Scandinavian approaches in systems development

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Abstract
When talking about the Scandinavian approach people often think about cooperation between trade unions and researchers. This approach, called the collective approach, is for sure the most well-known and the researchers belonging to this approach has produced a huge amount of research articles. But there are at least three other approaches: The system theoretical approach, introduced by Langefors, the socio-technical approach, influenced by Enid Mumford and the Work Informatics approach introduced by Markku Nurminen. In this paper I give a short description of them all and conclude that most workers today apply the Work Informatics approach without being aware of it.

Keywords
Scandinavian schools, Tavistock, Enid Mumford, Radical approach, Markku Nurminen, Börje Langefors

1. Introduction

The first commercial computer was Univac I and it was launched 1950. It was mainly used for file management, meaning batch processing using magnetic tapes. Organizing the information so the computer could process it effectively was the main issue. It raised some questions:

1. Which information do we need?
2. How should it be processed?
   a. Structure of information
   b. Dependencies of information

Figure 1 Börje Langefors

   c. Meaning of information
3. When should it be processed?
4. Programming
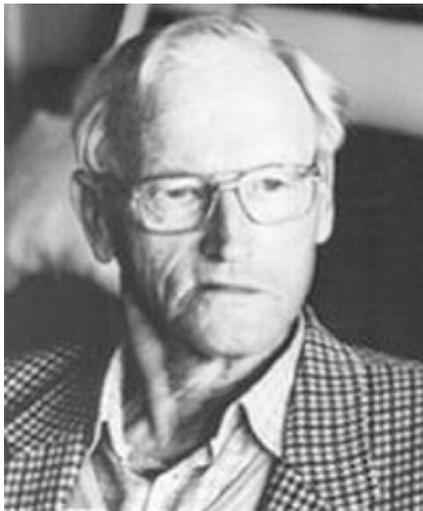
These questions were not asked explicitly, but presented as a systems development model, describing steps that were to be taken in order to construct an information system.

In Sweden there was a mechanical engineer who had done a lot of development of the Finite Element Method (FEM). His name was Börje Langefors and from 1949 he worked at SAAB airplane factory calculating the strength of Swedish warplanes Draken, Lansen, and Viggen. In doing so, he used the FEM method, which required a huge amount of rather trivial calculations. Langefors encountered Matematiknämnden, a Swedish governmental institute engaged in building the first Swedish computer: BESK (Binary Electronic Sequence Calculator). It was

commissioned in 1953 and it is said that it was the fastest computer in the word for some weeks (Hallberg, 2007).

Later on, in the 60's the drawings of BESK was sold to SAAB, who constructed some computers based upon them: D21, D22 and D23 but that's a history that must be told elsewhere. The important thing is that Langefors realized the importance of point 1-3 in table 1. He developed methods for answering these questions both for effective processing as for instance calculating the block size in the tapes and for information management. His book, Theoretical Analysis of Information Systems (Langefors B, 1966) was the dominating theoretical book for several years, from 1966 to 1980. Langefors was appointed professor in Administrative Data Processing (ADB) in 1967. 1970 I started studying ADB and 1972 I was engaged as teacher in ADB. Langefors introduced the idea of systems development in a systematic way and systems development models become the dominant research area in ADB in Sweden in the 70's and first part of 80's.

Langefors' main contribution was the insight that a lot of activities had to be carried out before programming and independent of the technical solution. He developed a theory and some methods and techniques for doing this (Olerup, 1974). He called the area infology, but that name was used only by himself. Langefors calls a data representation of a message for *a record*. For a part of a message we shall talk about *terms*. This means that an elementary message will consist of three term pairs identifying respectively *a system point, a point in time*, a kind of *state variables* and its measure. This lead to the notion of the infological equation, presented already 1966 (Langefors B, 1966) as a remark:

I = i(D, S, t)

Here Langefors explains it as information, I, is a function of data, D, structure S at the time t. He developed the explanation further in several publications, where I think his essay in Dahlbom's book (Dahlbom, 1993) is the most intelligible:

