Classification Schemes: Supporting Articulation Work in Technical Documentation

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Abstract: This paper is based on a field-study at a Danish large scale manufacturing company. It concerns the empirical analysis of articulation work in the reuse of drawings in the production of technical documentation. It is argued that in order to reduce and manage complexity of articulation work certain types of artifacts will be applied. The complexity of technical documentation is discussed. A classification scheme is discussed according to the concept of mechanisms of interaction (Schmidt, 1994). The analysis supports that people apply artifacts facing complexity in the articulation of reuse of drawings.

1. Introduction

The production of technical documentation in a large scale manufacturing company is a highly complex activity. It involves a large number of people, who are scattered, not only around one factory site, but worldwide. Moreover these people are mutually interdependent and they carry with them a whole range of different perspectives, objectives and competence into the work process. Based on field study findings, from a large scale international company, this paper will argue that access to manipulate and articulate distributed inclusion and retrieval of technical drawings in shared public repositories will reduce the complexity of the articulation work needed in order to facilitate reuse of technical drawings, in the production of technical documentation. One of the main sources for creating new documentation is the study of existing documentation of products similar to the one to be produced. Especially reusable drawings attract interest. Drawings exist as CAD-models and as traditional hand sketched drawings. The majority of drawings is archived in a local file-archive in the technical documentation department. Since archiving was very little systematised browsing the considerable amount of drawings in the archive was a very time consuming activity, a computer-based drawing index was invented to facilitate the storage and retrieval of drawings and CAD-models with the purpose of reuse. In this way reuse tend to reduce time costs but most important is that reuse supports the standardisation of the documentation.

The distributed and dynamic character of large scale cooperative work settings, where many or an indefinite number of persons participates, the articulation work needed to coordinate tasks becomes extremely demanding and complex. To reduce the complexity of articulation work people will apply various forms of symbolic artifacts like time-tables, schedules, classification schemes, etc. (Schmidt, 1994). These artifacts are in nature
underspecified in relation to the multiplicity of the work situations. As such they become objects of various forms of cooperative manipulation activities in order to facilitate the stipulation and mediation of the articulation of the distributed activities. In this way classification schemes can be considered as conceptual schemes used to index or classify information objects to make it possible to organise, manipulate and articulate the distributed inclusion and retrieval of objects in shared public repositories, archives, databases, etc. which is maintained and frequented cooperatively by an ensemble of users. This is in line with the findings of Borstrøm, Carstensen and Sørensen (1994). They found that a Product Classification Scheme reduced the complexity of articulation activities by providing different categories of users a conceptual structure for the distributed storing and retrieval of CAD-models. Also, in a case study of the development and evolution of the International Classification of Diseases - ICD - (Bowker and Star, 1991) it was found that the classification scheme served the purpose of articulating cooperative work which was distributed over time and space, and where the large number of people involved imposed a multitude of perspectives and goals onto the development and maintenance of the scheme.

The next section shortly discusses the research approach applied in the empirical study. The following section will shortly introduce the company under scrutiny and characterize the complexity of the production of technical documentation. Chapter four describe and discuss a mean applied in order to reduce the complexity of articulation work. The two last sections discuss the example presented and conclude the article.

2. Research approach

The field study focuses on the identification and analysis of the characteristics of social mechanisms of interaction and articulation work in general and classification schemes in particular in the production of technical documentation, related to new product development. The study spanned a period of three months of which sixty days where spend at the location. The techniques used were:

- Interviews (qualitative, unstructured)
- Observations (activity sequences, conversation, discussions, participation in meetings etc.)
- Document analysis (company standards, handbooks, technical documentation, lists, diagrams, drawings etc.)
- Still-video takes (interior, archives, computer displays, work situations, computer equipment, etc.)
- Participation (involved in work activities and decision making, recommendations)

Currently 25 persons has been interviewed at length (45-130 minutes). In addition a number of focused short interviews (length 5-20 minutes) have been carried out. The majority of these interviewed were located in the technical documentation department while others were located in several different departments (development, product management, computer services, quality, construction and marketing). The research approach is qualitative in nature and is inspired by Work Analysis (Schmidt and Carstensen, 1990) as well as an ethnographic approach e.g. (Hughes, 1992), (Atkinson, 1990) and (Hammersley and
Atkinson, 1983) The interpretation of the findings will take as a point of departure the concept of mechanisms of interaction. (Schmidt, 1994) p. 65.

"A mechanism of interaction can thus be defined as a symbolic artifact that serves to reduce the complexity and cost of articulating the distributed activities of a cooperative work arrangement by stipulating and mediating the articulation of the distributed activities."

Furthermore the mechanism must be a symbolic artifact which is standardised in format. In this way a classification scheme can be conceived of as a mechanism of interaction i.e. it is explicitly stated in a symbolic standardized format providing a conceptual structure for storing and retrieval of various sorts of objects in a predictable way. The next chapters will take a look at the complexity in the production of technical documentation and in particular relate the concept of mechanisms of interaction to the interpretation of the drawing index, which taken together with the product key classification scheme, which plays a role in supporting articulation of drawing reuse.

3. Complexity of technical documentation work

ALFA produces machining components. In its field it is amongst the three leading companies in the world. It employs around 8000 people in more than 30 countries. The main management, administration, production, product development and marketing activities are located at one site in Denmark. The main organisational units involved the production of technical documentation are the development departments, the product management department and the technical documentation department. The units are engaged in the transformation and mediation of technical information that is they produce, update, maintains, develop, translate, control translation activities, archive, coordinate distribution, store and distribute technical documentation. Around one hundred and fifty people are directly or indirectly involved in these activities.

