Instruments for the promotion of a sustainability oriented management of waste by inter-industrial coordination within an industrial region.

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1. Closing the loop and minimizing the output-input distance

The extraction of materials from nature always goes together with the consumption of large quantities of valuable energy and material resources. As this process is often accompanied by an even greater extent of resource degradation caused by environmental damages, the rise in material efficiency within our human technosphere should be one of the central goals in order to reach a more sustainable path of development. One of the main approaches in this direction is the closure of material loops within our economic system. Wastes should thus be transformed to secondary materials – wherever the total resource consumption of the recycling-oriented reduction process is lower than that of primary production. This latter statement is a very important restriction, as it indicates clearly, that a simple closure of a material loop is not necessarily superior to the use of nature for resource provision and waste disposal. Therefore human creativity should not only concentrate on the technical feasibility of loop closing, it should also concentrate on the minimization of distances between undesired outputs (wastes) and desired inputs (in the form of secondary materials) (Sterr 2001/2002; Sterr 2002). In this sense resource saving effects should be searched at least:

- in a substantial rise in the rate of reuse as well as of recycling processes that should be accomplished successfully with minimal downgrading effects
  → reduction of entropic[1] distance between output and secondary input.
- in a systematic lookout on spatially close output-input relations
  → reduction of spatial distance between output and secondary input.

And these two dimensions should be combined with a substantial rise in informational exchange between different actors, in order to reduce transactional costs or to remove obstacles of cooperation

→ reduction of social distance between actors.

2. The Pfaffengrund approach[2]

As practical experiences that where made by IUWA[3] during a research project in the industrial estate of Heidelberg-Pfaffengrund had shown clearly, especially SME have great difficulties in making substantial contributions to an industrial closed loop economy. Furthermore they paid for it with clearly higher costs per waste unit and a far greater extent of risks and uncertainty towards environmental regulations.

When the researchers from IUWA tried to identify the reasons for that finding, they recognized:

- that this was especially due to the fact that SME have to dispose a relatively wide variety of waste in relatively small quantities
  → limited possibilities for the realization of economies of scale but also
- that the companies' waste management was usually less than a one man show, as the employee who accounts for it has to do this job beside other major tasks.
  As a consequence of this situation, waste disposal enterprises often know more details about the waste situation than the industrial producer; In Addition, interesting opportunities on the waste market could not be observed on a regular basis.
  → limited information about actual waste-related data from inside and outside the company.
- That contacts among waste managers of neighbouring companies were restricted to former workmates
  → almost complete absence of inter-industrial communication even within the industrial area with the consequence, that confidence for the exchange of information and the identification of synergetic effects had not developed.

As many of the enterprises had to dispose rather similar kinds of waste and as they were situated in close neighbourhood it was one of the main hypothesis of the researchers from IUWA, that these SME should be able to reduce the delta of disadvantages compared with large companies to the extent that they are able to copy their internal situation. And indeed, the empiric results of the Pfaffengrund-approach proved clearly, that inter-industrial communication, informational exchange, virtual pooling of specific waste quantities, succeeded by substantial coordination processes resulted in rapid changes, as economic and ecologic win-win-situations became quite obvious without the need of greater technical investments.
As the Pfaffengrund area did not host more than 10 industrial producers with more than 100 employees, the probability of finding a fitting partner for waste-based input-output relations was rather low, which lead to the question, how far the system had to be extended spatially, in order to allow the closure of specific material loops. The regional level of the Rhine-Neckar Triangle already seemed to provide the critical masses for almost all of the major kinds of waste.

	Spatial dimension					
Closed-loop oriented process	Company level (internal)	Industrial site level	District level	Regional level	Directly neighbouring regions	More distant regions
Composting		accidentally	typically	in some cases		
Recycling of building rubble		accidentally	typically	in some cases		
Repairing of used pallets		accidentally	typically	typically		
Re-granulation and Re-melting of plastics	in the plastics industry sometimes already within the production process	accidentally	Often	typically (PE, PP, PS)	in some cases	
Oil Recycling	In some large enterprises (Emulsion cracker)	accidentally	in some cases	typically		
Recycling of electronic scrap		accidentally	in some cases	typically	in some cases	
Wastepaper recycling		accidentally	accidentally	typically	typically	in few cases
Recycling of scrap metal[4]	if the producer is a foundry	accidentally	typically (shreddering)	often (shreddering)		typically (blast furnaces of the Rhine-Ruhr area)

