernity, North-South.

She requires and integrates globalization but determines another globalization. A globalization which is distinct from that which produces simultaneously, in a competing or complementary way, the research of increasing the speed of circulation and the size of monetary flows and new products or of the extension of the additive regulation or subtractive powers of deregulation of the international, regional and national regulating institutions. These ones, in the absence of a global conceptual diagram, acting in a partitioned way and out of any project partnership with the major actors of the market and the other civil representations, appear as a simple force of coercion, with a disorganized surplus. They give rise to exclusively reactive strategies which worsen in fact their impotence and nourish the gears of the confrontations inside the couples State-Market, South-North, in which the seconds come out always victorious and sustainability always remains on standby.

3. About the construction of a virtual eco-pole of activities: theoretical fruitfulness and the local practical range of the reconceptualisation of the industrial system on a worldwide scale

The numerical construction of a eco-pole of activities, like prototype of demonstration but also of questionings, is a scientific and practical need to test the relevance, the fruitfulness and the limits of the analogy between industrial system and biological ecosystems and to define, *within the framework of an overall prospect*, the parameters, the methods, the obstacles and the criteria of a virtual evaluation of industrial sustainability articulating the local and the global, conscious of the ethical dimension of the sustainability and the cultural declension of the firms.

In practice, the local figures of eco-development of the industrial system know, in the experimental achievements, two spectacular forms, especially in Denmark, Canada and the United States. They are systematized in a concept which remains still that of the engineer, the industrial eco-park. This concept does not integrate all the global dynamics of the territory and the milieu in the technological processes and do not have interest in the social aspect.

The industrial eco-park could, technically, be described within its operation like a community of producers localized on the same site, centered locally around the mutual management of local flows of material, of energy, waste and information and forming an eco-territory of networks of exchanges in order to simultaneously increase the environmental and economic, individual and collective, local and global performance. Unlike the first case, the producers constituting a virtual industrial eco-park are geographically separated. Based on a regional approach and a numerical bank of data which is based partially on a knowledge of the components of the production process, it makes it possible to identify virtual links between existing and potential firms. By binding flows of material and by developing the exchanges of sub-products on a regional basis, this last approach makes it possible for the firms to explore eco-industrial connections on a more extended existing space and to better prevent the chain breakages, the risks of micro-economic instability and temptations of delocalization. The firms form, here, a eco-network of territories which overflows and recomposes the local "physical" borders.

However, the second case is not just an artifact, by default, of the first case, it is also an extension - which remains still technical – of the first case.

He raises the question of the territorial borders and the thresholds of a network of eco-connections and that of the conditions to which the regionalization of such exchanges could make it possible to the firms to make use of the opportunities of the world industrial infrastructure to carry out exchanges which, while resulting in the local lengthening of the loops of the cycles of material, would provide a general reduction, and on a worldwide scale, distances within an overall recombining of the loops of material.

The question of the articulations between the numerical networks of territories and the analogical territories of networks thus becomes a major aspect for industrial sustainability and sustainability in general.

Though simplistic, these local organizational forms, these local attempts of industrial ecosystems, are of the interest to work modestly but firmly starting from the existing constraints of the industrial system as a whole and the generic, geographical and historical relationship with the city on one hand and with the economic one on the other hand. They try, by and in the local, to redirect towards environmental maturity, the technological trajectories of this industrial system. In practice, the combination of the two forms is as necessary as useful but insufficient...

Because, even if the industrial eco-park tries to transform locally into an ecosystem the local industrial activities which, taken individually are not such, the hyper industrial society is not reduced to the local or regional industrial production. This one is a whole. The city, the mobility, the globalization, the diffuse dissemination of the pollutants, the information flow, the cultural segregations, are also aspects of its present reality. The

strategic choices of sustainability must thus be transported on the scale of the global social system and the great technological trajectories.

Consumptions, productions, representations and activities of the local populations are not circumscribed within the activities of industry nor to local flows of material which the parks organize, generate, enter or evacuate. They have activities of dwelling, transport and communication which draw their supplying and their representations of a much wider cognitive and material planet.

The inventory of the symbiotic groups of activities, the industrial biocenosis and the trophic networks thus proves essential to consider the whole of the practices of a territory, to trace its trophic territories and to be able to think its eco-reorganization. The latter makes out the local, the social, the cultural and the world an indissociable question within the knowledge and technological creation joined together inside the same long act of research and actions caused in a co-operative way by the implementation of the eco-industrial connections.