> *I is the information (or knowledge) produced from the data D and the pre-*
> *knowledge S, by the interpretation process i during the time t. In the general case,*
> *S in the equation is the result of the total life experience of the individual. It is ob-*
> *vious from this that not every individual will receive the intended information from*
> *even simple data (Langefors, 1993).*

Langefors emphasized the connection between the organization and the information. In fact he considered them as synonymous (Langefors, 1971), which points at the radical approach, described later. Langefors' approach was the first version of the Scandinavian approach, called the *system theoretical approach* by Jørgen Bansler (Bansler, 1989).

2. The Scandinavian approaches

Researchers often talk about "the Scandinavian approach" but this is not correct since there were at least four different approaches. They are described by Jørgen Bansler in his textbook: Systemutveckling – teori och historia i ett skandinaviskt perspektiv (Bansler, 1990).

	Control	Harmony	Conflict	Radical
Approach	System theoretical approach	Socio-Technical approach	Collective approach	Humanscale information systems
Systems development	Traditional systems development	User participation	Democracy	Individual support
Systems development model	Systems life cycle	Participatory design	Trade union control/Participatory design	Humanscale Information Systems

Tabel 1. The four main Scandinavian approaches

A similar description is provided by Iivari and Lyytinen (Iivari and Lyytinen, 1999). The picture below is a simplified description of their description.
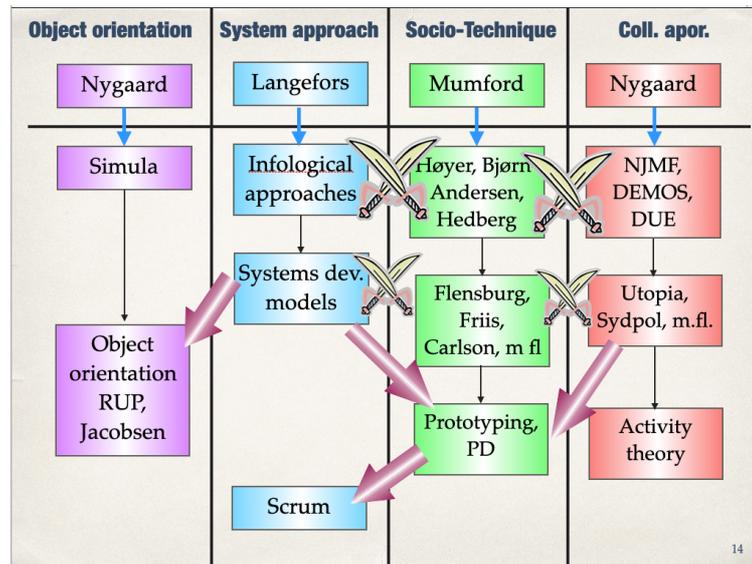

Figure 2. Simplified description of Iivari and Lyytinen

The crossed swords mean conflicts and the broad arrows means development. We see that the systems approach, introduced by Langefors, evolved into two directions: Object orientation, manifested by RUP and prototyping, manifested in Scrum. Today I think most systems are developed using Scrum or similar methods, based on the ideas of prototyping, where three of the approaches was united.

There are two other interesting facts in fig 1. The first is that Kristen Nygaard shows up on two very different places: Introducing both object orientation and the collective approach. His contribution to the object orientation movement was Simula, a programming language used for simulation and published 1967. Three years later he started the NJMF-project which was the first project where trade union and information systems researchers collaborated. In fact, these contributions are totally separated, further development of the object-oriented systems development was done by other persons, where Ivar Jacobsen is the most well-known (Jacobsen, 1999).

The other point of interest is that all approaches (except the HUGE traditional projects, that almost always fail) ends up in prototyping. In the beginning the collective approach and the systems approach was similar except for the fact the trade union, with support of external expertise, should conduct a parallel development. When decision were made, negotiations take place between trade union and management (Ehn and Sandberg, 1979). This was called the conflict view because trade unions and management by definition never could agree. There had to be negotiations! The socio-technical approach on the other hand assumed that management and workers could have the same goals and thus work in cooperation. However, I think that change promulgators of the collective approach admitted about twenty years ago that there was really no difference between their view and the socio-technical perspective. I was present at the IRIS conference where this was announced but I can't remember the year!

