Work Analysis

An Introduction

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Work Analysis

This is a note for the lecture on Work Analysis held on March 23, 1994 on Department of Computer Science, Roskilde University. It is based on the following literature:

Schmidt, Kjeld: "A Dialectical Approach to Functional Analysis of Office Work", *1986 IEEE International Conference on Systems, Man, and Cybernetics. October 14-17, 1986, Atlanta, Geordia.*

Schmidt, Kjeld: "Function Analysis Instrument", in G. Schäfer et al. (ed.): *Functional Analysis of Office Requirements: A Multiperspective Approach*, Wiley, Chichester etc., UK, 1988, pp. 261-289.

Schmidt, Kjeld: *Funktionsanalysemetoden. En indføring.* [The Function Analysis Method. An Introduction], Arbejdsnotater #89-1, 2. udgave, Fagbevægelsens Center for Informationsteknologi, Søborg, Denmark, 1989.

Schmidt, Kjeld, and Peter Carstensen: *Arbejdsanalyse, Teori og praksis*,[Work Analysis, Theory and practice], Risø National Laboratory, (Risø-M-2889), Roskilde, Denmark, 1990.

Besides the literature it is based on meetings and discussions with Kjeld Schmidt and Peter Carstensen.

Background

Work Analysis comprises an attempt to describe a theory of work, a conceptual framework, and a method for doing design projects in information systems development. The scope of Work Analysis is primarily design within office work in (complex) administrative settings with a reasonable content of problem solving, consideration, counselling, and decision making. Key elements of Work Analysis are inspired from the fields of function analysis, system thinking (Soft Systems Methodology), cognitive engineering, and ethnographic analysis of office work[1] (Simon, 69; Simon, 76; Checkland, 81; Checkland and Scholes, 90[2]; Mathiassen, 84[3]; Roth and Woods, 89[4]; Suchman, 83[5]; Suchman and Wynn, 84[6]; Suchman, 87[7]).

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[1]   A short introduction to some issues concerning the apparent contradiction in combining a phenomenological and a functionalistic approach, is outlined in Simonsen, Jesper: *Is it Possible to Combine a Phenomenological and a Functionalistic Approach?* Position paper for the 15th IRIS'92, (Information systems Research seminar In Scandinavia, 9.-12. August 1992) and Simonsen, Jesper: *The Role of a Phenomenological Approach in Designing CSCW*, Position paper for the workshop on Interdisciplinary Theory for CSCW design at the CSCW'92 conference, Toronto, 31 October - 4 November 1992.

[2]   Se forelæsningsnoterne om Soft Systems Methodology fra 25-2-94 og Herbert A. Simon, Administrative Behavior fra 11-3-94

Work Analysis is an approach still under development, mainly by Kjeld Schmidt. The development of Work Analysis can be seen as comprising three versions:

- In the first version it was called Functional Analysis (Schmidt, 86; Schmidt, 88; Schmidt, 89). A main part of its development originates from the ESPRIT-project FAOR (Functional Analysis of Office Requirements) as one of the instruments that this multiperspective approach describes; the Function Analysis Instrument (Schmidt, 88).

- In the second version its scope was broaden comprising a functional analysis, a preceding strategical analysis, and a link to a succeeding operational analysis. Its conceptual framework was developed further as a preliminary theory of work, hence the name Work Analysis. The most recently description of Work Analysis is a report describing this second version (Schmidt and Carstensen, 90). In the foreword it is stated that the purpose of the report is to discuss the theoretical basis and practical problems of Work Analysis (Schmidt and Carstensen, 90, p. 5).

- Currently a third version is under development. One effort is to elaborate the approach into the concept of CSCW (Computer Supported Cooperative Work) among others things as part of the ESPRIT-project COMIC (Computer-based Mechanisms of Interaction in Cooperative Work) (COMIC, 93)[8].

In the following Work Analysis is described as it appear in the second version. Its perspective and conceptual framework is examined, the method is described, and the suggested techniques are outlined.

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[3]   Mathiassen, Lars: *Systemudvikling og Systemudviklingsmetode*, [System Development and System Development Method], DAIMI PB-136, Due-rapport nr. 5, Datalogisk Afdeling, Matematisk Institut, Aarhus, Denmark, 1984.

[4]   Roth, Emilie M., and David D. Woods: "Cognitive Task Analysis: An Approach to Knowledge Acquisition for Intelligent System Design", in G. Guida and C. Tasso (eds.): *Topics in Expert System Design. Methodologies and Tools*, North-Holland, Amsterdam, 1989, pp. 233-264.

[5]   Suchman, Lucy A.: "Office Procedure as Practical Action: Models of Work and System Design", in *ACM Transactions on Office Information Systems*, Vol. 1, No. 4, October 1983, pp. 320-328.

[6]   Suchman, Lucy A. and Eleanor Wynn: "Procedures and Problems in the Office", in *Office: Technology and People*, Elsevier Science Publishers B. V., Amsterdam, The Netherlands, 1984, pp. 133-154.

[7]   Suchman, Lucy A.: *Plans and Situated Actions. The problem of human-machine communication.* Cambridge University Press, Cambridge, New York, 1987.

[8]   COMIC Deliverable 3.1: Computational Mechanisms of Interaction for CSCW, The COMIC project, Esprit Basic Research Action 6225, Computing Department, University of Lancaster, UK, 1993.

Perspective and Conceptual Framework

Basically Work Analysis considers human work as a purposive transformation (i.e. it is intentional) of an object into a product which satisfies a human need.

Work thus comprises the elements: the need, the object, the transformation, and the product. A work domain is defined as comprising the transformation, its object, and its product; i.e. trade, line, industry, or profession.

Work Analysis does not elaborate much on these concepts in its second version: this is one effort currently in preparation. The concepts may be adequate in describing a material production where some input is transformed into some output[9]. Concerning services (medical treatment, haircutting, acting, etc.) a more abstract use of the concepts is necessary: the object is then aspects of the conditions of the customer; the transformation is happening when the service is consumed; when the transformation has ended the need is satisfied. Within administrative work the object is perceived as economic relations which the administrative work communicate and control (Schmidt and Carstensen, 90, pp. 71f).

