Linking sustainability to the realm of built environment: Central Paradigms in Sustainability Research

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ABSTRACT: Sustainability oriented architecture is more and more in need for interdisiciplinary, integrated research in order to be able to integrate existing environmentally friendly technology into the design process. This paper shows how highly sophisticated information technology tools can support sustainability research, linking different qualitative and quantitative methods. It is based on the study “From Information to Knowledge” (“Von der Information zum Wissen” [1]), a pilot research project which deals with the allocation and use of knowledge in the realm of the emerging research field “sustainability” [2]. It uses highly specialised advanced information technology methods to build an information system that facilitates the analysis of large research texts. The study combines the bibliometric method BibTechMon with a qualitative analysis of artifacts combined with interviews. The basic data basis consists of 40 research reports from phase 1 of the research programme 'Sustainable development of Austrian landscapes and regions' (“Kulturlandschaftsforschung” - Austrian Landscape Research, ALR) [3] combined with other material and interviews for the qualitative research. In the upcoming knowledge and information society, the management of available information becomes a more and more stringent task - a problem well known in the architectural scientific community. The study shows the main topics that sustainability research puts forward; it shows how sustainability research should be linked with the built environment, taking the physical landscape as the common research topic. Several theses that have emerged in this study are relevant for the image of an architect regarding his soicetal wole. The paper shows ways in which these theses, developed on the basis of a study on landscapes, could be applied in understanding the self image of the architect.

Keywords: Landscape research, demiurg, circular design process, linkages between sustainability and architecture.

1. INTRODUCTION

Sustainability research produces a huge amount of available information and this can be seen as a capital and potential of the information society, but the organisation of this information needs further steps to become a knowledge. Sustainability oriented architecture – just like many other disciplines - is more and more in need for interdisiciplinary, integrated research in order to be able to integrate existing environmentally friendly technology into the design process. In the scientific discourse, scientists are mostly oriented to the scientific community through their own disciplines and the produced knowledge is increasing constantly. But the challenge of the mode-2-research and sustainability research is to establish interdisciplinary research programmes and to communicate beyond the different disciplines. where the scientific knowledge increases year by year. The realms of built environment and the research of physical landscape involve different disciplines and produces a huge amount of information.

The Austrian Landscape Research, ALR (“Kulturlandschaftsforschung) is an example of an interdisciplinary research program, addressing the new scientific discipline of sustainability. 500 Researchers, representing 40 scientific disciplines and 170 institutions were working in about 70 interdisciplinary modules on questions like biodiversity, life quality, perception, genesis and change in the landscape, multifunctionality, conflicts of usage, operationalisation, societal and physcial infrastructure, water and humid areas, town and region and as well as rural development. The project “From Information to knoweldge” uses highly specialised advanced information technology methods to build an information system that facilitates the analysis of large research texts. The study combines the bibliometric method BibTechMon with a qualitative analysis of artefacts combined with interviews.

2. BIB TECH MON

Reports of large research programmes contain huge amounts of environmental information. The interdisciplinary exploitation of this information encounters numerous barriers like different interests and available time potentials which prohibit an

efficient application of this generated knowledge. The method of BibTechMon is a software programme to analyse extensive text material which applies "Co-Word Analysis" and restructures the content of the material. With this software application, a different approach to existing information and a new handling of large amounts of text is possible. The software was first developed by the Austrian research center Seibersdorf, with the aim of monitoring limited information systems like databases of patents or scientific quotations. The innovative feature of the project "From Information to Knowledge" is the fact that we have extended this software to analyse large amounts of running texts in full text of scientific reports not only in abstracts.

The procedure in the project was the following: *"The running text and the textual description of tables and figures were stored as a whole in an access-database. To support more detailed analyses, formal units of the reports, as for example the abstract, introduction, conclusion were encoded separately. The applied code allows the identification of all parts of the original reports, and of the modules. Finally a set of 344 text sections was analysed. The final database includes the relations to the original database of the whole texts, in order to support the identification of the primary context of a word in the reports"* (Knoflacher et al 2002)[4]. With the software of Bib Tech Mon, the electronic data material was restructured in a new system: *"Not focused on analyses of single reports, but on interdependencies among all reports. For this purpose, the relationships among the reports were calculated on the basis of the standardised word list by the Jaccard index (Jij). Jij = cij (cii + cjj – cij)-1. The Jaccard index measures the number of couples between two words (cij) in relation to the occurrence of these two words (cii and cjj) in all reports. Results of these calculations are formal descriptions of the coupling intensities among all standardised words"* (Knoflacher et al 2002)[5].