3. The sociotechnical approach according to Tavistock

Figure 3 The Tavistock center in London

The socio-technical approach started at Tavistock, at the end of World War II. Tavistock was from the beginning a therapeutic establishment, concerned with mental health and individual development. The members came from different academic backgrounds.

The Tavistock approach was the first socio-technical approach. Later on, it has evolved into a "classical" approach (fig 4), mainly in USA.

This was more concerned with identifying variances in the technical system and less with the social system. The group was influenced by wartime experiences. Bion introduced the idea of small "leaderless, self-motivated" working groups based upon his book on group experiences (Bion, 1961). Kurt Lewin introduced democratic, autocratic and laissez- faire groups, from the 30's and Ludwig von Bertalanffy introduced the idea of open systems. The main feature was autonomous work groups. The first studies were undertaken in the English coal mines. The work there were highly specialized. Every person was responsible for a single task only. There was very low social interaction. High labor turnover and absenteeism was the result. The Tavistock research team recognized that technical optimization at the expense of the human system led to sub-optimal performance and so they introduced the general idea of autonomous work group. However, the researchers could only influence the social system.
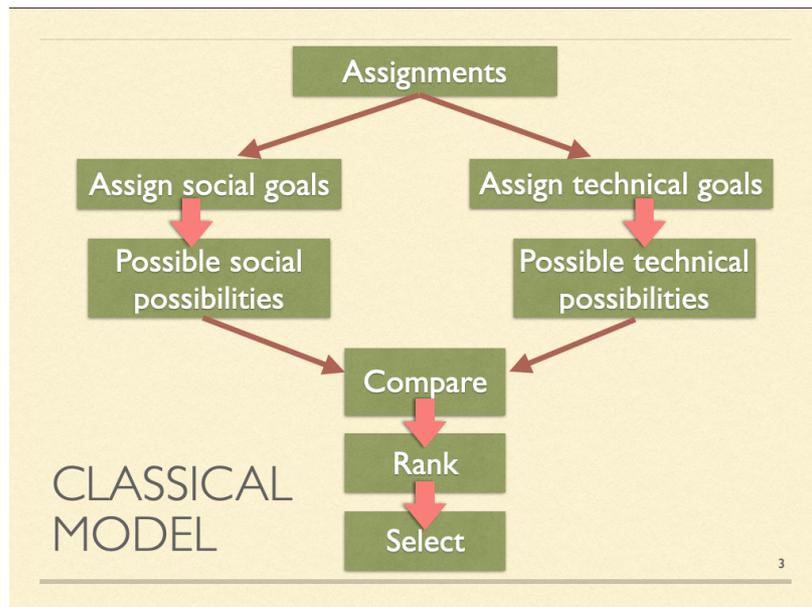

Figure 4 The classical model

The Tavistock group became interested in system theory and some system theorists, among them Ludwig von Bertalanffy, was associated with the institute. He developed the notion of open, controlled system. von Bertalanffy was biologist, so it was rather natural that an organism could be perceived as an open system. This metaphor was (and still is) very fruitful. Example: A living systems strives to establish a steady state. Therefore, it will always resist change. The theory of open systems could be used to facilitate changes. That's why management think socio-technical approach to be so great an idea!

Prominent members of the Tavistock institute:

- Eric Trist, one of the founders
- Hans van Beinum, action reseacher from the Netherlands
- Fred Emery, social scientist, organisation theorist, Austria
- Einar Thorsrud, Tavistock promulgator in Norway
- Enid Mumford, English participative design researcher who had great influence in Scandinavia

I will say a few words about Enid Mumford, whom I met for the first time in Pisa 1979 (fig 5). She was born 1924 in Merseyside in North West England, took a BA in Social Science from Liverpool University in 1946. Then she worked in industry as personnel manager for an aircraft factory and as production manager for an alarm clock manufacturer,

She entered the faculty of Social Science at Liverpool University in 1956, spent a year at the University of Michigan and then entered Manchester Business School (MBS). At the Faculty of Social Science at Liverpool University Mumford carried out research in industrial relations in the Liverpool docks and in the coal industry of the northwest of England.