The decisive point in Work Analysis' perspective of work is that work is purposive and intentional and hence can be interpreted in functional terms.

> Human work is purposive transformation, i.e. it is intentional [...] By providing human beings with the necessary means for satisfying their needs, work is functional. As opposed to other human activities, a work process is essentially determined by its function (Schmidt 86, p. 3[10]).

> Human work must be understood as a system of which the tasks and activities performed by individuals and organizations are functional parts (Schmidt, 88, p. 264).

Work Analysis uses Simon's description of an artifact as an interface between an inner and an outer environment (Simon, 69)[11]. The inner environment is the subject of the transformation, the work in question, defined as a work system. The outer environment - or just the environment - is that part of the world which impose requirements and demands on the work system and which impose conditions and constraints on the work system concerning its effort to meet the requirements.

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[9]   Checkland uses a similar notion concerning root definitions and conceptual modelling in Soft Systems Modelling: "A root definition expresses the core purpose of purposeful activity system. That core is always expressed as a transformation process in which some entity, the 'input', is changed, or transformed, into some new form of that same entity, the 'output'." (SSM, 90 p. 33). (Jvf. forelæsningsnote om Soft Systems Methodology, side 9).

[10] Min udgave af denne artikel er sidenummereret 1- 15. Jeg har ikke de korrekte sidetal ift. proceedings fra IEEE-konferencen.

[11] Jvf. forelæsningsnoten om fra 11-3-94 Simon, her specielt denne notes side 10.
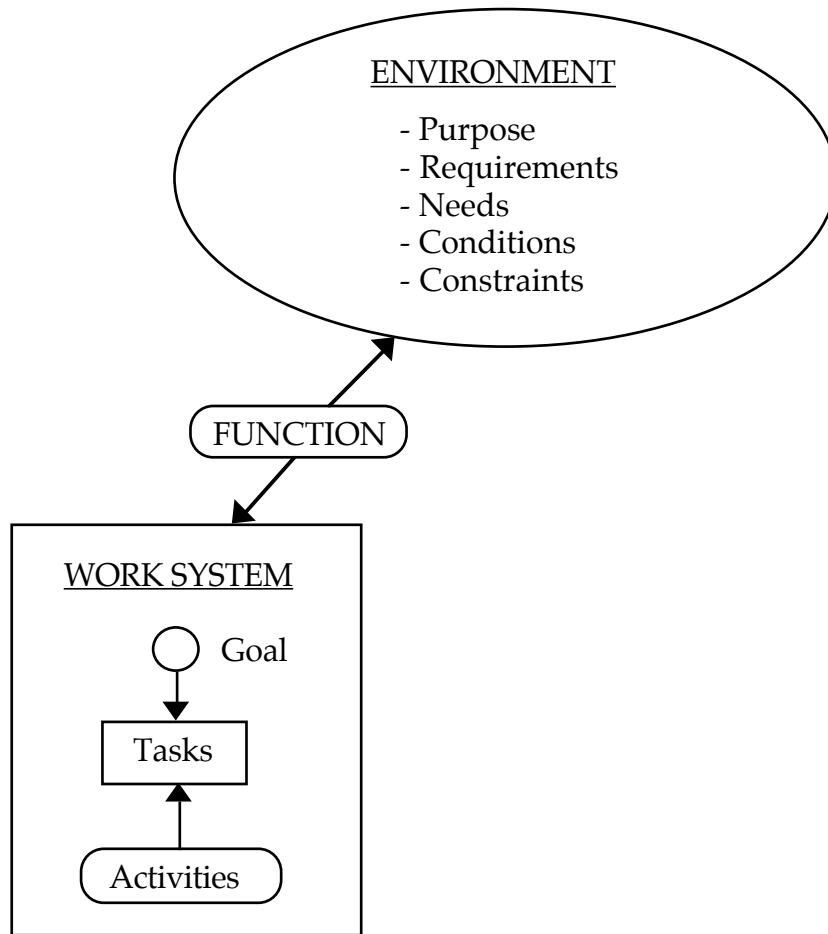
Figure 1: Basic conceptual framework, derived from (Schmidt, 88; Schmidt, 89; Schmidt and Carstensen, 90).

The interface between work system and environment is defined as the function:

> "Systemets funktion er den relation af formålstjenlighed, der forbinder systemets ud-formning og virkemåde med dets formål og de specifikke betingelser, hvorunder for-målet skal opfyldes" [The function is the relation of expediency, which links the systems configuration and mode of operation with its purpose and the specific conditions, in which the purpose must be met] (Schmidt and Carstensen, 90, p. 77).

> [A] function denotes the intention of the work. A function expresses the purposiveness of the processes, disregarding the method and the actual form of implementation of the processes (Schmidt, 86, p. 5).

> The function of an element of a system is the relation of necessity of that element to the system at large (Schmidt, 88, p. 264).

A function is thus a means-end relation between the work system and its environment (Schmidt and Carstensen, 90, p. 77).

The work system is perceived as a social or sociotechnical systems. The work system may not (and most often it do not) correspond to an organizational structure (e.g. an agency, a department, or an economic unit). A work system is a cooperative ensemble that constitutes a coherent system by performing interdependent activities.

> Being mutually dependent *in work* means that A relies positively on the quality and
> timeliness of B's work and vice versa and should primarily be conceived of as a positive,
> though by no means necessarily harmonious, interdependence (Schmidt and Bannon, 92,
> p. 13)[12].

The interdependent activities are often interpreted as exchange transactions[13] (Schmidt, 86, pp. 8f; Schmidt and Carstensen, 90, pp. 78f).

As a social system, the work system is created and maintained through the activities performed by its agents. Its purpose is represented in a distributed and contradictory manner as different individual interpretations of the work systems purpose. The actors participate and are guided by individual and different interests and motives. Hence one task in doing Work Analysis is to develop a theory of the work systems purpose and conditions (Schmidt and Carstensen, 90, pp. 78f).