We interpreted the writing of the reports as an encoding of the research texts, which normally leads to a decoding in the process of reading. Each scientific discipline applies particular code for representing its observations or ideas. In this new way, the bibliometric method serves an interdisciplinary approach as it further continues the process of encoding and decoding which is typical for any written communication, and opens it for further interpretation in a new context. The result of this bibliometric analysis is a network of keywords originating from all reports of the Austrian research programme on cultural landscapes which in the present analysis serves as typical example for sustainability research. It invites for qualitative as well as quantitative interpretation, even a way back through the decoding process to the original context: "All words can be presented with the whole section of the texts in the reports without any further consultation of the original reports"(Knoflacher et al 2002)[6]. With the restructuring of keywords in a new logic, a new connection between the disciplinary information is available. As there is a common understanding of sustainability as a place for interdisciplinary communication, we now proceeded to a next interpretation loop: how can a strictly qualitative hermeneutical approach be combined with the Bib Tech Mon results?

3. ARTEFACT ANALYSIS

The qualitative methods of social sciences supplemented the methods of BibTechMon and introduced its potential and capacity of deep and structured analysis of process oriented paradigms. The empirical material for the qualitative approach were an artefact and a set of interviews, both were analysed using the techniques of objective hermeneutics (Oevermann 1993)[7].

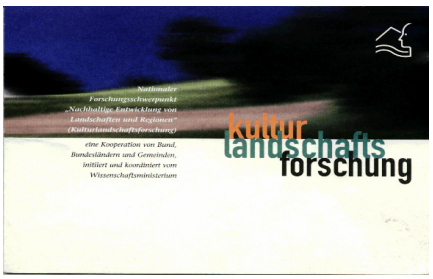

Figure 1: the artefact: folder of the ARL Research Programm, first page of six

With the analysis of the artefact, the research follows the basic ideas and the paradigm of the scientific community of the ALR Scientific Community. In the objective hermeneutics loop, the meaning, expectation, and the appearance of the material, including the inputs of production, are under consideration. In addition, we conducted several interviews with scientists related to the ARL programme as programme manager, scientists or observers. After transcription of the interview material, systematic analyses, and interpretation circles with specific experts, the research continued with the process of hypothesis building in a process of verification and falsification of the emerging theses within the given material. The following theses are the results of this qualitative approach representing a theoretical model that describes and reflects the main subjects of sustainability research.

Thesis 1: Future

Sustainability research deals with the perspective of future ways of life and considers "to protect and to maintain" as basic values.

Thesis 2: Causality

Sustainability research has a larger view than the cause-effect-theorem of natural sciences and sets the context of a more complex notion of reality based on understanding.

Thesis 3: Idyllic Nature, Demiurgical Man

The concept of a safe and sound nature is an underlying perception in sustainability research as well as a concept of "man as a master of nature".

Thesis 4: Spaces of Possibilities ("Möglichkeits-räume")

Sustainability research is based on the idea that man/woman disposes of spaces of possibilities for his or her actions; but it tends to overestimate and overrate the possibilities of decision making by the singular individual and underestimates the societal context and the constraints of value systems, of culture and politics.

Thesis 5: Relocalisation ("Verortung")

Sustainability is related to place and space and shows conflicts of usage at the example of common living places.

Thesis 6: Complexity

The integrative approach of sustainability research creates a compatible research methodology: interdisciplinarity, transdisciplinarity and thereby team research.

Thesis 7: New Research Questions

Sustainability research takes up new research fields: this research reveals latent aspects that are not yet fully thought out and are therefore a challenge for science.

