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## Linking Technical and Social Dimensions of Working Life by Means of a "Transcending Research Approach"

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### Abstract:

*This article deals with cross- and multi-disciplinary evaluation of production systems and work conditions by means of amalgamating practitioners' and researchers' goals and perspectives, in order to exploit valuable constructive synergies. The basis and illustration of this discourse are three questionnaire surveys conducted at two automotive companies in the Gothenburg area during 2000 - 2001. These surveys may be looked upon as an integrated research approach. In total, all activities discussed in this article proved to crystallise what might be referred to as a "transcending research approach" with practitioners and researchers cooperating from a cross- and multi-disciplinary point of view. At least two methodological key innovations were important to achieve synergy in the cooperation between practitioners and researchers linking technical and social dimensions of working life. Firstly, there was the use of department numbers in the questionnaire forms which made it possible to link the questionnaire data to the respective departments, the function of which in turn were understood due to one of the authors' earlier research and development work, but which was also complemented by study visits at work sites and sometimes also by the construction of tables (these tables were comprised of data from each department investigated). Later on, some of the problem areas, which proved to be of special interest were further analysed. Secondly, there was the use of various intensive co-operation procedures, such as the joint venture construction and prototyping of the questionnaire forms, common reporting, and discussions of the research results.*

### 1 BACKGROUND

Various intriguing phenomena appearing in large complex organisations have in most cases been evaluated from a strictly social, technical or medical science point of view. Thus it may be fair to claim that the understandings of these organisations and phenomena are satisfactory at least from a single-science point of view. However, particularly when viewed from an applied sciences point of view these phenomena might sometimes need to be evaluated by a cross- or multi-disciplinary research approach, which may pose additional challenges.<sup>1</sup>

In this context it is usually puzzling to gain an in-depth understanding on how, for example, social and technical dimensions interact on the shop floor at e.g. an automotive plant creating phenomena like psychosocial work conditions, operators' perception of work, incentives systems, etc.

	"Restricted research approach"	"Transcending research approach"
Researchers:	(1) Traditional single-science research.	(2) Cross- and multi-disciplinary research.
Practitioners:	(3) Practitioners working in a specific field, e.g. conducting restricted surveys.	(4) Practitioners in different fields of cooperation, e.g. union representatives in co-operation with engineers dealing with complex problems, such as product development activities.
Practitioners and researchers:	(5) Researchers from a particular scientific discipline in co-operation with practitioners.	(6) Researchers from different scientific disciplines in cooperation with practitioners.*

\* Note that practitioners by no means are in lack of complex intellectual or theoretical frames of reference compared to scientists. In their daily work they deal with intriguing problems requiring complex decision-making processes. This is most often the case independently of whether they are blue- or white-collar employees. However, industrial systems do not prioritise verbal and written formalisation combined with clarification of connections with already established frames of reference, while such formalisations and connections are a matter of course to scientists.

**Figure 1.** Table defining and exemplifying possible spectra of combinations of co-operation and research approaches.

During the last two decades one of the authors has conducted quite extensive research utilising a cross- and multi-disciplinary research approach in cooperation with researchers from e.g. pedagogy, sociology, psychology, and medicine within the automotive industry, especially regarding specific aspects of production system design and evaluation (e.g. Engström et al. 1995; Johansson Hanse and Engström 1998). This research design has, apart from scientific matters lead the authors to ponder upon relationships between practitioners and researchers. The aim of this article is to discuss an expansion of a cross- and multi-disciplinary research approach by

<sup>1</sup> Cross-disciplinary science means that the boundary between at least two scientific disciplines is transcended, while in multi-disciplinary science the scientist is specialised within his or her field of knowledge and co-operates with scientists in other fields (Axelsson et al. 1998)

amalgamating different categories of practitioners in the research process. The table in figure 1 defines and exemplifies combinations of research work. The discussions and research results brought forward in this article will specifically deal with field six in the table, i.e. the co-operation between practitioners and researchers with a cross- and multi-disciplinary research approach.