When you observe a work system "in action" you will notice a lot of different things happen: A copies a letter for Mr. B; C drops a sheet of paper on the floor; D prepares a draft of a contract; E drinks his coffee; F negotiates with G concerning a loan; etc. What is observed is processes. "The concept of process denotes the multiple facets of what is happening [...] accidental occurrences as well as the necessary" (Schmidt, 88, p. 269). In order to abstract the essential processes from the accidental "background noise" (Schmidt, 88, p. 269) Work Analysis provides the concepts: *process, operation, activity, task, set of tasks, goal,* and *function* (Schmidt, 86, pp. 4-6; Schmidt, 88, pp. 269-271; Schmidt and Carstensen, 90, pp. 90-96)[14].

The significant content in the processes are activities which are related to tasks which are one (possible) implementation of a function. Doing Work Analysis one must follow this chain from process to function.

The concept *activity* highlights the substantial in a process[15] with respect to the technical and other resources available. Hence the form assumed by activities is

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[12]   Schmidt, Kjeld, and Liam Bannon: "Taking CSCW Seriously. Supporting Articulation Work" in *Computer Supported Cooperative Work (CSCW).* Vol. 1, Nos. 1-2, Kluwer Academic Publishers, Dordrecht, The Netherlands, 1992. pp. 7-40.

[13]   See e.g. Ciborra, Claudio U.: "Reframing the Role of Computers in Organizations: The Transaction Costs Approach", in *Proceedings of Sixth International Conference on Information Systems, Indianapolis, December 16-18*, 1985, pp. 57-69.

[14]   The definition of the concepts task, activity, and process are inspired from Andersen, Niels Erik, Finn Kensing, Jette Lundin, Lars Mathiassen, Andreas Munk-Madsen, Monika Rasbech and Pål Sørgaard: *Professional Systems Development: Experience, Ideas and Action,* Prentice-Hall, New York, 1990.

[15]   Work Analysis does not elaborate much further *what* is the substantial and *what* is the accidental and negligible background noise. An example is given, though: Talking about photocopying as an activity you should ignore that you make a mess, drops the originals on the floor, and later collect yourself by drinking a cup of coffee while the photocopier is running (Schmidt and Carstensen, 90, p. 91). Maybe this example is not the best one you could choose. A significant and very referred study of people making a mess trying to photocopy was made by Lucy Suchman and described in her book: *Plans and Situated*

strongly influenced by the currently available implements. Activities may be decomposed into *operations*.

A *task* abstracts from the resources at hand and relates to a *goal* in terms of a specific end state striven for. A task is an operational denotation of a function. Basically a task appears as a problem where the path from the current state to the desired state is not known in advance. The problem is solved by finding a path to the desired state.

There is an important difference between a function and a task. The function is a quality of the work system as a whole: its expediency in relation to its environment. It continues to serve a purpose. It is independent concerning different possibilities of implementation. A task, on the contrary, has goal and hence a definite end state: when the goal is reached the task is done. A task is an operationalization, a way to realise and implement a function. "Functions exists while tasks come to an end"[16].

Typically a function may be specified in a *set of tasks* indicating what is requested. A set of tasks operationalizing a function is a manifestation of a specific problem solving method or heuristic. Sometimes it is a bit of a quibble to try to distinguish between a function and a set of tasks.

An example on a function from the Film Board is *Take care of film festivals*. A related task could be *to organize this specific festival next week*. Correspondingly an activity could be *right now I'm preparing these leaflets for the festival next week*. Finally an operation could be *to stamp the leaflets on the back page*.

The basic conceptual framework of Work Analysis is summarized in figure 1 above and in the following figures 2 and 3.

Actions. The problem of human-machine communication. Cambridge University Press, Cambridge, New York, 1987.

[16]   "Funktioner består mens opgaver forgår".

Intention (end)   Purpose
Abstract
point of view

                             Objective   Goal

                             Function   Task

                                                   Activity

Implementation
(means)
Concrete
point of view   Operation   Process

Essence (end)   **Appearance** (means)
Intention   Actual performance
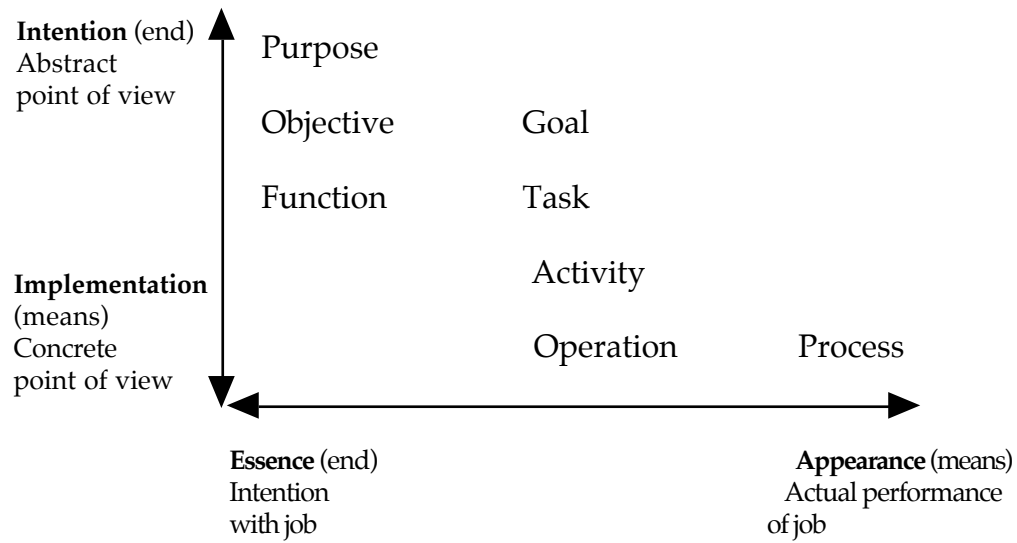with job   of job