The reconceptualisation, in terms of ecosystems, of an industrial system, which cannot be reduced to the industrial activity nor to its local organization in terms of parks, is essential to the practical implementation of sustainable development. The materialization of this reconceptualisation must in parallel insert in them a global vision of the possible operationalization of an industrial ecosystem on a worldwide scale and create its own margins of creativity and ductility in a world scale.

Industrial ecology offers a global comprehension of the operation of the industrial system and thus allows an optimal management of the resources and a regional territory of which viability could be that can be planned in a decentralized and participative way. With this intention, industrial ecology has a technical tool, the industrial metabolism of a substance, a group of substances, a product, a flow of products, an organization, a community. It can describe the qualitative and quantitative characteristics flows and stocks of matter and energy "from cradle to cradle" by integrating there synergies, the translocations and nonthe substitutability of certain environmental "services" of which the essential dangers are initially the effect of the industrial company on the disturbance of the cycles of the biosphere and less the wasting of the resources. It identifies the critical states and can define the priorities. It makes it possible to evaluate the potential risks and the suitable strategies of control and prevention of diffuse pollution.

But this reconceptualization must be fully accomplished: Industrial ecology provides a framework to understand And to transform the relation between cities and industry, The global world civilisation and the organization of local activities whose the numerical territories of networks would be one of its components.

It must be able to show its consequences upon the whole types of organizations, spatial occupation modes, life styles, but also upon the values and representations, disciplinary concepts which give them coherence, which justify them and leads them: economics, management, geography, law, philosophy.

The virtual eco-pole of activities concept, linking the analogical and numerical territories, could be a more appropriate physical representation to give back to the local its capacities to achieve a sustainable community and to develop, to expand by clusters, by diffusion and by successive steps, all the social technologies, locally initiated into a global view of the precise links introduced the industrial ecology into the global sustainability and induced by this sustainability into the social functionings, the governance modes and the world representations.

The eco-pole of activities, eco-networks of emerging projects of local eco-restructuration territories, which integrate industrial eco-park but a complete local perspective, is a concept of positive, attractive and rich local which is in the heart of urban eco-revitalization and of world industrial infrastructure.

It assembles simultaneously an eco-network of territories of projects and projects of eco-networks territories. The eco-pole *Phillips Eco-Entreprise Center*, introduced above in one illustrative document is a partial example.

The construction of a virtual eco-pole of activities, whose practical, heuristic and cognitive relevance is to be specified, its capacity of transposability or cultural adaptability and its practical exploitation, will cause necessarily interdisciplinary and international debates inside the team. The stake of these debates is, essentially, of anthropological nature for the industrial societies of the North, of economic and cultural nature for the North-South relationships, cultural, social and ecological for globalization and, through its conceptual, political, ethical, methodological and epistemological contents, for the transdisciplinarity induced by sustainability.

The course is to be built but the elements of the file are collected.

4. Methodology, principles of work and implementation of interdisciplinary work

- The research-action and work in network

EPIC and its partners have a national and international network of correspondents: researchers, academics, experts, members of Non Governmental Organizations. The members of the network are, for the majority, people involved in initiatives on the ground in the field of their competences and able to conceptualize and transmit their experiments. The network was set up in response to place orders and by spreading, during many missions of work and research abroad. The Earth Summit 2002 in Johannesburg, where the association EPIC was represented, devoted its links with the Non Governmental Organizations and the researchers interested by sustainability with the ongoing constitution of an international federation of researchers and actors of sustainability.

Within the network, the core of the made up team will control the criterology of the choices, the preparation of the investigations, the development of a grid of comparative evaluation, the organization of the consultations, the exchanges of information, the collection of the documents, the organization of seminars and evaluation of work, the set of themes of a conference, the writing of the stage reports and final report (sequence #1) and the installation of the numerical platform (sequence #2)

- The thought - self-realization

The construction of a virtual industrial eco-park is even accompanied by a thought on its production and offers the opportunity of a thought on the stakes of the articulation between the numerical territories and the "physical" territories.

- The comparative method

The choice and the framework of the object even of research requires it.

- The decisional multi-partnership of project

The partnership and international implication in the same structure of research is under the researchers and institutional and associative confirmed professionals' responsibility.