In order to collect information for the dock research, she became a canteen assistant in the canteens used by the stevedores for meals. Each canteen was in a different part of the waterfront estate and served dockers working on different shipping lines and with different cargoes. The coal mine research required her to spend many months underground to talk to miners at the coal face.

Enid was a pioneer in many ways. The first woman to set foot underground in the mines of the North West Coal industry. At the Manchester Business school she was the first person to do research on the human side of computing. She was amongst the first to introduce the principles of the Tavistock Institute and the socio-technical school to the information systems field. Enid Mumford has influenced the thinking and research of scholars all over the world

Figure 5 Enid Mumford

4. The collective approach

Due to mistrust between companies and trade unions in the UK, it was not practical for Tavistock to continue their research work there.1962 the Norwegian industrial democracy project was initiated and they asked Tavistock for help. Eric Trist, Fred Emery and Einar Thorsrud began the "Participation project" autumn 1962. The objective was: How to achieve increased democracy in working life in Norway? It had two parts:

1) An investigation of previous and similar projects
2) Action research oriented experiments.

As usual in Tavistock, the main feature was autonomous working groups. Interest spread all over the world and it was associated with "human relations school" (Bruce and Nyland, 2011).

The aims of the socio-technical is increasing the individual's ability to participate in decision making and exercise control over the immediate working environment. If the interaction between the social and technical organization is optimized the production is increased and the skills of the individuals develop. The domain of the design is work organization. Development and use of IT is one part, but only one of work design! In systems development we tend to completely neglect the work design!

As previously mentioned, trade unions mistrusted the socio-technical approach. The notion of conflict and harmony view was introduced by the trade unions. This meant that the socio-technical approach assumed that management and workers had the same goals and therefore could come to an agreement, but in the trade union view the management and the workers always had conflicting goals. Therefore, the trade unions had to negotiate about every decision taken.

1970 Kongsbergs Våpenfabrik in Norway decided to implement a new production planning system called KVPOL. The trade union at the enterprise realized the working conditions of employees would deteriorate. They also realized that they knew nothing about computerized systems and were not used to negotiating at that strategic level. They were used to negotiate about the hourly wage and the the piecework pay. So they asked the researchers for help and Kristen Nygaard and Olav Terje Bergo started the famous NJMF-project (Nygaard and Bergo, 1975, 1973) which was the first project in Scandinavia where trade unions and researchers collaborated in order to strengthen the union's position.

Similar projects followed in Sweden (Carlsson et al., 1978) and in Denmark (Kyng and Mathiassen, 1979). These resulted in national versions of a co-determination law. In Sweden Åke Sandberg suggested a trade union systems development model (Fig 6). Principally two parallel investigations were
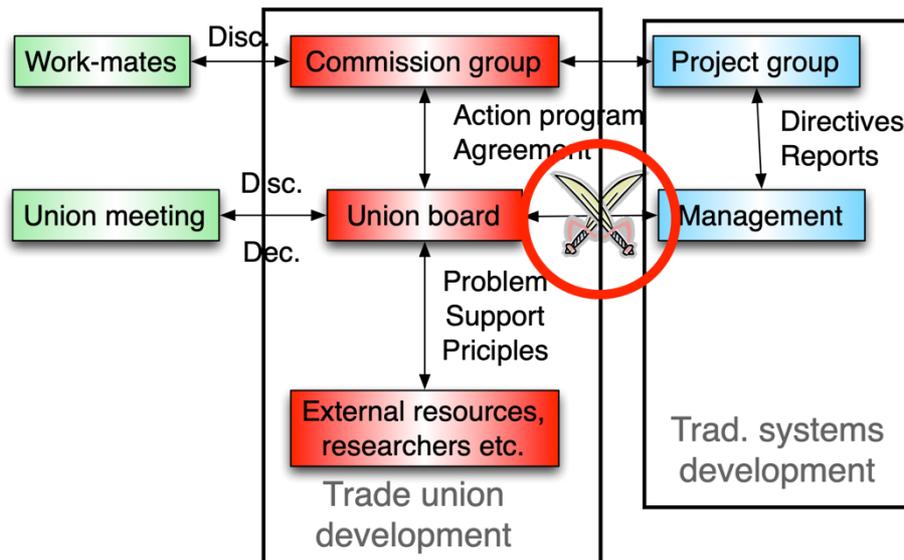
Figure 6. The trade union system development model