The practitioners usually deal with everyday problem-solving as an integrated part of established industrial frames of reference. The researchers, on the other hand, belong to a scientific context and look at specific theoretically significant aspects and will usually try to formulate or verify some more general hypotheses about e.g. working life. Thus the goals of the practitioners and the researchers are not always in agreement.

An especially intriguing situation appears when a "transcending research approach" is established, which itself comprises both researchers from different disciplines and practitioners in the data collection and analysis. If such a research aims at amalgamating practitioners' and researchers' goals and perspectives in order to exploit valuable constructive synergies then a specific way of organisation is called for, a matter only touched upon below. As a result such a research approach will certainly call for some reflection on research methodology.

## 2 SOME ASPECTS OF THE CO-OPERATION

The findings and experiences brought forward in this article illuminate some merits, as well as some pitfalls of a cross- and multi-disciplinary research approach in co-operation with practitioners within an applied field of science. The authors will also sketch a procedure for reporting extensive data materials, which could be used for establishing a communicative process between researchers and different categories of practitioners.

Questionnaires are commonly used for evaluating various aspects of working life and this has also been the case here. As a basis for conducting surveys the authors have at their disposal a selection of approximately 150 questions used by different researchers in Sweden. From this selection it is possible to construct prototype questionnaires suited for specific case studies. This procedure has been carried through for evaluating e.g. the Volvo Uddevalla plant (Engström et al. 1995). See also e.g. Jonsson and Fredholm (1984) or Fredholm and Jonsson (1987) who deal with incentives and salary systems.

This article will, as an illustration of the co-operation between practitioners and researchers, report on recent findings from three questionnaire studies in two large automotive enterprises in Gothenburg area, denoted Company A, Company B, and a suppliers village belonging to Company A. However, this article will only present some selected aspects of the findings since the data available has not yet been fully exploited, nor is the data analysis entirely complete. The questionnaire has also been complemented by the use of tables comprised of data from each department investigated (see figure 3), and in some cases by schematised layouts (see figure 4).

Briefly recapitulated, the authors' background to the problem areas touched upon above is as follows: By earlier contacts with the union at those companies the authors received an opportunity to conduct a series of surveys at the companies A and B.

For three reasons these surveys have proved an opportunity to link one of the author's earlier research work within the Swedish automotive industry with the goals and perspectives of the union representatives.

Firstly, some of the questionnaire variables developed proved to be of common interest. Secondly, methodological aspects were of specific interest to the researchers while, on the other hand, the need for more stringent methods and procedures in guiding the union representatives when conducting their own survey studies in the future was a joint ambition. Thirdly, the union representatives were concerned that their own previous surveys might not have been sufficiently professional regarding data analysis, which is a field of knowledge mastered by the researchers.

In this context it ought to be noted that today it is difficult to conduct extensive surveys within the automotive industry due to slimmed organisations. It has e.g. proved difficult for the union to organise necessary meetings with all the involved operators present. This fact is explained by outsourcing, removal of intermediate buffer volumes on the assembly line, modular product

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architecture, etc. Another reason is that the companies have been more reluctant to establish long-term relationships with external researchers and this has especially been the case within newly established large international conglomerates not yet fully integrated.

The co-operation with the union was thus an important opportunity for the authors to get legitimised entrance to conduct these surveys, which were distributed to all employees in about 3/4 of the two organisations, but also to get opportunities to make complementary interviews, study visits at work sites, etc. as well as get practical help with various time consuming details like e.g. distributing and collecting questionnaire forms. The three questionnaire studies (denoted questionnaire: I, II and III) are overviewed in table in figure 2.

	Work site	Response rate	Number of distributed questionnaire forms	Comments
Questionnaire study I (March - May 2000)	Company A and B	>90%	200	- Included questions concerning work and production, the employees' working hours and their views on working hours, relationships between working and leisure time, salaries and views on salaries, etc.
Questionnaire study II (October - November 2000)	Company B	>70%	1 600	- Aimed at evaluating "customer-oriented work time" and at the authors' ongoing research
Questionnaire study III (March - April 2001)	Company A	>70%	1 800	- Aimed at evaluating "customer-oriented work time" and at the authors' ongoing research.