4. BRIDGEWORDS

Bridgewords combine the theses about sustainability with the quantitative approach and combines different information systems. By the term information, this study understands structures with inherent rules for order like reports, images and texts. The same source of information can carry different levels of information (a picture or a photo, for example, carries the direct and manifest impression as well as a latent symbolical message). Knowledge, to the contrary, is the application of information in a new context – like the developing of new thoughts, the formulating of texts or the manufacturing of products. As sustainability is such a new context where information form different disciplines should be put together to form new knowledge, a combination of the existing information according to new rules constitutes a promising approach, based on information theory to guide into a harmonisation between the qualitative and quantitative methods.

Main research question: Which words and topics are typical for the emerging research field of sustainability?

The horizontal statistical analysis goes beyond the level of specialisation and the thematical definitions and shows which words are equally distributed over all report texts (within their disciplinary context, some words are used much more often than in another one). It gives a comprehensive profile of frequency (Häufigkeitsverteilung) for every keyword according to the studied reports. It came up with the following results, showing which words constitute a thesaurus of sustainability through all the reports of the Austrian Landscape Research. Statistically speaking, the bridgewords are those whose frequency above the modules in the texts have a low variance. These results represent a combination of part of the bridgewords like "system" or "environment", which are words that are used in the different scientific disciplines and contexts that deal with sustainability. The precise definition of these words may be different from discipline to discipline, yet they form a bridge between the disciplines and can be considered as anchor words for the interdisiciplinary communication. Our results allow for the thesis that sustainability has a special jargon which BibTechMon describes as words with high horizontal presence.

In this procedure, we used all sorts of words - nouns as well as verbs or adjectives, in some cases even grammatically interesting forms. They are the result of several steps of cluster analysis. Conducted by the qualitative approach, we applied a horizontal anlaysis (Querschnittsanalyse) and we came up with the following template.

The 86 most frequent keywords in ALR with high horizontal presence (Querschnittspräsenz):

Table 1: The 86 most frequent words in ALR with high horizontal presence (Querschnittspräsenz)

entwicklung	169	entwickeln	66	hilfe	48	ermöglicht	30
unterschiedlich	163	theoretisch	65	einsatz	48	detailliert	30
wesentlich	141	zukunft	62	erfahrungen	48	gesamt*	29
österreich	127	ergeben	62	zeitlich	46	rasch	26
ökologisch	123	gesamt	62	viele	46	europa	25
beispiel	115	veränderung	61	praxis	44	unbedingt	24
ökonomisch	105	haupt*	58	trotz	44	änderung	24
sinn	103	wenig	57	vielzahl	44	regelmäßig	23
ziel	99	intensiv	56	erfassung	42	pflege	22
bereits	98	system	56	reihe	41	dauer	21
zeit	93	struktur	55	bewertung	40	beobachten	19
grund	84	definition	55	verwendet	40	beobachtung	18
daten	84	boden	54	pflanzen	40	eignen	18
basis	78	gruppe	54	relativ	40	erlauben	18
ressourcen	78	möglichst	53	zeitraum	39	institut	17
grundlage	78	kein	53	erhebung	36	verbessert	17
konzept	77	weg	52	wegen	35	zusammengefasst	16
schritt	77	methode	50	ansätze	34	digital	15
wasser	76	auswahl	50	bericht	34	flüsse	14
notwendig	71	anzahl	49	erkennen	32	universität	14
komplex	68	qualität	49	wiesen	32		
sollte	67	komplexität	49	zielsetzung	31		

When combining the qualitative thesis process with the quantitative analysis, we can now define these notions on a combined basis. Starting from the statisticial incidence, we combine the thesis of sustainability focusing on the meaning of the counted words by lingustic interpretation. Thereby the extraction as well the contextual application of the words were considered.

Thesis 1: Future

Thebuilding community, by it intrinsec self definition, deals with the future: the future house for the client, the future devleopemnt of the city. With this topic, it fits into the overall landxcape of sustaianblity research: future orientation is a relevant factor as it is the point of encounter between research and societal development. In the sustainability research, this aspect influences the focus of studies and research questions.

The following bridge words support the thesis that sustainability deals with the future and future strategies of development (in decending order):

Entwicklung (development), Ziel (target), Konzept (concept), Schritt (step), entwickeln (develop), Zukunft (future), Veränderung (change), Weg (pathway), Änderung (change).