*Figure 2: Basic concepts depicted in two means-end dimensions, derived
from (Schmidt, 86, p. 5; Andersen et. al., 90, p. 42).* Objective denotes the
intended outcome of the function. Purpose denotes the intended outcome
sub specie the wider system benefitting from the work (Schmidt, 86, p. 5).
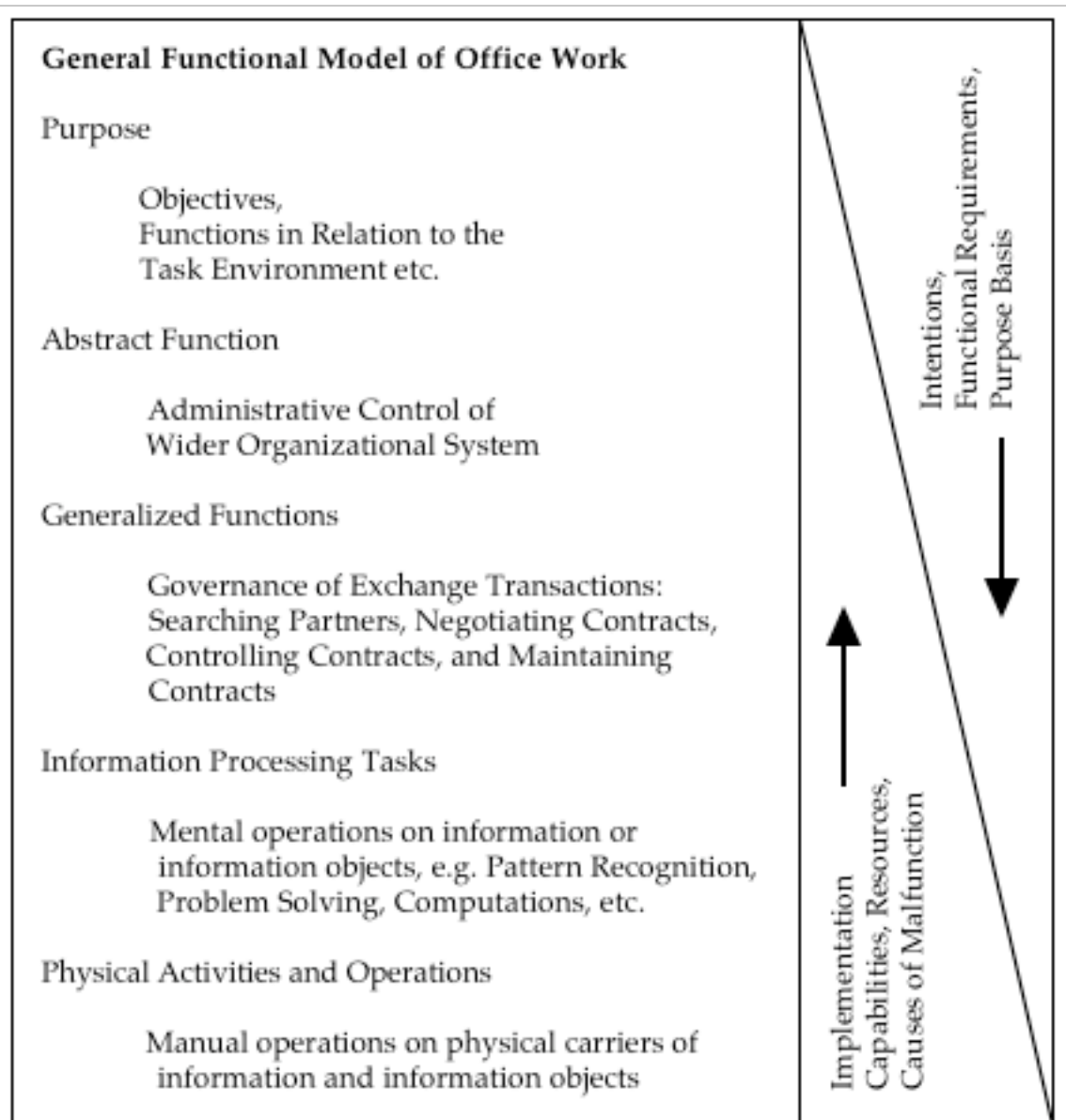
General Functional Model of Office Work

Purpose

> Objectives,
> Functions in Relation to the
> Task Environment etc.

Abstract Function

> Administrative Control of
> Wider Organizational System

Generalized Functions

> Governance of Exchange Transactions:
> Searching Partners, Negotiating Contracts,
> Controlling Contracts, and Maintaining
> Contracts

Information Processing Tasks

> Mental operations on information or
> information objects, e.g. Pattern Recognition,
> Problem Solving, Computations, etc.

Physical Activities and Operations

> Manual operations on physical carriers of
> information and information objects

Intentions, Functional Requirements, Purpose Basis

Implementation Capabilities, Resources, Causes of Malfunction

Figure 3: General functional model of office work (Schmidt, 86, p. 10).

The conceptual framework and perspective of Work Analysis is heavily influenced by the work of Herbert A. Simon: Work Analysis has a rational theoretical background and, also, a focus on decision processes.

Work Analysis claims that the interpretation of the results of the analysis into this abstraction and conceptual framework will provide relevant recommendations (or the relevant "zooming"; Gougen and Linde, 93)[17] **(NB: det giver**

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[17]   Gougen, Joseph A. and Charlotte Linde: "Techniques for Requirements Elicitation", in
       Proceedings of the IEEE International Symposium on Requirements Engineering. January 4-6,

områder **relevante/potentielle for zooming i Gougens forstand)** regarding support from information systems: these systems must support the function that is the expediency of the work system towards its environment, "[...] so as to provide a rational basis for requirements specification" (Schmidt, 88, p. 261). The requirements and conditions from the environment are viewed as the "field of force" in which the work system exist. The work systems functions corresponds to these - to a large extent given - requirements and conditions. If the work system cannot fulfill its purposes according to its environment its resources will drain and, finally, it will cease to exist: if it does not fulfil these demands in a reasonable way it is "out of business".