- The systemic approach, methodological holism, transversal approach, interdisciplinary work

The objective of the sequence #1 of the project is the interdisciplinary construction of conceptual tools of industrial sustainability and the exploration of its range on the new configurations of the knowledge and the new scientific contents. The concerns raised by the concept of sustainable development are multiple, and the new fields of study are numerous. The methodological approaches and tools are still missing or are in exploratory phases. The conceptualization still gropes. In the current situation, one tries to select indicators from the economic and social point of view as well as from the environmental and of the development one. When, for instance, states of the environment are drawn up, the steps consist in collating statements of the pressures and impacts or setting up structures and procedures allowing this monitoring. At this stage, certain statements of facts can be put in but the analysis, that it is uni-criteria or multi-criteria, remains hazardous, the link between the various observations necessarily being objectified or not being validated. Industrial ecology escapes from this temptation.

But the evolution of the present knowledge passes, as in the past, by empirical phases of observation and collating of facts to start binding them together. It passes through hazards, too. "The paths towards complexity are at the same time those of a knowledge which tries to know itself", notices Edgar Morin in its book "Science with conscience raises". The juxtaposition of information is a phase. A dynamic cognitive approach must in particular be set up at the researchers' level, to recognize and accept complexity and to implement methods, techniques and practices to take it up.

The choice of a transversal systemic approach articulated with the practical research-action appears suitable to compare the steps of the various ground teams formed, in this case in network, and to consider possibilities of transposition between local various initiatives.

The research-action would take place on each of the grounds and, to support the implementation of interdisciplinary work within the project, would consider the practices of work and also on the exchanges between teams working on topics related to the concept of industrial ecology and durable development. On another side, the examination of the practices will have to also put in perspective those in the context of the local and global stakes.

The concept of durability relates to the interrelationships between the man and men and the man and the biosphere. For industrial ecology, the outside and the inside are not separable. The new field of study and the new object of science: "Le lien-le lié-le liant" introduced by the concept of sustainability submit conditions to the development, those which the maintenance of the link organizes and requires. It invites to question the disciplinary divisions, the dominant idea of the specialization of labour and the compartmentations of information.

It orders to deviate from methodological individualism, the economic insularisms, the institutional territorialisms and the disciplinary summations to rebuild, in the interdisciplinary one, the concept of development and to be able to connect on the one hand ethics, politics and science and, on the other hand, industry and ecology, the city and nature, the economy and the culture.

The concept of industrial ecology, which integrates an oxymora in its terms, is by construction trans-disciplinary. The reconceptualisation of the industrial system that it orders has a range on all of the other disciplines and constitutes, through the concept of eco-efficiency, an essential anthropological challenge for the industrialist North.

TOOLS OF INTERDISCIPLINARITY

METHODOLOGICAL HOLISME SYSTEMIC APPROACH, ETHICAL STANDARD AND TRANSVERSAL APPROACHES

- * **ONE IS NOT ALL.** No part of a whole, whose elements are put in interrelationship, has all the intelligence of itself, neither of all the intelligence of each other part of this same all, nor of all the intelligence of this all. It does not transmit and collects only minimal information necessary to its survival and its functions (**principle of the minimal effort**). No part of a whole can thus represent, control or impose itself to the whole.
- * **A PART IS IN A WHOLE.** The reproduction of an element of a system resulting from all the interactions of its elements depends on the capacity of the system to maintain its structure (**principle of downward constraint**).
- * **THE WHOLE IS MORE THAN THE SUM OF THE PARTS.** The setting in interrelationship of elements results in the appearance of new properties (cognitive capacities) unknown of the elements taken separately (**principle of emergence**). The correct functioning of an element depends on the quality of information that the whole provides its (**principle of downward interdependence**)
- * **THE WHOLE IS LESS THAN THE SUM OF THE PARTS.** Each element have activities which are ignored from the whole (**principle of specificity**). The correct functioning of a system depends on the quality of information that each one of its elements provides its (**principle of ascending interdependence**)
- * **AND THE WHOLE IS NOT ALL.** To reach a given goal, a system can use several different ways (principle of equifinality). The quantity of constraints which is deployed on each element of a system always corresponds to the necessary strict minimum to ensure the emergence of the finality of the whole (**principle of local autonomy**) at the same time as are preserved the degrees of freedom allowing other possible purposes (**principle of minimal constraint**). No central element of a whole can by itself and for itself to control, decide or impose itself to the whole.
- * **BUT THE WHOLE REMAINS A WHOLE:** The industrial system remains a social production and this one cannot be apart from the biosphere. Sciences cannot dissociate nor to be dissociated from ethics, politics, culture and the imaginary: the satisfaction of the vital needs, the respect of equity and of the cultural difference, the conservation of the species, the individual social responsibility and release of human imaginary by any knowledge.