The word “Entwicklung (development)” is one of the most frequent words: This word certainly suggests that the researchers, when thinking of the future, think of change and not of a continuous extended present. They have concepts, targets and objectives, they think in concrete terms of steps to do or pathways to show.

At the same time, they show their hesitations and the fact that the sustainable change might not be so easy: many things “should” happen, “if possible”(möglichst) and are often in contradiction with the given situation – “notwithstanding” is also a term often used. In the word “future”, time is a relevant factor, representing the context of societal development: The words Zeit (time), Zeitraum (period), rasch (rapid) and Veränderung (change, diversification) show the context of time in the reports.

Thesis two: Causality

The ARL research focuses on societal as well as on natural processes research offers a paradigm that considers systemic interrelations. The sustainability research tends to understand the present situation in its complexity as a basis for acting in society. Therefore, words representing the causality contravene with words of a new circular thinking. Among the 86 most frequent bridge words, a set of words supports the thesis that the concept of causality is at stake in the sustainability research. In opposition to the concept of causality, sustainability moves towards a process oriented approach which is exemplifyed through the following horizontally frequent words: Sinn (meaning), komplex (complex), Komplexität (complexity).

Notwithstanding these hints that the ARL-researchers consider the cause-effect-theorem as obsolete, in their day-to day business they still use sets of words relating to linear processes:

Grund (cause), Grundlage (basis), notwendig (necessary), ergeben (produce), Hilfe (help), Erfahrungen (experiences), trotz (notwithstanding), wegen (because), verbessert (ameliorated).

Circular as opposed to Causal: A linguistic analysis that looked not only into the horizontal analysis, but into the overall body of words showed that both, the concept of causality as as well as words representing circular approaches, find several ways of reverberation in the reports.This means that the researchers are questioning the old paradigm of cause-effect-relation, but by doing so, they get into a serious field of contradictions.

Causal: anfanglose Schleifen (loops without start), basieren (to be based), bewirken (leading to), deswegen (therefore) , falls (in case), mithin (therefore), mittelbar (indirect), Sequenz (sequence), Trend (trend), Verursacherprinzip (principle auf cause), worauf (hereon), zugrundeliegend (basic), zurückzuführen auf (caused by).

Cirkular: Denkkoppelung (plugging in the thinking), dreifach disziplinärer Zusammenhang (triple disciplinary context), Entgrenzung (end of limits), zyklisch (cycical), Wissenszusammenhänge (contexts of knowledge).

Several combinations of words show the insecurity in formulating a thought that does not yet have its precise linguistic counterform: analytischer Brückenschlag (constructing an analytical bridge), Ein-Zweckbewegungen (movements that have one scope).

In sustainability research, the concept of systemic interdependencies and of networking starts to substitute the preexisting theorem of causality We have identified a whole field of words concerning interweaving and netting that supports this thesis:

Austauschprozesse (process of exchange), eng verknüpft (strongly linked), Verschmelzen (to merge), Schnittpunkt (intersection), benachbart (neighbouring), Bündel (bunch), enge Verflechtung (narrow interweaving), Entflechtung (de-interweave), Gefüge, gekoppelt (coupled), gemeinsam (together), Konnex (connex), Landschaftsmosaik (mosaique of landscape), Mindestkomplexität (minimal level of complexity), Puzzle, synoptisch (synoptical), Uneinheitlichkeit (non conformity), Überlappungen (overlapping), Verzahnung, Verknüpfungsregel (rule for interweaving), vielschichtig (mulitlayered).

As the scientific jargon does not yet offer enough wordings to reflect the new concept of systemic interdependencies, these words are often taken from a day-to-day-spoken language and transported into a scientific context. This tendency also shows that sustainability research has a more direct link to daily life issues than other traditional research fields – a characteristic that may also be helpful for the architects reflection of his own work: a design process carries similar features: realting to the topic of complexity and circular procedures as well as the link to daily life issues.