When Work Analysis describe complex work it is often reduced to decision making:

> Work Analysis is confronted with the challenge of investigate, describe, and interpret complex work. Within complex work the actual approach in a decision process is not known in advance; different decision makers uses different decision strategies and one may often change strategy during the decision process (Schmidt and Carstensen, 90, pp. 75f, authors translation).

> Complex work is often characterized by comprising several object domains[18], and a significant part of the decision process is juxtaposition of information from several object domains (Schmidt and Carstensen, 90, p. 83, authors translation).

Often a function involves one or more "prototypic" decision situations. Work Analysis does not require, though, that a function always must involve a decision situation - often that is not the case. Within administrative work for instance (especially in the financial sector) three superior processes are often observed: obtaining/gathering information; collocation/juxtaposition of information; decision on the basis of the juxtaposition. This often corresponds to three functions.

Method

A model describing the main components in systems development emphasizes that system developers basically perform two types of creative activities (Andersen et. al., 90, pp. 42ff):

- A product-oriented activity creating a computer-based system, i.e. a computer system and changes in the user organization. This performance-related activity includes design, analysis, and realization.

1993, San Diego, California. IEEE Computer Society Press, Los Alamitos, California, 1993, pp. 152-164.

[18]   An object domain is a coherent accumulation of knowledge with vital importance for the work domain. It is areas in the environment that the work system need to know about. (På dansk kaldes det "genstandsområde". Min oversættelse til object domain er ikke særlig god syens jeg, men pt. kan jeg ikke finde på noget bedre).

- A process-oriented activity creating a project resulting in the planned computer-based system. This management-related activity includes planning, evaluation, and regulation.

The description of the Work Analysis-method, given in (Schmidt and Carstensen, 90), focuses on the product-oriented activity and basically ignores issues concerning management of the process of doing Work Analysis.

The method for Work Analysis cannot be more structured than the work system in question i.e. the analyst must experiment and conduct the analysis with a pronouncedly iterative approach. Hence the method consist of a collection of heuristics, guidelines, and principles, basic functions, tactical recommendations, and suggested techniques (Schmidt and Carstensen, 90, p. 105).

In the following the method is described by presenting and discussing

- its general approach (this includes some general principles and heuristics);

- its three analytical levels (this comprises the tactical recommendations, basic functions, and a number of guidelines);

- and, finally, some suggested techniques.

General Approach

The basic methodological principle in Work Analysis is given with reference to Herbert Simons parable of the ant[19]:

> In stead of trying to record and model the - changeable - decision paths and cooperative patterns, observable in the work system, it is more appropriate to record and model the - relative stable - properties of the environment of the work system (Schmidt and Carstensen, 90, p. 76, authors translation).

The general approach is to interpret the work system as having a purpose in terms of its function corresponding the requirements and conditions from its environment.

Apparently the starting point could be an analysis of the environment leading to a "logic" model of the function of the work system and finally an in-vestigation of the work system searching for tasks etc. constituting its function. Work Analysis have in its different versions had some troubles in deciding whether the analysis should take its starting point by a logic modelling based on an analysis of the environment, by a more "semantic" analysis of processes (activities and tasks) observable in work system, or both:

> The workings of the inner environment of the target system is deliberately ignored in function analysis. [...] Function analysis does not address the inner environment, but

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[19]   Jvf. forelæsningsnote om Herbert Simon fra 11-3-94 side 10f.

rather addresses the interface between the target system and its task environment (Schmidt, 88, pp. 269f).

Concerning work, which is characterized by problem solving, it is [...] meaningless to try to record and model the path followed in the individual case (Schmidt and Carstensen, 90, p. 96, authors translation).

An analysis of a specific decision situation must [...] comprise an analysis of the strategies, which are used in that kind of decision situation. The analysis must 1) expose which strategies are actually used [...] 2) identify strategies that are effective and reliable [...] 3) identify the information, mental models, and cognitive resources implied by the respectively alternative strategies (Schmidt and Carstensen, 90, p. 98, authors translation).

[T]he dialectical approach to functional analysis unites the systems and the semantic approach. The systems approach identifies the functions of the given office by deriving them from its task environment, whereas the semantic approach identifies functions by deriving them from the *meaning* attributed to the activities actually carried out (Schmidt, 86, p. 13).

A meeting with Kjeld Schmidt and Peter Carstensen in September 1992 clarified a general (and pragmatic) approach as the following:

Start within the work system in question and move from here towards the environment. The actors within the work system are the central persons having the work as one main part of their world. Then ask the persons in the nearest environment, e.g. other related departments and get an understanding of this boundary to the work system. Finally visit the more "distant" environment, e.g. the customers outside the organization. By then you will have the best questions ready. The customers relation to the system is often only a very peripheral part of their world.
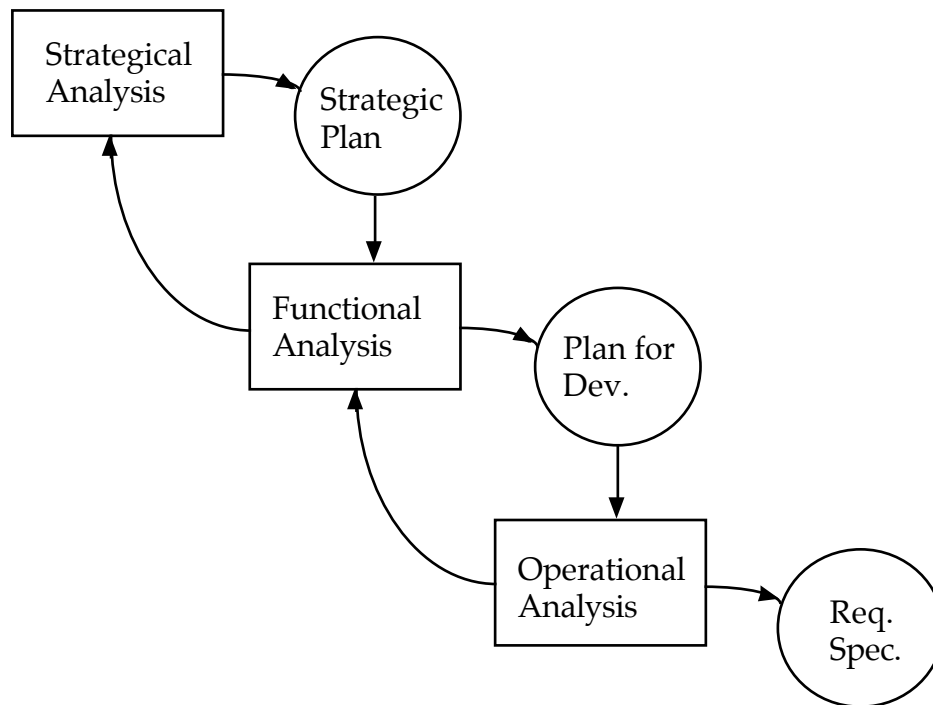
Three Levels of Analysis