\* The response rate is difficult to ascertain since the number of employees at a specific department is often unclear. The data received from the Personnel Department differ from the data given by the local union representatives. This might be explained by the fact that some employees are sometimes lent to other departments, that the data are mirroring different time perspectives, etc.

Figure 2. Table describing the three questionnaire surveys conducted.

Surveys I, II and III were complemented by the construction of tables comprised of data from each department investigated. Note that all questionnaires included a question concerning at which department a particular employee was working at the moment. By means of these tables, as illustrated in figure 3, it was thus possible to relate the questionnaire variables to the organisational structure as well as to the plant design. This construction, which was developed and carried through in co-operation with the union, is somewhat unique and allows for a possibility to relate the questionnaire data to specific characteristics on a single department or clusters of departments. In short, the total plant design was grasped by combining department numbers, where each department's function in turn was understood due to earlier research work complemented by strategic study visits at work sites, which sometimes also included construction of schematised layouts (see figure 4).

DEPARTMENT NUMBER	DEPARTMENT CODIFICATION	NUMBER OF EMPLOYED	WORK TIME	ACTIVITY/COMPONENTS FITTED	LOCAL METAL UNION COMMITTEE NUMBER	CONTACT PERSON:
66 732	1.00 - XXX	13	Nightshift	XXXXXX	No 3	Edmund Dahlström
66 733	1.01 - XXX	45	Nightshift	XXXXXX	No 24	Dan Jonsson
66 734	1.02 - XXX	36	Nightshift	XXXXXX	No 12	Eva Johansson
66 800	1.1 - XXX	7	Nightshift	XXXXXX	No 7	Lars Medbo

Figure 3. Example of a table describing the various departments comprised of data from each department at Company A. Note that these tables enclose all departments in the company regardless of whether they were included in the surveys or not. Thus it was possible to overview the total function of both companies which, in fact, is helpful when e.g. constructing different analytical categories to be compared, i.e. clusters of departments with similar functions, similar production systems, similar type of work, etc.

In the case of questionnaires I, II and III the authors personally visited all departments included in the surveys. During these study visits at work sites, lasting about half a day where union representatives guided the authors and arranged direct dialogue with various personnel concerning specific questions put by the researchers, i.e. personnel such as operators, manufacturing engineers, and other specialists. These study visits at work sites were aimed at understanding the manufacturing process more in detail (thus the use of schematised layouts containing buffer size and location, material flow structures, equipment, etc.).

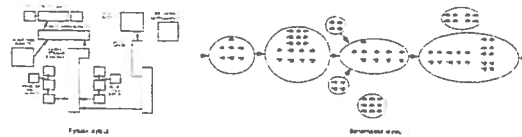


Figure 4. Example of a schematised layout used in a questionnaire survey conducted at a body shop in an automotive plant. Since the physical layout (to left in the figure), as well as a verbal description of workstations and work groups (not shown) were also included in the questionnaire, it was possible to e.g. formulate questions on workstation level. With this approach the authors were able to relate the statistical analysis of the questionnaires to e.g. specific workstations or to specific work groups.

3 PROCEDURES OF REPORTING AND SOME SELECTED FINDINGS

In figure 5 to the left the various cooperation procedures are schematised. These procedures comprised e.g. a number of interactive activities. For example:

(1) "Preparation for data collection" (B1 in figure 5 to the left) comprised e.g. defining the exact number of employees at each department, which was somewhat intriguing since the company's organisational structure and the union organisation were not congruent, combined with the fact that the personnel departments' lists of employees work sites were inconsistent due to sick leaves, personnel being off on education or lent to other work sites, etc. In order to control the data collection each department received the exact same number of questionnaire forms corresponding to the assumed number of employees.

