SOCIO-TECHNICAL SYSTEMS: HISTORY AND STATE-OF-THE ART

E. Hanappi-Egger
Department of Computer Science, Vienna University of Technology, Austria

Keywords: Socio-technical systems, Taylorism, Toyotism, automation, work process, informatization, optimization, rationalization

Contents

Summary

The organization of work played always a crucial role in the economic field, in particular since more and more technical systems were introduced. While the classical approach (called "Taylorism") focused mainly on the work process organized as a sequence of tiny single steps, the "process approach" (first discussed in the 50's by the Tavistock institute) stressed the importance of human skills. This was the birth of the idea of socio-technical systems stressing the importance of both sub-systems: the technical as well as the social. Thus 'optimization' refers to the optimization of both components. The socio-technical approach has attracted even more attention with the development of information and communication systems, since they imply an increasing 'automation' of mental work. The article will present a critical overview of the historical development of work organization theories and the meaning of the socio-technical system approach with respect to information and communication technologies.

1. Introduction

There is no doubt that labor processes play a crucial role in the economy. Generally spoken the discussion on the meaning and definition of work has a long and virulent tradition. As Egger (1996) shows the German word for work ('Arbeit') has its origin in the meaning of torment, drudgery, exertion. In the middle ages church played an important role in the discussion of the meaning of work: The Catholics tended to characterize work as God's punishment when Adam and Eve were driven out of paradise; a paradigm willingly accepted by the exploiting feudal leisure class. And it was only Luther who adjusted Christianity to the needs of the emerging bourgeois society by giving work and its fruits for the non-feudal entrepreneur, i.e. profits an explicitly positive connotation. The 'Protestant ethics' indeed marked a sharp turn from

UNESCO – EOLSS SAMPLE CHAPTERS

the former denial of religious importance of any worldly activity like labor to an appraisal of the confluence of spiritual and secular activities.

As soon as wage labor became increasingly easier, its meaning was extended to activities of free workers (e.g. in manufacturing). In the classical Marxian sense 'work' describes the proletarians' activities necessary to earn income - because they do not have 'workless incomes'. By distinguishing between the abstract exchange value of a product and its value in use (modern economists would call the latter 'utility'), human labor - the product workers sell - also acquires this two-fold character: on the one hand it remains 'concrete labor', the special activity of the worker, on the other hand it becomes 'abstract labor', an amount of labor time to be sold for a wage.

In capitalist firms workers are 'alienated' in a double sense: first the entrepreneur takes away the product ('alienates' it) and returns an abstract amount of money, and second the whole organization of the labor process becomes an 'alien' force opposing the workers.

'Co-operation' is defined in this respect as the working together of multiple individuals in a conscious way, be it in the same production process or in a different but connected one. As Schmidt (1991) - with respect to the meaning of computer systems pointed out, 'co-operative work occurs when multiple actors are required to do the work and therefore are mutually dependent in their work and must co-ordinate and integrate their individual activities to get the work done'. Notice that though co-operation refers to concrete labor and to specified activities, it nevertheless presupposes the existence of the 'abstract' forces of wage labor, i.e. the existence of capitalist firms. Evidently co-operation always emerges when individuals try to overcome their own limitations.

This means that "work" is a two-fold process: it consists of a (shared) mental model of the work process and the single tasks themselves. The mental model is the pre-condition for the concrete performance of a job: Without knowing what we should do, what our job is, we could not start to do it. Thus in a cooperative setting the involved people have to share a certain imagination of what their group's task is. Nevertheless it might be necessary to communicate in order to clarify the situation.

The question how to organize the single tasks emerged early, in particular it coincided with the emergence of large geographically centered production projects. The developed organizational principles were also a matter of political conflict occurring between entrepreneurs and workers. The latter were handled as resource being exploited according to the requirements of profit maximization. This perspective neglected the political dimension of working processes and reached also limits in increasing productivity. Thus new ways of organizing labor were investigated by entrepreneurs, while on the other hand the political pressure of trade unions to humanize working places accelerated. Both streams converged to the so-called socio-technical system approach.