carried out and negotiations should take place before any decision was reached (Ehn and Sandberg, 1979). That's why trade unions were against prototyping because there were no distinct decision points and the individual workers had great influence. Over the next 20 years many similar projects were started and lots of case studies were published. (Bjerknes and Bratteteig, 1988, 1987; Ehn, 1988; Flensburg, 1994). Also, many PhD-thesis were published.

The collective approach is fairly well described elsewhere (Bødker, 1988; Ehn, 1988; Kyng et al., 1987) as well as the sociotechnical approach (Flensburg, 1986; Friis, 1995; Mumford, 1983). But the most radical approach, the human scale information system or the work information system approach, is not well known, so I will describe it here in more detail.

5. The radical approach

Some minutes ago, my wife asked me what I was doing. "I'm writing a conference paper" I said. I didn't say "I'm using Word". But that's what a systems developer would have said if asked what he was doing. Tomorrow I will go shopping, but a system developer thinks I'm going to use the car. As a user I'm an appendix to the system, I'm an operator of a computer. But from my own point of view, I'm working and use many tools and skills in that work. "Word" is one such tool, but I don't see my main occupation as user of "Word". I'm against the notion of "user" (Flensburg, 2015). Similar ideas can be found in Nissen (Nissen, 2002).

The system-theoretical, socio-technical and collective approach consider thus the system as an actor. But the workers have tacit knowledge about their work which can't be made explicit, else it was not tacit (Polyani M, 1968). However Nonaka takes another standpoint, saying that tacit knowledge can be made explicit (Nonaka and Takeuchi, 1995). But working in a social interaction is the process Nonaka recommends for people to develop knowledge within their organizations. "Knowledge is alive because it changes continuously… transferred through human interaction" (Stillwell, 2003). But there are also researchers thinking it is not possible to externalize tacit knowledge (Virtanen, 2009), In my opinion working skill is tacit and cannot be described verbally, but learned in a prentice-like way.

But all approaches demands that the tacit knowledge must be put into the system. Since this is not possible it is one explanation why so many systems fail. Only 29% of IS projects were successful according to Standish Groups CHAOS report 2015 (Kim and Kishore, 2019). It has remained stable at those number the last five years.

Markku Nurminen (Fig 7) introduced a "humanistic" system, where only humans can be actors (Nurminen, 1988). This results in highly personal systems containing just the information needed for the job tasks of a particular person. These personal systems are connected in a network – not automatically programmed but enabled by mutual negotiation and decisions of participants.

Figure 7. Markku Nurminen

In my opinion this will lead to a ban of the concept "user". Instead, we shall talk about clerks, workers i.e. people in their work roles. A basic prerequisite for knowledge is that there exists somebody who knows.

Knowledge is related to something to be done, and the knower can interpret a piece of knowledge correctly, when applied in his or her work. She is a competent actor.

There are three types of knowledge needed to be a competent actor:

•   claim knowledge
•   aquainted knowledge
•   know-how

The problem is that computers are capable to store only a limited spectrum of the knowledge needed in practice. Nurminen (ibid) claims that our society has overemphasized the theoretical (claim) knowledge at the cost of the other two. The first type is also more readily formalizable to be put in the computer, and Nurminen sees a danger, that more intuitive aspects of knowledge will get too little attention in system design.