(2) "Iterations of diagrams and discussions" (C1 in figure 5 to the left) utilising 95 diagrams, which were discussed with the union representatives who also used these statistics for reporting the findings to e.g. their members.

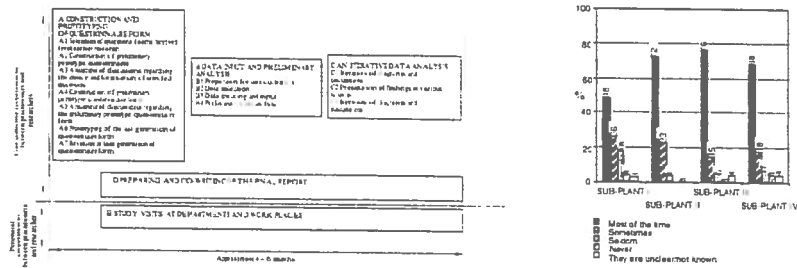


Figure 5. To the left, a schematisation of various co-operation procedures during the execution of the three questionnaire surveys. To the right, a comparison between sub-plants composed from specific departments within Company A concerning the perceived possibilities to fulfil the production goals according to questionnaire III.

Originally, the authors had the ambition to report each survey as a separate publication. Later on the idea of writing one single report surfaced. Such a combined report could then be split into two reports, one for Company A and one for Company B. This was a rational choice to make since many of the written passages were almost identical. One advantage was also the possibility to include comparisons between the two companies. Originally it was not the intention of the union to make comparisons between the two companies, but as the work proceeded and the findings successively were evaluated these kinds of questions turned up.

The reporting of the findings was conducted in different contexts which generated feedbacks from different categories of practitioners. As an example the results from the questionnaire surveys were presented at union meetings in which the researchers participated. The discussions among the union members gave the researchers valuable insights in the ongoing analysis of the statistics.

To summarise, discussions and communications carried out with various practitioners during a period of approximately half a year left the researchers with a vast amount of interesting findings

and interpretations and also with proposals for future analysis and a complementary data collection.

As was mentioned above, the use of the department numbers as a background variable made it possible to aggregate specific functional units at the plants and this signifies an important analytical potential. It means that single departments formed clusters (analytical categories) due to similar types of work such as non-machine, semi-machine and machine-paced work; or work accomplished in similar production systems (e.g. work performed at assembly lines, by work groups in parallel product flow production systems or at individual sub-assembly stations).

Figure 5 to the right compares four sub-plants at Company A, in this case answering the question "Do you and your co-workers manage to fulfil the productions goals formulated by your company?" asked in questionnaire III. The diagram is one example of the number of diagrams discussed at various intensive co-operation procedures with the union representatives who also used these statistics for reporting the findings to e.g. their members.

	SUB-PLANT I	SUB-PLANT II	SUB-PLANT III:	SUB-PLANT IV*
Characteristics of work	- Highly qualified work (maintenance, programming of equipment, etc.)	- Machine-paced and short cycle time work - Quite qualified work.	- Machine-paced and short cycle time work	- Highly qualified work (maintenance, programming of equipment, etc.) - Machine-paced and short cycle time work
Type of production system used	- Two transfer lines with mixed automated and manual workstations and sections	- One transfer line with mixed automated and manual workstations and sections.	- One serial product flow assembly line	- Three transfer lines - Metal cutting of components (e.g. sub-frame)
Comments	- A new transfer line is under introduction - Some sections totally automated.	- Some sections totally automated - This plant was built in 1992	- Quite a high personnel turnover.	- Established in 1986

\* A suppliers village.

Figure 6. Example of comparison between sub-plants I - IV within Company A regarding characteristics of work and type of production system, including some comments.