In the following the article highlights the milestones in organizational theory of socio-technical systems understood as joint optimization measure of both sub-systems, the technical as well as the social. In short it can be concluded that the discussion of

UNESCO – EOLSS SAMPLE CHAPTERS

industrial democracy and microeconomics on new labor concepts whose aim was to exploit the potential for cost reduction and increases of productivity, initiated changes in the design of work processes, a theme becoming even more important in the light of new technological improvements. See *Total Systems Intervention.*

2. The Role of Automation of Work Processes

During the 19th century the industrialization of the labor market started. The traditional manufacturing processes were substituted by factories and mass-production. The new places of production lead to the emergence of management problems,- how to co-ordinate huge amounts of people and machines. This was the birth of management theories.

The first contributions to organization and management theories considered this management task as an engineering task with according economic aspects. Thus they identified several important factors to be applied such as:

- Accumulation of knowledge
  It was already evident that knowledge plays a crucial role in the labor process. Thus an important objective of management has to be to accumulate all knowledge being available. Knowledge concerning the know-how of the workers (how to do things) as well as knowledge concerning the organization of the sub-tasks should be collected in order to proceed to the next step.

- Transforming this knowledge into applicable rules and laws
  In order to use the knowledge available in labor processes it has to be operationalized. This means that knowledge has to be translated into laws and rules. Those laws and rules represented behavioral guidelines for workers who should accept them since they were the result of accumulated knowledge and thus scientific.

- Establishment of clear performance standards.
  A main objective of the new management style was to get control over the work processes and the workers. Thus the invention of the clock was very important, since it allowed for the realization of discipline. Control meant also to leave no space for interpretation or uncertainty. Thus the formulation of clear performance standards free of misunderstandings and interpretation was essential. Those performance standards served as reference for performance control.

Considering the management task as engineering tasks makes the underlying idea visible: labor processes are processes free from any social or political dimension. At least this was the wanted view of the new managers. To coordinate the whole work one has to construct a division of sub-tasks, ordering them into a sequence and control this sequence.

Similar ideas were formulated by the "father of scientific management", namely Frederik Taylor (1856-1915). Taylor (1911) stressed the importance of a scientific approach to management questions resulting in clear rules and laws of how to co-

UNESCO – EOLSS SAMPLE CHAPTERS

ordinate people and machines in a production process. Contrary to the view that the organization and co-ordination of people and machines in a production process is mainly an intellectual challenge of an entrepreneur Taylor seeks the success in applying scientific rules. This perspective has also to be confronted with the actual political situation of this time: As known, there were severe conflicts between the capitalists and the workers leading to the labor movement. The workers resisted against exploitation and degrading working circumstances and achieved some improvement such as the limits of working hours per day, holiday regulations and better working conditions. Thus Taylor tries to lead the discussion on how to manage labor processes at a "scientific" level. He states that division of labor and their sequential order are crucial in terms of increasing productivity.

The basic ideas of Taylor's organizational principles are the following: Break down the work process into tiny single step so that rather unskilled (and therefore cheap) people can perform them - or machines. De-skilling refers to the view that workers have just to know about their specific task not more. Since people with high qualification had to be paid better than those with low qualification the former caused crucial cost decreasing the profit of the entrepreneurs. In order to reduce the additional staff cost due to higher qualification a "solution" was to make higher qualification useless by dividing the work into very tiny sub-tasks requiring only narrow qualification. This was an important aim. Centralized decisions were made by management which has the overview of the whole working processes and is controlling the performance.

A similar approach was proposed by Ford (1923) with respect to assembly: "The first step forward in assembly came when we began taking the work to the men instead of the men to the work. We now have two general principles in all operations - that a man shall never have to take more than one step, if possibly it can be avoided, and that no man need ever stoop over. The principles of assembly are these:

1. Place the tools and the men in the sequence of the operation so that each component part shall travel the least possible distance in the process of finishing.
2. Use work slides or some other form of carrier so that when a workman completes his operation, he drops the part always in the same place - which place must always be the most convenient place to his hand - and if possible have gravity carry the part to the next workman for his operation.
3. Use sliding assembly lines by which the parts to be assembled are delivered at convenient distances.

The net result of these principles is the reduction of the necessity for thought on the part of the worker and the reduction of his movements to a minimum. He does as nearly as possible only one thing with only one movement".

Evidently the view of a highly specialized organization making each part dependent on the other lead also to a specific view of the involved workers: They have to do what they are told, there is no space for self-determined action. Thus discipline became a crucial role in the whole work process: Workers are told to get the greatest possible amount of work done,- if "each man were permitted to act in his own way, production would suffer and therefore pay would suffer. Anyone who does not like to work in our

UNESCO – EOLSS SAMPLE CHAPTERS

way may always leave." (Ford, 1923).