Thesis 3: Idyllic Nature, Demiurgical Man

Aestetic aspects, as well as the image of the demiurg intervening in the outside world are tpics that an arhcitect is well familiar with.The ARL programm was developed out of the research of natural scientists observing the harmful ecological change of the natural landscape. Thus, the scientific community starts to consider the landscape as a cultural setting and as an aesthetic product of the human being. An idyllic connotation of nature shows up in some natural scientists appoaches, especially when presenting strategies to protect nature in an innocent state (“as it is”). But the human being – including the researcher - acts as “man as a creating individual”. The self-conception of the sustainability researcher as a demiurg heading towards a changing world is supported by different terms – for instance “help”(Hilfe). The presence of this word shows that sustainability as world view looks for support and shows a self image of the researcher as the guiding force in the process of change. The frequency of the combination “ermöglichen” (to make possible) shows the same direction.The researchers are also aware of the urgency of their work: their results need a “basis” (Basis), and are “essential” (wesentlich). Essential is the third frequent horizontal word in the whole ARL (only development and diverse have a higher horizontal rate). When looking at phrasemes, we found images like “intakter Lebensraum” (habitat in

good order) to describe what could be the aim of a sustainability approach.

Both streams, the view of nature as an idyllic entity to be protected and the wish for change and intervention, as contradictory as they may seem, are both observed in the wording of the ARL scientific community.

The fact that, in some remote corner of their being, the sustainablity researcher has an idyllic, idealistic image of the world as it should be lead to what we have called "the lyric approach" that counterbalances the idea of men as creating individuals.. A linguistic analysis of the writing style and vocabulary shows that here and there, this idyllic background slips even into a scientific text. Some examples of this "research lyrics":

Forschungslyrik (lyric of reserach): Agrarromantik (romance of agriculture), Alpenherrlichkeit (delightfulness of the alps), jungfräuliche Erde (maiden earth). These words are examples and out of the context of the reports, but they show the interpretation of nature in its lyric appearance.

Other orginal quotations from the text that are near to non translatability:

Bauernherrlichkeit (glorious farmership), charmantes Misstrauen (charming suspiciousness), chice Aufgeregtheit (chique excitement), heroische Erhabenheit (heroic sublimity), intakte Dörfer (villages in good order), intakte Natur (nature in good order), übersinnlich wunderbar (transcendentally wonderful), lieblicher Dorfcharakter (mellifluous village character), sich in der melancholischen Unendlichkeit verlieren (to get lost in a melancholic unboundedness), romantisches Refugium (romantic refuge), rosig leuchtende Almkuppeln (pink luminescent mountain pasture domes).

For an architect, the quest for idyllic features is a phenomenon well known in his discussions with the clients.

Thesis 4: Spaces of Possibilities ("Möglichkeitsräume")

Thie notion of spaces of possibilites was developed in previous theoretical work of the authors and proved to be helpful even in the context of the huge amount of texts that this study is interpreting (Dumreicher, Kolb 2003 [8]). Sustainability research is based on the idea that human beings dispose of spaces of action and that, by trying out their possibilities, they can further develop their radius of influence. In order to do this, they need examples (Beispiel), they make things possible (ermöglichen), and these actions will allow (erlauben) for new expansion of activities.

Besides the spatial context that the studies all consider as basis for their work, we can also analyse the fact that the forth dimension – time in which the change shall occur – is a notion considered by the scholars. They have a time frame that shows the urgency and need for change in short time (rasch). These spaces of possiblities have a target (Zielsetzung), have facilitated (ermöglicht) actions and change and are necessary without fail (unbedingt). We would certainly be curious to know what the individual researchers thought that these spaces of possibilities might allow (erlauben), and the data base "from information to knowledge" would help identifying every single orignal text and wording.

Thesis 5: Relocalisation ("Verortung")

ARL shows different kinds of spaces – local, terrestrial space and space in the sense of universe. It shows the space for local action and space for local and global pollution: act locally, think globally.

ARL deals, from the very beginning, with concrete political spaces like towns, regions and other space-related, localised case studies. Although ARL is an Austrian study programme, the researchers take the larger space of possibilities into account which is Europe(Europa). Bridge words that concern the spatial aspects of sustainability show that relocaltisation, a topic counterbalancing the global aspects of change, show up with high frequency in the horizontal words. They are mostly related to ecosystems: Wasser (water), Pflanzen (plants), Wiesen (meadow), Flüsse (rivers).