Fig. 1: Spatial dimensions of loop-closing processes (here: production – reduction connections) in the industrial region of Rhine-Neckar[5] (Source: Sterr 2001b)

3. Potentials of the regional dimension

As shown in Fig. 1 the spatial dimension of an industrial region with about 1.9 Million inhabitants proved to be large enough to allow the closure of material loops. This was an important finding, as it stood for sufficient economic, technical and organisational potentials and thus for the problem solving competence of representatives of private industries. Above that several actors are usually found not only on the supply but also on the demand side, which

means, that a considerable redundancy of actors can be stated and that the stability of a (potential) system is (/ could be) rather high.

These facts allow at least an economic oriented management of waste on the level of an industrial region. And if we add the facts that the Region of Rhine-Neckar incorporates two important universities and a couple of other educational and research institutes, high level science is also part of the endogenous pool of force. The same is true for politics with three major cities with more than 100.000 inhabitants and a mutual regional planning agency. The potentialities for endogenous dynamics coming from the regional dimension are thus very widespread.

Nevertheless the question has to be asked, why this spatial dimension should not only speed up economic processes but also a sustainability oriented development? Indeed there is no inevitability that this would be the case, but there is a great variety of factors that point clearly in this direction:

1. Causes and effects of decisions overlap on the regional level to a relatively great extent, which means that industrial decision-makers decide about their private quality of live and that of their families and neighbours. Possibilities to externalise negative environmental effects of own decisions may thus be limited.
2. Regions with a long history[6] have usually developed regional identities, which promote feelings of responsibility by a large number of different representatives of society within the region. The probability of the development of a complex social milieu that is not only characterized by mutual help but also by public control, is rather high.
3. Mutual personal confidence which is a precondition to cooperative action can be developed rapidly, because face-to-face contacts can be provided regularly, they can happen by chance but also planned and spontaneously, whenever there is a need for it.
4. Especially in the field of waste management the problem solving competence of an industrial region (economy – science – politics) is very high. It is embedded or even constitutes a milieu that provides the preconditions for sustainability oriented solutions and can get rather creative.

Fig. 2 Potentialities of the regional dimension as a breeding-ground for sustainable development (Source: *Sterr*, 2001/2002, p. 308)

4. The Rhine-Neckar approach[7]

Although the potentials for a sustainability oriented development on the field of waste-based output-input relation are rather large, this capacity is far from being exploited. This is at least partly due to the fact, that adequate instruments for inter-industrial exchanges or even inter-organisational exchanges had not yet been developed on the regional level. Considered the fact, that the largest deficiencies were found in the informational situation of SME two kinds of instruments were developed to facilitate the acquisition and the advantageous usage of waste information by inter-industrial coordination on the level of the industrial region.
As information on the composition of a certain waste is relatively scarce, the transfer of materials is accompanied by substantial costs for control, that can only be diminished or substituted by mutual confidence between the two actors. And even a pure informational exchange of waste manager-data between different enterprises would hardly work without a face-to-face contact. Our transparency-guided approach to promote regional sustainability did thus include the development and institutionalisation of an inter-industrial network, that first of all incor-

porates industrial producers (especially SME) but also other actors, that stand for the problem solving capacity of the region (i.e. Universities, political administrations and other institutions) and can thus contribute to the identification and implementation of sustainability-oriented solutions in such a living space.
As informational coordination between a growing number of potential partners becomes more and more complex, there is a rising need for standardized information. This can be found in the comprehensive, clear and systematic informational structure of a waste management system, which we developed as a software tool. The software was designed to meet all the needs not only for internal information and communication but also for exchanges with potentially fitting output-input partners outside the border of the enterprise.