Figure 4: 3 levels of analysis, derived from (Schmidt and Carstensen, 90, p. 110).

Work Analysis suggests an (ideal) distinction between 3 levels of analysis, see fig. 4:

- Strategical analysis. This analysis results in a strategic plan for the use of information systems in a work system. Focus is the functional requirements of the environment upon the work system considered in general. This could e.g. be the overall purpose of an entire organization, as related to the requirements of its environment. The result should define those domains of work, decision situations, and domains of tasks which are of crucial importance for the work system considered in general, and therefore would be appropriate to support by information systems. This leads to a "prototypic" decision situation with the decision of where it "hurts" - where to perform the functional analysis.

- Functional analysis. This analysis results in a plan defining the overall functional design. Focus is on the functions and the requirements that they are supposed to live up to - within the system of work, as defined in the strategical analysis. This could e.g. be one specific department, a specific decision situation, or a domain of tasks in the organization. The result should specify the functional division between the employees and the information systems (what are the tasks managed by the employees and what kind of information and other support do they need). This leads to another "prototypic" decision situation where the functional user/technology-division and the priority of possible information systems are made.

- Operational analysis. This analysis results in the design specification. Focus is on the information system(s) in question, as specified in the functional analysis. As the purpose and the function of the information systems has been clarified from the strategical and the functional analysis, the operational analysis has a fairly clarified starting point from which to choose the succeeding method of analysis. The process of this analysis could e.g. be highly structured, as suggested in various methods e.g. structured analysis (Yourdon, 82)[20].

The scope of Work Analysis can be described as consisting of the strategic and functional analysis, while the major part of the operational analysis is out of the scope.

The distinction between the three levels of analysis is ideal and does not mean that the analysis is conducted divided into strictly separated phases. The levels reflect that the analysis roughly serves three different purposes and *thus* proceeds in three different levels. On the other hand the purpose of the preceding analysis serves the succeeding and, hence, the three levels reflect a main direction in the total analysis. For instance it is a typical situation that Work Analysis starts as a functional analysis and during the analysis reveals issues that brings the analysis to include a strategical analysis.

Strategical Analysis

The purpose of the strategical analysis is to develop an information technology strategy for a given work system, e.g. an entire organization or enterprise. The strategy should include a formulation of the overall objective of the work system which in a condensed form states the purpose of the work system (what is this business all about). This objective should be expressed in a plan with a succession of related actions. The strategy should include an objective of the development of the work system which corresponds to the requirements from the environment. The strategy thus should identify functions (work domains, decision situations, classifications of tasks, etc.) with a vital importance for the work system as a whole: which areas are of a strategic importance? Which areas are bottlenecks? Which areas "hurts", i.e. where do we need to prioritize support of some kind (e.g. by information systems) seen from a high organizational perspective, e.g. from the enterprise as a whole (Schmidt and Carstensen, 90, pp. 110f).

The result of the strategical analysis serves as an ideal basis for the functional analysis: The overall functional requirements and the purpose regarding an information technology strategy are clarified, and the function(s) that need support and hence are the starting point for the functional analysis are identified.

The strategical analysis includes the following functions (Schmidt and Carstensen, 90, pp. 111-115):

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[20]   Yourdon, E.: *Managing the System Life Cycle*, Yourdon Press, New York, 1982.

- *Problem formulation*. This corresponds to stage 1 and 2 in Soft Systems Methodology in its 81-version[21]. Work Analysis recognizes that problems need to be realized and formulated - they are not "just there" as a starting point. Most likely the problematic situation is a complex of many (usually interrelated) problems that need to be identified. The work system is subject to diverse and contradictory requirements from the environment, and different actors have different perspectives on the situation in relation to their work, interests, and motives. The point in problem formulation is not to choose a certain interpretation of the problematic situation (as in Soft Systems Methodology) but to try to identify aspects (problems, requirements, motives, etc.) that constitutes the most dominating factors. The aim is to formulate a rather comprehensive and general interpretation of the problem situation that serves as a criteria in succeeding question of priorities.

- *Definition of work system*. The purpose of this function is to clarify the basic requirements from the environment, the boundary between the work system and the environment, and, hence, understand and describe the work system. The CATWOE-mnemonic from Soft Systems Methodology is suggested as a guide for the central questions to answer. The system definition (root definition) serves as a guide for the further analysis and must thus be discussed and possible approved by central actors in and interest groups to the work system - this does not necessarily mean managers.

- *Identification of central functions*. This includes the identification of functions (work domains, decision situations, classifications of tasks, etc.) with a vital importance for the work system as a whole. Among these the critical functions which needs support and which are expected to benefit from support by information systems should be pointed out: where does it "hurt", where should we prioritize to perform the functional analysis.

- *Cost-benefit-analysis*. Finally the expected effectiveness from support with information systems should be weighed pros and cons of the expected costs.