A modern clerk performs a lot of tasks. Some are formalized, some are routine based, some demands huge efforts, other almost none! As support the clerk has different systems, for instance for planning, book-keeping etc. Information is moved between these systems and being processed in-between, often using Excel. The clerks must know the system, understand them and work around their limitations. Over the time the clerk learns this so well that he forgets how to do it, he just does it! That's tacit knowledge! The systems are something the clerks use in their work-life. It just exists and is used to produce something, namely useful information! It is simply at hand, it is a tool, that the skilled worker masters.

When you work together you must adapt to the common work. This the clerks manage very well They don't need a clumsy and hard to use system some EDP-expert has forced upon them. They do it themselves.

Most clerks use Excel but in very different ways. In fact, Excel is a tool for the clerk to design his own job. Excel gives you a set of predefined functions and possibilities to apply them on selected data sets. The clerk describes what to do with the information and Excel simply does it! One might wonder if there are other applications that do the same thing that excel- Could you for instance have a similar system for database lookup and consolidation, covering different sources and systems? What is needed is creative systems like Excel, which allows clerks increasingly design their own jobs. Putting together, interpret, transform information from many different sources and systems. Ordinary database systems like MS Access can't do that, at least not in a simple way.

6. Conclusion

The idea that a lot of activities and analysis had to be done before programming of a computerized information system was introduced by Börje Langefors (Langefors B, 1966). It was the first Scandinavian School. The main issue was logical deduction of needed information from the goals of the company. But soon people from organizational theory realized that also social issues must be taken into account (Bjørn-Andersen and Hedberg, 1977; Hedberg, 1971; Höyer, 1976). This lead to a socio-technical approach where job satisfaction was the main issue (Mumford, 1983). This was much adopted in Scandinavia and become the second Scandinavian approach.

Already in the 60's a project about democratization of working life was started in Norway. Due to mistrust between Tavistock and trade unions in England researchers from Tavistock moved to Norway and inspired the first trade union oriented project in systems development, the NJMF-project (Nygaard and Bergo, 1975). They in turn inspired a lot of other researchers in Scandinavia to conduct similar projects and they formed the third Scandinavian school, called the collective approach. Very often one refers to this approach when talking about the Scandinavian school. In the beginning there were mistrust between the socio-technical approach and the collective approach, mainly due to two reasons: First the

socio-technical approach was seen as the employer's extended arm which always and by definition conflicted with the workers, represented by trade unions. Second, the socio-technical approach focused on the actual users of the intended system, thereby giving trade union less power. Ironically, they have the same origin in the Tavistock institute and in the beginning of the second millennium representatives for the collective approach admitted there were no or very little difference in their view on systems development.

The forth Scandinavian approach, here called "the radical approach" was introduced in its most basic ideas 1981 by Markku Nurminen (Nurminen, 1981). Nurminen describes the basic ideas as:

> *Traditionally, work has been located in the context of the focus called information systems. Work informatics swaps the focus and context. Work is in focus, and information technology is but one part of it (or even part of the context) and thus receives only secondary attention (Nurminen, 2017).*

The concept was from the beginning purely theoretical, and no information system has been built with the ideas explicitly expressed. But Nurminen and his colleagues in Turku have used the ideas for analyzing faulty information systems and explained the basic mistakes. Nurminen called his approach Human scale Information Systems (HIS) in his 1988-book (Nurminen, 1988), but later he renamed it Work Informatics. Here I call it the radical approach and I'm much in favor of it.

I applied the idea of focus on the work in my thesis and in another paper in 2015 I draw the obvious conclusion: It is meaningless to talk about users (Flensburg, 2015)! Looking at how clerks and other workers work, I think we see they work very close to the Work Informatics ideal, if the company is successful. The computerized information systems are just tools among others, but powerful tools. Therefore, it is very important that the workers should not be subordinate to the information system. Use them without being a user!

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