Several of the space related words can be understood in a direct as well as in a metaphoirc usage. This is the case for words like Boden (base), Grund (ground), Weg (path). The word base can be related to the actual question of property or soil just as well as for describing the basis for a development, or for a hypothesis. Applied in a disciplinary context like architecture or urban disign, its meaning and context may also vary.

Thesis 6: Complexity

Sustainability cannot be subdivided and constantly follows a stream of complex, integrative issues. This reverberates in the methodological approaches like inter- or transdisciplinarity; it is also mirrored by the fact that most researchi in sustaianblitiy is done as teamwork.

The data base shows the theoretical acknowledgement of complexity with words like komplex (complex), gesamt (overall), System (system), Struktur (structure), Komplexität (complexity), Vielzahl (big number of). These words, too, follow the order of horizontal presence and show a high rate of studies that use the word.

What is not present is a vocabulary of methodology. This leads to the assumption that, although the need for complexity is recognized by the sustainability community, there is still a need for application and operationalisation.

Thesis 7: New Research Questions

Sustainability is often seen as a concept that is in narrow linkage with the concept of modernity and of development. This leads to a new research question: is sustainability the last outcome of the modernity theorem – or is it already an emerging post-modern era subject?

The language used in the reports shows that sustainability research opens new linguistic spaces. It is an emerging language, and there is not yet a confirmed language ductus within a terminology of sustainability. The new topic leads to uncertainty in the speech and to a series of new word creations not be found in dictionaries. We see an emerging specific

scientific jargon with its own internal code, shifting between factuality and norms. The decoding works within the discipline even with words that are newly created – the longest word we found was „Düngemittelbeschränkungs(jahr)response“ (literary translation: yearly limitation response for fertilizer).

In order to identify the new research questions, quantitative methods obviously have a limited potential: they can serve as a counterform for missing notions. Several topics that are not mirrored in the horizontal analysis have come up in the qualitative hermeneutics interpretation loops – topics like the change of paradigm from research “against” something (namely against pollution) towards research “pro something” – for spaces of possibilites, for systemic approaches etc. Other empty spaces and black wholes seem to fit into a wishlist for arhctectural research: the question of power relations and a critical apprehension of values and thinking systems in the sustainability research community.

5. DATA BASE AS KNOWLEDGE BASE

Outlook for the use of the devleoped method for users who would like to be informed about the existing knowledge in architecture as related to sustainability: a similar procedue like the described combination of qualitative and highly sophisticated quantitative methods to create a data base can be replicated according to the needs of such a clientele. The analysis of the words can give an overall, rough image of the possibilities of such a data basis. In a next step, with Bib Tech Mon, the study developed a visual information system. We could look for partnerwords in the orginal texts (“What are the terms that frequently show up in relative nearness to the chosen term?). in this way, one can find out what concepts for the future have been developed by the different studies. We can also re establish the original context in the whole sentence or paragraph in order to check whether our first understanding corresponds to the contectual situation. The result is visual information system and a wordmap, an instrument visualizing the relationships among all anaysed words.. But what is more interesting is the possiblity of contextual searching: starting form one specific keyword, the information system allows for discovering different sorts of connectivities, providing a basis for further research. In the further resaerch of the Co-Word-Analysis, the intensity of relationality between notions (words or phrasems) are analysed in relation to all other relation intensities occuring in all the reports; the graphic representations allow for quick and intuitive recognition of these relationships. Interactive maps of interdependencies among all standardised words in the reports can be devleoped using the BibTechMon software.

6. CONCLUSION

Besides new knowledge about the nature of the upcoming new research field sustainability as shown in this paper, the project “From Information to Knowledge” also shows how such a combination of qualitative and quantitative methods can sort out central targets out of a huge compound of texts. This can be a tool to make these results available for interdisciplinary communication. This can support the young field of sustainability, which is developing its own specific scientific language and can also be characterised by a set of topics that differ this research field from the previous field “environmental sciences”. This tool can also bes useful in the building realm, where different sources information are the necessary for housing, landuse and urban town planning.

The existing results show how a relation between sustainability research and architecture could generate reciprocal inspriation for the self evaluation, but also in understanding the complexity of the appraoches.

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