Figure 5, to the right, shows that operators in sub-plant I to a lesser degree than the others managed to fulfil the production goals defined by the management. Note also that in total it was approximately 1/3 of the employees who were not able to fulfil the production quantum. This particular finding makes it interesting to understand what exactly the various stipulated production goals are. What are the job descriptions for each category of personnel? Exactly how extensive are the technical disturbances, reliability, etc? Even though the researchers possessed knowledge of the production systems it was helpful to discuss e.g. the causes of these differences with the union representatives (and also with the employees) in a systematic way and during an extended period of time. In this case the extensive automation was most likely the cause of the perceived difficulties in fulfilling the stipulated production goals. This was especially the case in sub-plant I, which comprised quite a number of newly installed automated equipment, while in sub-plants II - IV the work mainly included various types of manual assembly work. In order to understand these findings more thoroughly it would be interesting in the future to study these matters in greater detail with for example the manufacturing engineers and the personnel department representatives. A further statistical analysis of the authors' data will illuminate some questions brought forward above since one question included in questionnaire III concerned the reasons why the employees did not fulfil their productions goals.<sup>2</sup>

The two most frequent answers were technical disturbances (60%) and personnel shortage (43%). The amount of disturbances was somewhat puzzling to the union representatives since the company during the 1990s had tried to attend to these problems as a general adaptation to a more pronounced competition situation in the automotive industry. Earlier the need for efficient production had not been that vital since the market was quite advantageous for the company's products. The personnel shortages, on the other hand, seemed like a plausible explanation and the

<sup>2</sup> This question had the response alternatives (a) the productions goals formulated are unrealistic; (b) there are not enough people employed; (c) me and my co-workers do not have the competence required; (d) technical disturbances (such as lack of materials, troublesome equipment), or (e) some other reason, and in that case, which?

response rate of 43% was not perceived as unreasonable by the union representatives. These communications with the practitioners might not seem to be that unique. But various intensive cooperation procedures, however, proved to bring forward aspects which might otherwise have remained unnoticed if e.g. the questionnaire surveys – as is sometimes the case – would have been solely aimed at confirming predestined hypotheses or theories.

#### 4 DISCUSSION

The findings and experiences brought forward above illuminate some merits as well as some pitfalls of a "transcending research approach" with practitioners and researchers in co-operation from a cross- and multi-disciplinary point of view.

At first, the authors will briefly discuss some of the gains of the co-operation which can be divided into two aspects: practical co-operation and analytical synergies. As mentioned above the union representatives gave the researchers an opportunity to collect data within the two companies, but also set up an appropriate organisation for distributing and collecting the questionnaires, as well as dealing with other practical details of importance, all in a way that would otherwise have been difficult to arrange. This co-operation also facilitated access to all employees involved, not only a small sample of employees. The response rate was high, partly due to the fact that the union functioned as a guarantor of the surveys being of value to the employees. The union also arranged several necessary meetings and interviews with other union representatives and employees.

Later on, the union helped to arrange for the authors to conduct video recordings of the assembly work in two different departments at the two companies in order to evaluate different production system designs. In the future it will be possible to link these data to the findings in the questionnaire surveys. The analytical synergies are of course more complex to evaluate and the authors will elaborate upon this in the future. However, there are some aspects worth noting that have not been touched upon above, such as the general need for an enhanced systematic discourse regarding various aspects of working life based on "true shop floor data". One interesting procedure to be mentioned in this context is the use of the union's homepage as a means for reaching employees. In that way issues like the findings from the surveys might be debated via e-mail. In this specific case the union representatives in fact already have an impressive computerised network of communication at hand for fast communication concerning union matters. And from an international perspective this is a communication network which in fact is quite unique.

Some pitfalls to be underlined are e.g. different lines of thought in-between practitioners and researchers and the variation in conceptualisation as well as verbalisations of phenomena. One aspect which is especially worth noting in the context brought to light above is that a union is in fact an interest organisation. Accordingly, it might be difficult to co-operate with a party embracing quite specific goals which might be opposed to a scientific point of view striving to be free of value judgements. However, since union values and ideologies are in many respects explicit this makes it possible for the practitioners and the researchers to define the problem areas of common interest in which co-operation would be valuable.

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