Information and the co-ordination of activities in organisations

P. Hoeken, Radboud University Nijmegen, internal publication,

1 Introduction

The essential reason of existence for every organisation is the co-ordination of activities to achieve one or a number of goals. Knowledge on the control of activities applied to the design of organisational tasks and structures should help organisations to improve their performance, effectiveness and efficiency. The theories and models, presented here are certainly not new. Bringing them together and advocating their use in thinking about organisations and organisational design should have the effect of an appetiser. This article directs the reader towards further knowledge enabling the reader to consciously select a suitable (re)design strategy in efforts to improve organisations.

2 Systems theory and control paradigm

A fundamental instrument in business management science is systems theory. We assume that the reader is familiar with the basic principles of the general systems theory. We use the following definition (de Leeuw, 1974). A ***system*** is a set of objects that have relationships amongst each other in such a way that there is no real non-empty subset of objects that do not have relations with at least one of the other objects in this set. A ***subsystem*** (of a system) is a subset of the systems objects with all their relations. An ***aspect system*** describes only certain types of relations amongst the objects of a system.

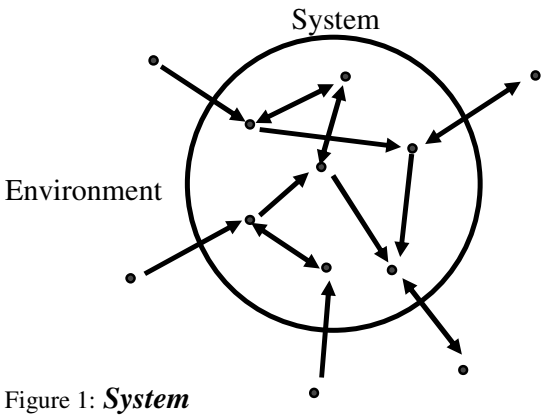

Figure 1: ***System***

The principle objective to describe a system (making use of systems theory) is to make a model of a certain phenomenon in reality. The reader should notice that in practice all system descriptions are of the type "aspect subsystem". This is due to the fact that it is impossible to describe *all* objects and *all* relations of even a small part of reality.

With regard to the concept 'control' the so called 'control paradigm' (de Leeuw, 1974) is of interest. This systems theoretical model describes the phenomenon "control" See figure 2. The basic principle is that in every control situation one can identify two subsystems. The controlling body and the controlled system In case an open system is being

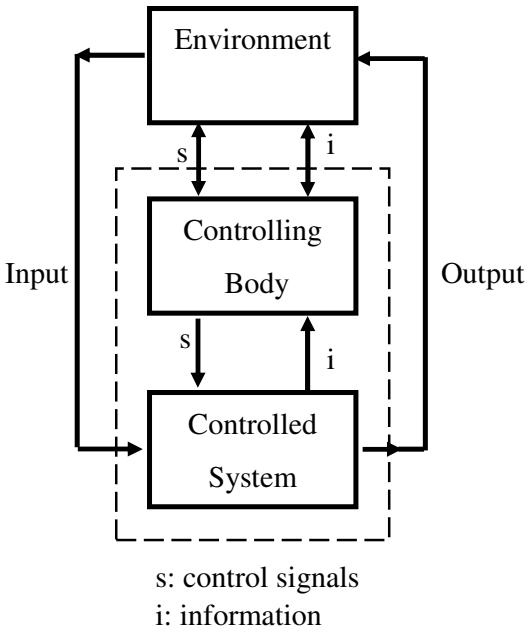

Figure 2. ***The Control Paradigm*** , (de Leeuw, 1974)

modelled there is also an environment. An ***open system*** is by definition a system of which at least one object has a relation with at least one object not belonging to the system. This control paradigm can be applied to all real world control situations. The paradigm is recursive in the sense that the controlled system can be described in terms of the paradigm and the same goes for controlling body. The paradigm can be used to describe a range of simple technical systems up to a complex organisation like a company.