4.1 Promotion of informational exchange and common action on the regional level

Within the boundaries of a company, information systems are well developed and opportunities for establishing of personal trust are abundant. Informal nets thus often exist even without being regarded or identified as such. And even if they don't dispose of platforms for regulated discussions, the chance of finding promising solutions by chance stays quite good.
If the boundary of the enterprise is crossed, there is a sharp fall in the number of contacts as well as the quality of information transferred. Furthermore, even the contacts within an industrial site are more or less restricted to contacts during trade fairs. In addition to that, these people are working more or less in the same input-output system and thus the probability that someone is found, who is interested in somebody else's waste, is almost zero. On the other hand, the problems that have to be solved in the area of waste disposal management are usually rather similar, regardless whether they belong to the same industrial sector or not. For this reason even different partners could profit at least from synergetic effects of informational pooling and, in addition to that, on common action towards the waste disposal industry.
If we look for enterprises that are connected vertically, the informational exchange between them is comparatively well developed. Indeed coordination along the productivity chain have already lead to substantial integrated approaches along the whole supply chain with the effect of a sometimes even total renunciation of special toxic substances in the production process, or a significant reduction in materials intensity and undesired outputs. This kind of development has only poorly taken place between companies, that stand in horizontal relations to each other, because they often share the perception of being more or less direct competitors. And it is almost inexistent between two actors that would constitute a relationship beyond a

vertical or horizontal dimension. On the other hand, such diagonal relations do possess different input-output-structures and they do want to reduce input costs, e.g. by substituting primary through secondary materials, what makes them very interesting for waste based connections.
What is missing is a platform that can bring them together. In fact there is usually no institution apart from the Chambers of Commerce that could contribute to these processes. However, this facility can only care about the presentation of general subjects but it is not able to dip into individual problems of the management of specific materials. As waste is usually regarded as rather a sensitive subject, even the transfer of waste related information requires a high level of mutual trust between potential partners. A neutral positioning of the informational knot should thus facilitate the transfer process, if it acts carefully and respects individual sensitivities. In the Pfaffengrund-project the IUWA had been perceived as such, and thus a network nucleus could be developed[8]. It did not incorporate more than 14 companies which were all settled on the same industrial site. The aspect of spatial proximity had thus been used as a key element to create or strengthen social proximity and mutual trust and thus to create an environment that maximized the intensity and quality of informational transfers and minimized transactional costs.
On the other hand Fig. 1 showed clearly that the problem solving capacity in the field of loop-closing connections within an industrial site is rather low, compared to that one, which could already be achieved on the regional level. Thus the network of the Pfaffengrund-nucleus had do be extended constantly but carefully from immediate spatial neighbourhood to a more regional scale. This is the step that was implemented with the creation of AGUM[9] as a network for environmentally oriented management, that should take materials flow management as a first focus in a wider range of potential subject areas in the field of environmental management in industry. As figure 3 shows problem solutions that would be restricted on exchanges between industrial actors tend to be sub-optimal, in case they do not use the full capacities and competences. Especially the incorporation of political institutions and the use of managerial or technical competences that are developed in the sciences might be rather advantageous as they can provide additional services which contribute to a systematic look on stable, attractive and entropy-saving solutions.

Fig. 3 Potential partners of an industrial producer (1) in a closed loop materials economy presented in a systemic perspective (Source: *Sterr*, 2001/2002, p. 308)

AGUM has therefore been structured as an interorganisational network with industrial producers in its very centre, but surrounded by other key actors especially from science (IUWA), politics (municipality of Heidelberg) and intermediates (local Chamber of Commerce). Legal competence is represented by a lawyer's office. The fact that not only spatial but also mental distances and interests among the members of a regional network are far greater than those of a sub-communal one (Heidelberg-Pfaffengrund) had been one of the main reasons, why AGUM was formally institutionalised.

4.2 Inter-industrial waste data communication through the aid of a software tool

One of the greatest obstacles in the communication of data across the informational boundaries of an industrial plant is the lack of compatibility. In consequence to that, data pooling, benchmarking and other strategies that can rise the informational transparency in the waste management sector for each of the network members could only be realized within a single big effort, that stood almost at the end of the Pfaffengrund-project. As a substantial and continuous rise of network members could be expected within die implementation of the regional approach (Rhine-Neckar), innovative solutions had to be found on how to solve this problem of rising complexity.

Considering that the employees in charge of waste management in their company articulated growing problems with the provision of actual waste data for new disposal contracts, certifications, liabilities towards officials or environmental indicators, IUWA decided to develop a waste management software in close relation with industrial users.