Functional Analysis[22]

While the strategical analysis focus on the work system as a whole and the functional demands given by the environment, the functional analysis focus on specific functions performed by the work system. The purpose is to characterize the functions and specify the functional division between user and technology: what could be supported and/or automated by information systems and what should be taken care of by the actors in the work system (Schmidt and Carstensen, 90, p. 116).

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[21]   Jvf. læsningsnoten om Soft Systems Methodology fra 25-2-94.

[22]   The major part of this description of the functional analysis originates from meetings and discussions with Kjeld Schmidt and Peter Carstensen.

The result of the functional analysis serves as an ideal basis for the operational analysis by specifying the information systems needed and the function they should support. Recommendations from the functional analysis should be able to outlive the lifetime of a specific information system.

The starting point for the functional analysis is one or more (overall) function(s). For each function a corresponding work system is defined and described in a root definition guided by the CATWOE mnemonic.

A general heuristic is to cover three levels of functions in the analysis, one level above and one below the function/work system in question. In order to define the work system for a function and its boundary to the environment the analysis starts by moving up one level to "see the map", i.e. all major functions and work systems in the organization or the part of the organization with relations to the work system in question. This is not, though, a very thorough analysis. When the root definition is made (and hence the work system defined) the analysis moves "into" the work system: which basic functions does it perform? This analysis thus moves one level down and exposes the subfunctions that constitute the work systems overall function.

It is the problem situation which determine the starting point of the level for the functional analysis. By the problematic situation means the analysts' interpretation of the problematic situation as it is recognized by the actors from the work system (not necessarily the manager's perspective). This interpretation of the problem(s) may, during the analysis, appear to be wrong, e.g. to be a symptom on one or more problems on another level. In that case the analysis may shift its level, e.g. one level up and the functional analysis hence may turn into a strategical analysis. This is referred to as a iterative and recursive approach for the analysis.

In decomposing[23] the function into subfunctions one level down, some guidelines/heuristics are given:

- Asking the actors in the work system *why* they accomplish certain tasks and activities, may lead to functions towards the environment which can reconstruct purposes and specific conditions.

- Asking actors in the environment what they expect, need, require, etc. may lead to a focus on the work system: where is this function performed?

- An analysis of purpose and specific demands, requirements and conditions in which the purpose must be met often reveals specific functions. E.g. concerning a portfolio management agency (Schmidt and Carstensen, 90, pp. 98-104; COMIC, 93, pp. 75-78) the customers, often investing large

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23   To decompose a function into subfunctions should be interpreted as describing it in more detail. "Decomposition of functions is meaningless. A function may be understood and defined in more or less detail, of course. However, enlargement or enrichment of a picture is not decomposition of it. In fact, decomposition of a function would be a description of a sequence of activities determined by a *specific* problem solving method or by the *current* implementation" (Schmidt, 86, p. 6).

amounts of capital, were nervous. This caused the consultants to thoroughly explain their recommendations for investments and they organized their work according to this very important requirement. In that case it was meaningful to refer to it as a function.

- A function may be decomposed into subfunctions for each decision situation. As a general heuristic a coherent decision situation correspond to a function; a one to one mapping between "prototypic" decision situations and functions is recommended; one decision situation may not be decomposed into two functions.

- Very often different functions refer to different object domains, e.g. "make inquires about this object domain".

- In case of several object domains you will typically find functions that connect and link informations from each object domain (mediating functions).

Functions should only be decomposed into a level where they describe sociotechnical systems. The functional analysis clarifies the boundary between user and technology: which elements of the function (e.g. a decision situation) are supported by information systems and which by the user? Which data and information could an information system support appropriately? Functions in Work Analysis has thus nothing in common with functions in information systems - a function in an information system correspond to an operation in Work Analysis. The lowest level the functional analysis may reach is a description of the kind of data, information, and functionality an information system should support for a given function. It is the task of the operational analysis to systematize and structure this in more detail. In other words, when a specific information system is outlined the functional analysis ends. The intermediate stage between the functional analysis and the operational analysis should be regarded as a milestone (a "prototypic" decision situation) where the functional allocation between user and technology is decided.

The final result of a functional analysis takes the form of a report with the following outline:

- A description of the environment and its requirements, needs, conditions, constraints, etc.

- A description of the object domains.

- A description of the functions performed by the work system.

- A discussion of problems and recommendations for information systems that could support the relevant functions.

In Work Analysis reports Kjeld Schmidt and Peter Carstensen have not "translated" the concepts from the Work Analysis into concepts more known to the target group. By using (and explaining) these concepts, which the actors of the work systems in question have not known in advance, it is avoided that they are given other (wrong) interpretations. They have experienced that the

target group could relate to, and qriticize, such descriptions. Especially managers find that the functional descriptions describe their domain in very clear terms. From these descriptions it is possible to discuss specific elements (e.g. a specific function) separately. This way to outline the final report has thus been experienced as a basis for decisions providing discussions concerning "what should we aim at".

Operational analysis

The purpose of the operational analysis is to realize an information technology strategy by developing and implementing information systems. The result of the operational analysis is a design specification which forms the basis for the purchase, development, implementation, installation, etc. of information systems. Focus is on the information system(s) and the environment is the users and the tasks which the information system should support (Schmidt and Carstensen, 90, p. 118).

Ideally the result of the strategical and functional analyses provides the operational analysis with a basis which permits a structured approach. The outcome from the strategical and functional analyses takes the form of a decision of a basic design which corresponds to the rather well-defined starting point of e.g. structured or object oriented analyses.

Usually the operational analysis is performed by others[24] than the ones performing the strategical and the functional analyses, e.g. employees from an internal information technology department within the organization.

Hence, the scope of Work Analysis can be described as consisting of the strategic and functional analysis, while the major part of the operational analysis is out of the scope.

Techniques

Work Analysis suggest a number of techniques to support respectively the inquiries and interpretations in the strategical and functional analyses (Schmidt and Carstensen, 90, pp. 119-130). The central technique supporting inquiries is the unstructured interview. The central technique supporting interpretations is the functional modelling.