Example: The heating system of a house, can be described in terms of the paradigm. The controlled system is the total of boiler, pipes, pump and radiators. The controlling body is the thermostat. In the environment we define the rooms to be heated and persons that use the thermostat. The controlled system provides heath (output) and uses fuel and oxygen from the environment (input). The controlling body (thermostat) receives a signal from the people living in the house who provide a set-point. It provides information to the environment in the way that one can always read the set-point and often a thermometer is integrated in the thermostat. The control signal is a simple on/off electricity current. The information input from the controlled system to the controlling body is the room temperature. To illustrate the concept of recursiveness, the thermostat itself can be described in terms of the paradigm. The thermostat consists of a thermoswitch and often a small heating device that causes the switch to turn off earlier. This feature reduces the magnitude of the temperature fluctuations caused by the heating of the rooms after the boiler is turned off by the thermoswitch. More advanced systems switch also time based. Some systems even measure the outside temperature and adjust the boiler heating temperature. In the other direction of recursion one could describe the person changing the set-point as the controlling body.

3 Variety, complexity, stability and predictability

The co-ordination burden of an organisation is directly related to the complexity and stability of the organisation itself and of its environment. Complexity is related to the number of elements, attributes describing the elements and the number of relations between the elements of an organisation and its related environment. The higher the numbers the more complex a situation (organisation and environment) is. Stability is related to the changes over time in the valuation of attributes. The more intense and more frequent changes occur the more unstable the situation is. The mathematical product (if this is a valid operation) of complexity and instability is called variety. Ashby (1956) formulated the law of requisite variety, stating that “External variety can only be counterbalanced by internal variety”. In terms of the control paradigm this means that the variety within the controlling body will be on the same level as the variety within the controlled system and its environment. Van der Zwaan (1999) applies this theory to organisations as a whole (product and capacity complexity) and to individual balanced job design (task complexity or control needed versus a persons discretion or control capacity). Writers on decision making add to the phenomenon of ‘requisite variety’ the concepts of ‘uncertainty’ and ‘predictability of future states’. The more uncertainty there is the greater the effort will be to expand controlling activities in an attempt to reduce the effect of uncertainty on the activities within the organisation. The expanding of controlling activities causes the need to process more information. In case uncertainty increases controlling bodies tend to increase the frequency of information gathering and taking decisions and ask for more detailed information.

4 Galbraith’s theory on the design of organisations

In organisation theory implicitly or explicitly Ashby’s law and the control paradigm are often used to create models, organisation structures, design principles and analysing techniques.

Galbraith (1973) has developed a theory that describes four methods to co-ordinate separated activities:

1. ***Hierarchy:*** distribution of authority to take decisions over a number of levels, it reduces the co-ordination by the upper levels and creates the need for vertical communication.

2. ***Target setting:*** delegation of responsibilities by defining goals. As long as the targets are met there will be no interventions from higher hierarchical levels. This reduces the need for vertical communication, although regular reporting will be put in place, only in case of exceptions interventions take place. Note that the co-ordination effort is depending on the balance between the ambition level (targets) of the organisation and its capacity and abilities. If you reduce the ambition level by simply reducing the required level of performance you will also reduce the co-ordination effort needed (Bemelmans, 1994).
3. ***Rules and programs:*** prescription of behaviour, introduces the need for communication to set up and adjust these rules and programs, but reduces the need for horizontal and vertical communication, when working according to these rules and programs.
4. ***Lateral relations:*** horizontal co-ordination, reduces the need for vertical co-ordination along the 'lines of hierarchy', the co-ordination burden is distributed along both the horizontal and vertical axis of the hierarchy.

To enable an existing organisation to control increasing external or internal variety Galbraith suggests that the organisation can apply four strategies. In principle all organisations develop, by tacitly or explicitly making use of one or a combination of these strategies.

1. Create ***slack resources*** (reduces the need for co-ordination and information processing)
   Buffer stocks, for example, reduce the need for co-ordination between sales and production. On the other hand stocks will lead to additional costs and risks (loss, decay, becoming obsolete). Other examples of slack resources are redundant or oversized capacity, waiting lines, fall back agreements for the provision of additional capacity. Creation of slack resources will increase costs and reduce the need for information processing. The opposite of slack resources is reducing the performance margins. Just in time delivery and line-production concepts are examples here.
2. Design of ***self contained tasks*** (reduces lateral and vertical co-ordination efforts)
   The change from functional task design to one in which each groups have all the resources needed to perform its task. This implies a reduction in the output diversity according to a division off the product / service range, customer category, geography or product market combination over a number of groups and it reduces dependencies and interference. Creation of self-contained tasks, such as business units, product groups, customer focus groups, might increase costs (multi-skilled employees, additional resources and less efficient use of resources). The need for co-ordination is reduced and with this the need for information processing. It increases the effectiveness of the organisation. An extreme design in this sense is the so called *self directed work team*. Here activities are grouped and assigned to a group of people in such a way that the individuals can easily perform the co-ordination by direct communication and mutual understanding of the activities within the task group. Training efforts and job rotation replaces a lot of co-ordination effort and communication on the run.
3. Invest in ***vertical information systems***
   Overload of the hierarchical channels is prevented by increasing the capacity to process information in these channels. The decision maker will be supported by information systems (automated or manual) which enable him to process more information and take more decisions. Managers working in over time is a common reaction on increasing variety. One could say that this is an unconscious application of this design strategy.
4. Increase the use of ***lateral relations***
   The lateral co-ordination instrument is used to relief the hierarchy. This will however increase the need for horizontal information flows. It decentralises decisions without creating self-contained tasks. Means