To maximize the probability of internal application of our new instrument at each of the industrial project participants, the instrument should meet at least the following requirements:[10]

- Fulfilling the current requirements on the company level and thus ensuring the staus quo of present uses within each enterprise;
- Sticking to essential functions without paraphernalia;
- Providing security by always meeting legal requirements and related tasks of documentation and accounting (e.g. waste balances);
- Offering clues about internal weaknesses and potential factors for the growth of economic and ecological efficiency;
- Providing a simple but nevertheless flexible and error-tolerant user interface with input restrictions and multiple choice masks;
- Minimizing data input and update requirements by concentrating the needed inputs on a single entry mask;
- Providing easily accessible data reports with variable structures by providing sophisticated data analysis functions;
- Creating an added value for the company as a whole that goes beyond the information needs of the waste manager and offers potential synergies;

To raise its applicability as an instrument for an explicit support of a sustainability oriented management we equipped the software with a detailed table of indicators, which are calculated automatically. This and several other features can supply the user with important information on actual relations between different figures and may thus serve as an instrument for the identification of weaknesses or the development of the figures along the time axis.

5. Matching of the instruments

The following fig. 7 is concentrating on the actual modules of the regional approach for the promotion of waste based inter-industrial coordination in the Rhine-Neckar region. It is clearly visible, that we work with three different kinds of spheres

a.) the company's sphere, represented by the waste management software,

b.) the IUWA sphere with its trustful data pooling and data evaluation for the companies cited in a.) and for an inter-company exchange of aggregated and filtered data by an intranet-platform which is only accessible for the waste-manager users (exceptionally industrial producers) organized in

c.) AGUM, the environmental management network cited above (see 4.1.).

Apart from that IUWA is using two further instruments

a.) Umberto as a petri-net-based software for the calculation and illustration of material flows) and

b.) A regional GIS that will help us to visualize material flows in space and also to optimize route planning in the area.

Fig. 7 Instruments for communication and data transfer in a regional environment (Source: *Sterr*, 2001/2002, p. 308)

6. Conclusions and perspectives

As sustainability oriented management is not limited to qualitative aspects (in the ecologic, economic and social dimension) but also includes continuous progressions in this direction the paper cannot close without treating the question of autonomous stability of especially the newly developed instruments (waste manager software, waste analyzer software and AGUM) that were identified to be necessary or at least very useful to promote waste based inter-industrial coordination on a regional level. In fact table 1 could show, that the endogenous potential of the Rhein-Neckar Region is high enough, to further stabilise and speed up the situation. With AGUM and our waste manager we could eliminate important gaps and we were able to develop instruments, that have meanwhile been adopted by the private industry although it had to pay for it[11].

Nevertheless the financial situation is not stable yet. But as the instruments that we discussed above have already proven their applicability and as they are used by a growing number of participants we are rather optimistic in this point. Within a second period of BMBF-funding our approach surely be able not only to reach financial sustainability, but also be tested in another industrial region. We hope that the transferability of the Rhine-Neckar approach can also be confirmed by experiences in the Region of Ulm, with whom we want realize the next steps.

7. Selected Literature

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[11] entropy = measure for the degree of disorder (in a closed system).
See Georgescu-Roegen (1971) who introduced the ideas of the entropy law in economic research and made it fruitful especially for applications in the field of resource economics

[S] See Sterr (1998), Sterr (2000) p. 286 ff.

[3] IUWA = Institut für Umweltwirtschaftsanalysen (Institute for Eco-industrial Analysis)

[4] As the metal branch in Baden-Wuerttemberg is restricted on metal processing industry with only few foundries and no blast furnaces in the whole state, the metal circles are usually closed via North Rhine-Westphalia; for non-ferrous metals also via Hamburg or other states of Germany.

[5] Based on empiric studies within the "Stoffstrommanagement Rhein-Neckar" project (1999-2001).

[6] F.e. the Rhine-Neckar-Triangle on the territory of the former Electoral Palatinate

[7] Liesegang / Sterr / Ott (2000), Sterr (2000), p. 289 ff

[8] the so-called „Pfaffengrund-Arbeitskreis"

[9] AGUM = Arbeitsgemeinschaft Umweltmanagement

[10] Sterr (2001a), p. 143.

[11] See Sterr (2001a), S.49