Summarized it can be stated that at the beginning of industrialization there was much effort to find general principles of organizing workers and machines. The focus on the work process was strongly functional, i.e. it was tried to divide the whole process into single steps and to find the optimal logic of the order of these steps. In particular assembly lines were designed according to the (rather expensive) machines' beat, human beings were considered as appendices of the machines. The tight coupling of workers to the machines should lead to the highest possible productivity by reducing the non-work-related time to a minimum.

In the last consequence this idea lead to the vision of a factory without any humans but steered and controlled by machines only. A vision becoming rather realistic with the development of computer systems. Another advance of automation occurred with office automation: The early 80s were the time when it was tried to support human work in offices by computer systems thereby eliminating non-work-related times. The basic idea was the same as in the production field: to transfer as many tasks as possible to the machines (now to computers), leaving unskilled (cheap) handling jobs for the human beings.

Nevertheless there were high 'passive' parts in the production process (and also in office work) emerging from strictly divided qualification profiles. If all machines are running, the maintenance staff has 'nothing' to do and if the process is interrupted, the workers have to wait (Kern et al. 1984, pp.302). These facts - namely unused capacities of employees representing cost - went hand in hand with the development of product diversity. This means that the corporations were able to produce more and different products with the same machines. In order to be able to react to the new requirements too narrow qualification was not very helpful. Instead a high and flexible qualification of the employees were wanted. This means that in the beginning of the 80s there was an increasing *economic* interest in new work concepts exploiting the rationalization potential. This rationalization potential stemmed from the inability of less qualified workers to react to new requirements. In order to adapt their know-how to the new situation further training and education measures were necessary - causing cost. Thus under the changed production circumstances more flexible qualification were asked for.

-
-
-

UNESCO – EOLSS SAMPLE CHAPTERS

TO ACCESS ALL THE **13 PAGES** OF THIS CHAPTER,
Visit: http://www.eolss.net/Eolss-sampleAllChapter.aspx

Bibliography

Allen B. (1998) *Stepping Beyond Lean to Agile: Work Reorganization in the Auto Industry*,

http:///www.labournet.ca/lean.html (accessed February 2000) [This work presents the role of efficiency in work organization].

Egger E. (1996) *CSCW: The Bargaining Aspect*, Peter Lang, New York [This book gives an overview on the relevant research disciplines concerning the bargaining aspect of CSCW].

Ford H. (1923) *My Life and Work*, London: William Heinemann [This works presents the main ideas of Henry Ford].

Kern H. and Schuhmann M. (1984) *Das Ende der Arbeitsteilung*?, Verlag Beck, München [This book discusses the role of new technologies in the division of labor].

Schmidt K. (1991) *Riding a Tiger, or Computer Supported Cooperative Work*, in: Proc. ECSCW'91, Amsterdam [This article tries to define CSCW].

Taylor F.W. (1911) *Principles of Scientific Management*, New York, Norton, 1967 [This work presents the main idea if management based on a scientific perspective].

Trist E. (1973) A socio-technical critique of scientific management, in Edge D.O. and Wolfe J.N. (eds) *Meaning and Control*, London, Tavistock: pp. 95-119 [This work presents an overview on the critique of the socio-technical approach].

Ulich E. (1991) Gruppenarbeit - Arbeitspsychologische Konzepte und Beispiele, in Friedrich J. et al (Eds), *Computergestützte Gruppenarbeit*, Stuttgart [This work presents theoretical as well as empirical aspects of group work].

Wasserman S., Faust K. (1994) *Social Network Analysis - Methods and Applications*, Cambridge Press [This work gives an overview on methods and applications of the social network analysis].

Young R. (1990) Scientism in the History of Management Theory, in *Science as Culture*, No.8, 118-143, cited from: http://www.human-nature.com/rmyoung/papers/shmt.htm (accessed February 2000) [This work provides a critical assessment of the role of science in management theories].

Biographical Sketch

Edeltraud Hanappi-Egger was born 1964 in Austria. She made her master in Computer Science in 1987 and her PhD in 1990 at the Vienna University of Technology. She was assistant professor at the Vienna University of Technology from 1991-1993. From 1993-1996 she was scholar of the Austrian Academy of Sciences, since 1996 she is Professor for Applied Computer Science at TU Vienna.

UNESCO – EOLSS SAMPLE CHAPTERS