are: direct contacts, interdepartmental problem solving groups, creating integrating or liaison roles (Quality circles, logistics management, temporary teams, product manager or account manager).

Galbraith's theory helps organisations that face increasing variety or experience problems in co-ordinating their activities to decide consciously for a strategy or a combination of strategies to resolve their problems. One can observe that organisations that do not pay explicit attention to the choice of organisational design strategy tend to make use of slack resources or expend the information processing capacity in the lines of hierarchy. Symptoms of the first are increases of safety stocks and work in process, the hiring if additional (temporary) staff, waiting lines, increasing delivery times and reduced service levels. Symptoms of the latter are managers working overtime, increased use of (personal) information systems, the cry for extension of information systems.

5 Information Systems Theory

Bemelmans (1994) and Hoeken (1980) present an information systems design dependency model. This model states that the characteristics and the design of an information system should be based on the characteristics of the control structure that has been designed for the situation of discourse. On its turn the design and characteristics of the control structure should be based on the design and characteristics of the production process and its environment. In short: **P → C → I**

6 Socio-technical systems theory

The socio-technical systems design theory advocates the reduction of complexity (and with it variety) in the design of production processes and the balancing of variety on macro, meso and micro level. A basic concept in the socio-technique is the “whole task group” or “self directed work team” and within every task group there should be a balanced job design for every worker (or position) in it. The control paradigm is used explicitly to model the production process structure, the control structure and the supporting systems structure. De Sitter (2000) explicitly defines these three structures (subsystems) and focuses his theory on the design of the production structure in interrelation with the control structure. See: de Sitter (2000), van Amelsvoort and van Amelsvoort (2000) and for further reading: van Amelsvoort (2000) van der Zwaan (1999) and Eijnatten (1993). Figure 3 illustrates the division into three subsystems.De Sitter (2000) supports the idea that the design of the information structure should follow and support the control structure, which on its turn is based on the production process design. However he strongly points at a serious risk in this approach. This way of thinking might lead to a practice in which problems in the production process are compensated by the design of its control structure, which on its turn induces a complex information structure. The socio-technical design theory emphasises strategies to reduce complexity in the production structure, like parallel order flows, production flows, segmentation, integration of control loops and self directed work teams. This approach advocates the idea that one should always try to reduce variety first rather than compensate it by designing complex control and information structures. In this line of thinking Prakken (2000) states: “(Re-)organize first, then informatize and if needed computerize”. More precisely: although a problem might seem to be an automation or information problem, one should always investigate whether the optimal solution for the problem is to be found in the P, C or I domain. Not intended, but understandable this theory is often interpreted as a preferred chronological design order to be followed: first design the production structure **P** then design the control structure **C** and finally from the control structure the information structure **I** is derived. In fact there is no chronological dependency, but a functional dependency in which P, C and I are mutually dependent. Although the structure of P is guiding for the design of C and the C structure on its turn is guiding the design of I, the technical possibilities and feasibilities in the I domain are broadening or restricting the room for solutions in the C and P domain. A similar reasoning

goes for the availability of means and control concepts that broadens or restricts the room for solutions in the P domain. See also section 7.