Techniques supporting inquiries

The unstructured and qualitative interview (with employees, managers, customers, etc.) is the essential technique in eliciting the knowledge for the strategical and functional analyses (Schmidt and Carstensen, 90, pp. 121-124).

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[24]   This raises an issue of anchoring the vision, which is not discussed in Work Analysis.

The analyst should prepare himself by having some overview of the work system in question and he must try to explain his hypothetical assumptions clearly. Focus in the interview is "why"-questions e.g. concerning how certain tasks and activities are accomplished. This may lead to functions towards the environment which can reconstruct purposes and specific conditions. A successful unstructured interview takes the form as a dialogue where the analyst and the interviewee intercommunicate and realize important aspects related to the work system.

Other techniques suggested are:

- Structured interview.

- Questionnaire and diaries (written by the actors in the work system).

- Document analysis.

- Observation. Observation is emphasized as a central technique concerning analysis of cooperative work. Observations may be supported by audio and video recordings.

Techniques supporting interpretations

Functional modelling is a graphical diagramming technique to model the functions within the work system and between the work system and its environment. The technique is suggested as primarily a private tool for the analyst though often functional models are presented in reports from Work Analyses. The diagramming syntax is quite simple. A function is represented by a box and object domains by circles. Relations (i.e. transformation of information, logical dependencies, etc.) between functions and between functions and object domains are represented by arrows.

Figure 5 and 6 below are examples of functional models from the Editorial Board. Also, they illustrate two levels in a functional analysis (the third and lowest level was included in a description of each of the functions on the second level.
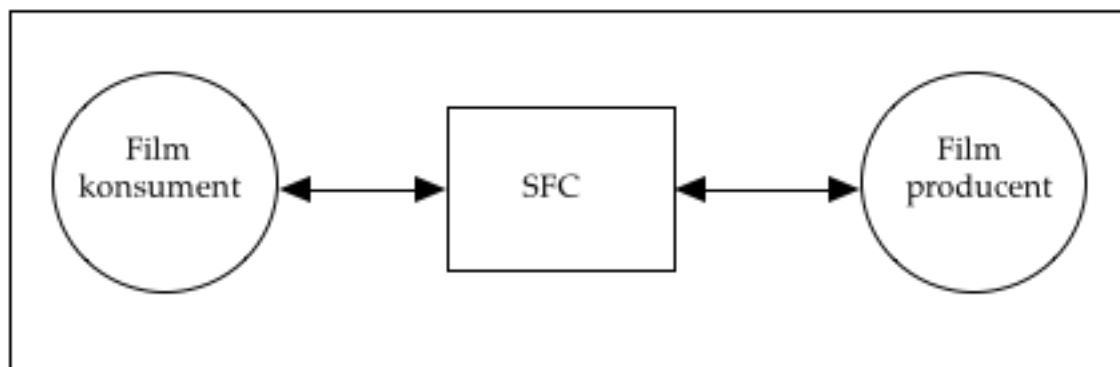

Figure 5: Functional model of Film Board, first (highest) level.
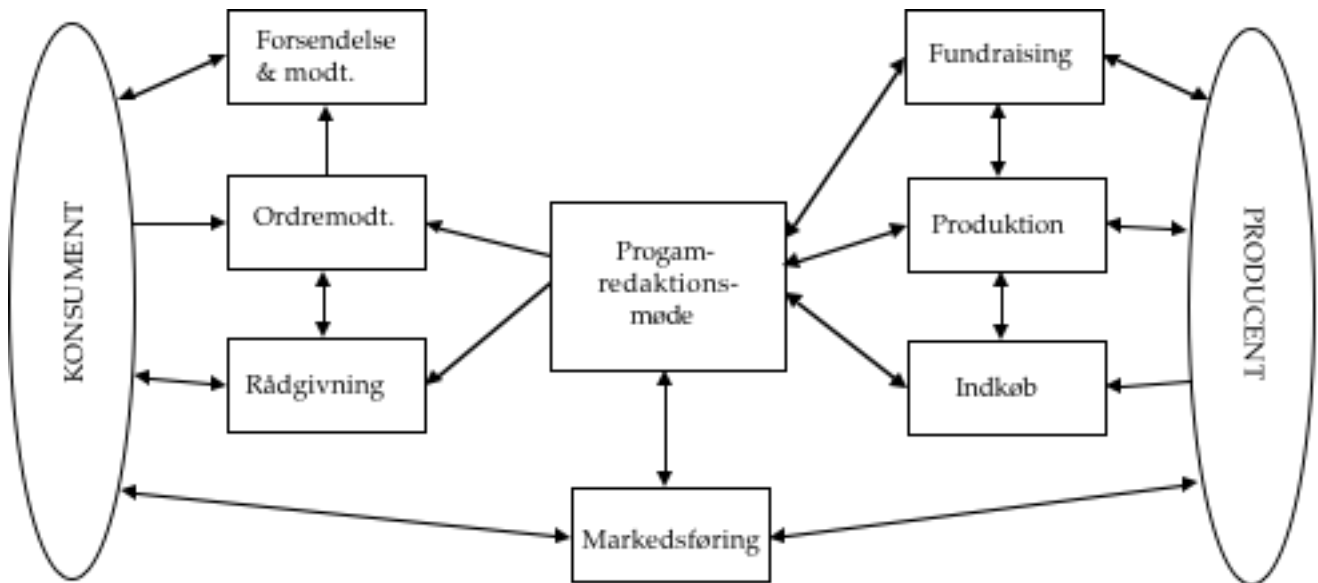
Figure 5: Functional model of Film Board, second level.

Other techniques suggested are:

- Root definitions. In Work Analysis a root definition is a definition of a work system, as opposed to the root definition in Soft Systems Methodology, which Work Analysis claims to be a perspective on a hypothetical system.

- Rich pictures.

- Means-end hierarchies. These are illustrated in figures 2 and 3.