Example of methods of implementation of interdisciplinary work used in the experiment of the GEEPSIH (Université libre de Bruxelles)

Work of the GEEPSIH at the ULB articulates research-actions and actions in the Environment-Health field. One of the contributions to the field of the evaluation of the risks was, from field data and laboratory analyses, to set up a methodology of ecosystemic nature to improve the scientific base of the development of standards of protection of the public health and environment.

The research-actions relate to the evaluation of the health risks for the Man of exposures to domestic or industrial pollutants. They allowed to highlight various weaknesses in the traditional approach of evaluation of the risks and in the modes of development of standards, to test various assumptions, individually or combined. The traditional approaches have a lack of sensitivity when specificity is high, or a lack of specificity when the sensitivity is good. According to our opinion, there was an inadequacy at least partial between the selected approaches and the existing problems, linked to the compartmentation between various disciplines.

On the contrary, the consideration of the complexity of the system and the identification of sequences of events put forward the interrelationship between many parameters and their relationships with the time horizon. This nourishes the analysis of the causality of associations between parameters of various levels. These are the endless interactions between research and the ground and the integration of information which made it possible to identify the problems of the traditional approach, shown the interest of an alternative inductive approach and validated this one to correctly identify the degrees of exposure and the more vulnerable groups.

The realization of the research work is the fact of a collaboration of scientists and welfare officers in a really interdisciplinary spirit. With not very invasive means for the people, the research-actions have already formulated certain very concrete measures to the authorities for a better protection of the examined populations, regarding the management and control of health risks related to the environment. They provided recommendations having had various impacts on the development of standards and government regulations. The development of one of the projects - the "Network of Intervention in Health and Environmental Quality" - in the form of a non-profit-making association articulated with the research-actions carried out - intends to contribute to a concrete implementation of the sustainable development in the field of the Environment and Health. The contacts with the families, the authorities, the experts and other actors are the opportunity of various sensitization to meet the sustainable collective needs – such as the access to salubrious resources (housing, living milieu, food, water...) and to the relations between these questions and the socio-economic level. The approach quantifies and models the structural nature of the problems of pollution and those of public health which they imply by showing in particular the link with the industrial wastes and the characteristics of opening of the industrial society in Belgium and elsewhere¹⁻².

In addition, the approach - in the form of an application in the field of the evaluation of the chemical risks on the ecosystems related to the anthropic blow described by industrial ecology - is included in the pursued teaching in Ecotoxicology where it is in particular the subject of a reflection compared with the methods of the regulated evaluations by the European Union in the fields of the evaluations of the ecological risks and the risks on Human beings³

¹ "The Belgium Ecosystem. An Essay of Industrial Ecology " collective document G Billen, F Toussaint, P. Peeters, M. Sapir, A. Steenhout and J-P. Vanderborcht, Socio-Political Information and Research Center, Brussels, 1983.

² " Ecotoxicological Study of the circulation and the accumulation of Pb on Human and in his environment" Doctorate Thesis in Sciences, Université Libre de Bruxelles, A.Steenhout, 2 volumes, 1986.

³ "Courses in Ecotoxicology and Evaluation of the Risks". A. Steenhout. Course given to the students of the "Diploma of Specialized Studies in Management of the Environment" of the Institute for the Management of the Environment and the Regional Planning of the "Université Libre de Bruxelles", Annual Edition since 1994

5. Originality of the project - Collaborations - Valorization

The originality of the project is multiple:

The choice and the fruitful range of the field of research, the industrial ecology, young science, unknown and object of confusion with environmental industries, green or clean technologies and the "cleaner production".

The exploration of a concept, the concept of industrial ecology, an oxymore which joins, by its terms, together, and from its construction, an interdisciplinary contents, calls simultaneously hard sciences and social sciences and set itself as an objective the overstepping of the discrepancy between two disciplines, economics and ecology and two fields traditionally antagonistic, industry and nature.