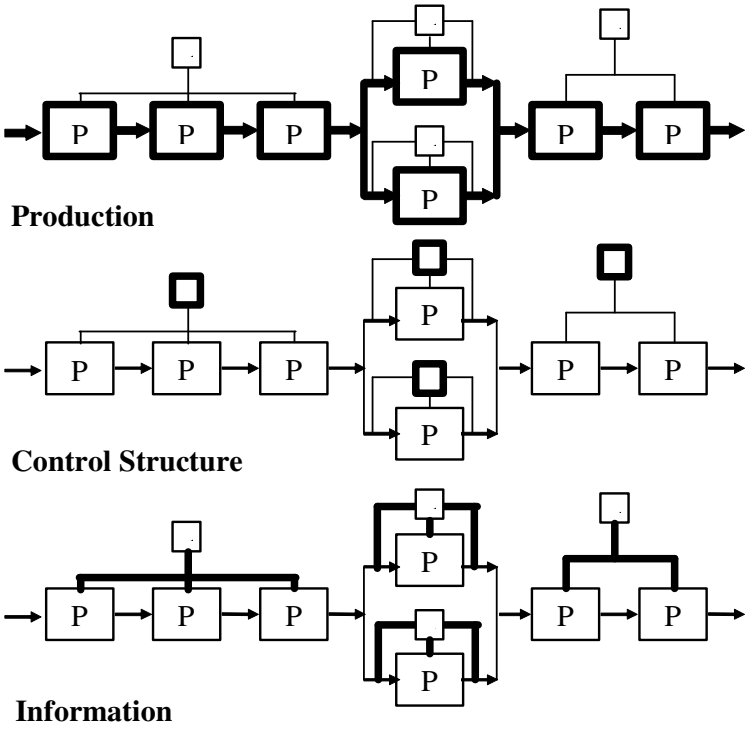

Figure 3: ***The P C I model*** (de Sitter,

7 Information and communication technology is enabling process redesign

Headed by Hammer and Champy (1993) a large number of authors have described and advocated the enabling role of information and communication technology (ICT) for the rethinking and the redesign of business processes or even the rethinking of business objectives.

Hypes and practices like EDI (electronic data interchange), BPR (business process redesign), ECR (effective consumer response), strategic use of information systems, E-business, supply chain management, internet based applications have certainly influenced business processes and their control structures. They proofed that the information technology possibilities can lead to new viable concepts in the control and production domain.

Does this turn around the **P ← C ← I** model? The early **P → C → I** models didn't take in account the enabling role of ICT, but whatever happens the logic behind the model still counts and also the socio-technical design theory still holds its value, but organisational design will have to take into account opportunities offered by ICT to rethink processes and their control structures. Due to ICT the number of alternative solution has increased drastically. In every stage in designing primary processes, control structures and information structures one should look 'forward' or 'back' into the **P → C → I** chain in search for the optimum solution. The more uncertainty there is about the feasibility and efficacy of a certain design, the more iterative (looking forward and looking back) the design process should be executed.

8 Conclusions

Here I presented a brief overview of general systems theory and the concept of variety to introduce a number of relevant theories that are useful to study the role of information and information systems in organisations. It is my conviction that professional analysis of organisations and their problems is supported by these models and will contribute to a well balanced use of possibilities offered in the P, C and I domain to create the optimal structure for an organisation and its processes.

References

Amelsvoort, P, (2000), *The design of work and organisation*, ST-Groep.

Amelsvoort, P and Amelsvoort, G, (2000), *Design and developing self-directed workteams*, ST-Groep.

Ashby, W.R., (1956), *Introduction to Cybernetics,* Chapman Hall Ltd., London.

Bemelmans, T.M.A., (1994), *Bestuurlijke Informatiesystemen en Automatisering*, Kluwer Bedrijfswetenschappen, Deventer.

Eijnatten, F.M., (1993), *The Paradigm that changed the workplace,* Van Gorcum, Assen.

Galbraith, J.R., (1973), *Designing Complex Organizations*, Addison-Wesley Publishing Company.

Hammer, M. and J. Champy, (1993), *Reengineering the corporation: a manifesto for business revolution,* Harper Business, New York

Hoeken, P.P.W.M., (1980), *Produktiebesturing en informatiesystemen*, Graduation thesis, Technical University Eindhoven, the Netherlands

Leeuw, A.C.J. de (1974), *Systeemleer en organisatiekunde*, Stenfert Kroese, Leiden

Prakken, B., (2000), *Information, organization and information system design,* Kluwer Academic Publishers.

Sitter, L.U.de, (2000), *Synergetisch produceren, Human resources mobilisation in de productie: een inleiding, van Gorcum & Comp. b.v. 3e Druk.*

Zwaan, A.H. van der, (1999), *Organising Work Processes, Van Gorcum & Comp, Assen.*