The exploration of the range of an subject of research, the local construction of the eco-industrial connections through its own emergence, its development in practice.

The mode of treatment of a subject by a research team engaged in the field of the experimentation and which articulates the systemic analysis, the methodological holism, the comparative approach and transversely associates the ground, the techniques and the theory.

The applied interdisciplinary construction of a practical and operational subject: the virtual eco-pole of activities.

The trilingual numerical edition (English, French, Spanish) of the progression of research, the results and the final report.

But more especially:

The research-action... that by which the actor of the field and the researcher are simultaneously put in situation to exchange their information, to conceptualize them together, to give them a practical application and that by which a common need, the information flow and its permanence, finds its structure.

The meeting on a common work of the researchers of the human sciences, social sciences, sciences of the material simultaneously associating the practices, the techniques and the theories to reinforce the concepts and the analytical tools of the trans-disciplinarity.

The partnership of decision on project between institutions in the field, the research laboratories and confirmed associations - and thus between their actors -, the crossing, in the same structure of the project, experts, decision makers, members of associations, researchers, and academics is another strong originality.

This partnership and this structure register in themselves the need for scientific research for holding together the researcher and the information sources which it needs and to create them and to join them together with the actors who produce it in a rough state within the act of research.

In addition to the communication of the results to the researchers community, another manner of developing a knowledge is that it can give place to practical, perceptible and experimentables achievements and whose social echo can be simultaneously carried by actors of the field and the

researchers. It is even the manner of self organizing and of working of the team which is formed. Inserted for several reasons, in full, multiple, various and crossed networks, the team of research is not a summation of individuals or existing structures but actors who work and practise the interdisciplinarity, the interprofessionalism, the international field, the intercomparability, on the field and in network, and have a meeting on a new joint project. It is perhaps there an invaluable originality there. The planned conference, the organization in network, the implementation of the numerical virtual eco-park, the numerical edition of the documents in 3 languages (English, French, Spanish), innovative topicality of a concept which meets a practical and theoretical need and the diversity of the involved actors in this project, whom many of them have many achievements in practical field, guarantee the diffusion of the results, the resonance of the debates, and the valorization of the learning studies.

- drafting and submission of the report of stage: results of ground, treatment of the methodological questions and first conclusions

13-18 months: cognitive working and conceptual production

setting in interdisciplinary phase of the concepts of the sustainable development and the concepts of the durability of the industrial system

conceptual and technical conditions of durability principles and local operating mode of the industrial system of sustainability conditions of the practical, scientific rigour and ethics of durability relevance, fruitfulness and limits of the analogy between industrial system and biological ecosystems "methodological toolbox and best practices" tools for evaluation of the policies and the actions of industrial sustainability interdisciplinary variation of the concepts of the sustainable development and the the reconceptualisation of the industrial system: stake and means of the interdisciplinarity, anthropological stake for the companies industrialists, economic and cultural stake in the North-South relationships, resulting social and ecological for universalization

- launching of the international conference (14th month) on the topics, the results and the questioning of the team which will be held approximately 2 months before the submission of the final report for purposes of evaluation before final drafting.
- drafting and submission of the report of stage: results of ground, treatment of the methodological questions and first conclusions

19-24 months: developments and preparation of the sequence # 2

22 2nd month: international conference on the topics and the questioning for diffusion evaluation and deepenings of the first results

translation of the methodological, technical and theoretical results for the preparation of the sequence # 2 (the construction of the virtual -pole of activity)

drafting and submission of the final report

trilingual numerical edition of the final report/ratio (English, French, Spanish)

25-36 months: sequence # 2:

The interdisciplinary construction of the virtual eco-pole of activities

In reflexion-action-creation, it is the practical result of the work undertaken at the time of the sequence n?1 formatted experimental within the framework of a virtual model on numerical platform operation, the representations, the concepts and the tools for evaluation of the industrial system of local and total sustainability, the local cultural variations of the model, the practical achievements of the transdisciplinarity enter in debate

- methodological Tools, parameters, criteria of evaluation and virtual operation of industrial durability
- Articulations between the analogical territories of durability and the numerical territories.

The elements of the file are joined together, remains the course to trace once the results of the acquired preceding sequence.