In focus of the field study is the technical documentation department with its staff of twenty-five. The technical documentation department was segregated as a distinctive organisational unit in 1983. Before 1983 the world wide spread subsidiary companies produced their own documentation. Besides that some documentation was produced by the service department and the marketing department. As it was the documentation standard varied from one subsidiary company to the other. In order to strengthen the standardization of the documentation to be produced, taken together with the reiterative character of the work processes involved in the documentation production, the top level management made the decision to combine the documentation efforts.

Technical data and information like drawings, performance data, component parts lists, product specifications, etc., serve the purpose of construction, production, control and management in the company. Technical documentation like installation and operating instructions, company internal product information, parts lists, etc., serves the purpose to inform about the use and maintenance of specific products, disseminate product knowledge in the company, provide a basis for company internal and external training and provide servicing information.
The documentation technicians retrieve technical data and information from development engineers and product managers through interviews, observing and participating in product tests, so called scrutiny meetings, etc. As a frame of reference the documentation technicians use their own existing mass of documents. The mediation of the technical data and information take form in the production of series of heterogeneous and standardized technical documents meant for internal as well as external customers and recipients. In this way the production of technical documentation can be conceived as the transformation of technical data and information into immediately communicable technical documentation meant for a broad variation of customer categories. Prototypical customer profiles are applied to ensure that the documentation is shaped directly for and considers the specific needs of the different customer categories. The set up of the profiles is the result of ongoing informal negotiations among members of the documentation department. The product managers act as supervisors, i.e., they proof-read documentation, and engage in documentation scrutiny meetings, and as informants of structural elements in the developmental life of products by contributing to the technical documentation activity survey list. As such the product management department coordinates the introduction of products. This includes to some extent the coordination of the technical documentation production process, e.g., to assure that the certain types of technical documentation ideally are available when products are to be released for sale. The output of development activities is, e.g., CAD-models, performance data and various other forms of product data which is utilized in the technical documentation production. Through retrieval activities such as data-base querying and informal as well as formal meetings, the documentation technicians try to get hold of the information. Since these activities can be very time consuming and cumbersome the existing stock of documents in the technical marketing department functions as a document format and information reuse pool. Roughly speaking we are talking about information on 25,000 or more product variants. The transformed information is reflected in around 1,500 document variants. The technical documentation production faces a series of problems which has to do with the complexity of the work settings, e.g.:

- The increased customization of products and reduction in product development time has to be met on the documentation level.
- Number of product variants. The estimated number of variants is around 25,000 while the number of document variants is around 1,500.
- The heterogeneity of customer groups. e.g., subsidiary product and sales companies, end-users, installers, service, and marketing people, product trainers, etc.
- Product complexity. For example the introduction of software into control systems of the products influences the complexity of the documentation to be made.
- The amount of documentation to be updated is drastically increasing.
- Lack of adequate integration between software systems means a high degree of replication of data.
- Inadequate flow of timely information between departments in the company means a high degree of time pressure.
The many people engaged in the production of technical documentation and furthermore these people are geographically distributed, not only at the factory site but world wide.

4. Articulation work and technical documentation

The main sources for reuse are the technical department file-archive with drawings. The drawings are indexed according to type of product. The archive is crucial regarding reuse of drawings. Browsing the file-archive is though a very time consuming process. In addition drawings easily get mixed or misplaced. Many drawings, especially older ones, are not available elsewhere in the company. Furthermore many drawings consist of a mix between CAD-models and hand sketches created through the use of repro- and photocopying techniques, which means they are not electronically available. Storing and retrieval of drawings is distributed among several categories of users involved in the production of technical documentation. Facing the problems mentioned above activities were set ahead to systematise reuse of drawings. The idea was to create computer-support to index drawings in the file-archive as well as CAD-models used in the technical documentation. The computer-based drawing index provides a mean for distributed handling of storing and retrieving drawings used in the technical documentation. Every drawing gets a calculated number according to the week and the year they were created. The number is created when completing index cards in the system. For every drawing used in a document an index card has to be created. The index card is shown in Fig. 1.

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Description: Type of product, type of model, type of drawing
Code: Week, Year
Creator: Name
Date: Year, Month, Day
Status:
Placement: The agreed physical location in the drawings archive
Stibo/no: Number
Format: Paper format (A4, A3)
Product: Type of product
Changed: Date
Drawing replaced by: New drawing number
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Fig. 1 The index card which is used in classifying drawings.

I will not go into any detail regarding the completion of the index card here. The most interesting question is, what kind of classification tool is used filling in the index cards? Many of the index fields are rather self-explanatory. The drawing categorisation is performed.

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\(^1\)Borström et al (1994) postulate that drawing archives is easier to handle than CAD-databases. This finding seems to argue against their claim.
by completing "Description" field, where the product type, the type of model and the type of drawing have to be stated. Stating the type of drawing is fairly straight forward and relies on engineering conventions. A so called product key classification scheme is used to designate type of product and model. A simplified example of the scheme is shown in Fig. 2.

![Diagram](image)

**Fig 2. A simplified example of a product key classification scheme.**

The scheme is ordered in a tree-structure with many layers. The around 25,000 product variants have to be covered by the classification scheme. As shown in the example the class KP has six product model categories. One of these is the model 100 which has two subcategories and two sub-sub-categories. By using the scheme a distinct result is ensured, i.e., the drawings get a proper and predictable description. New classes are of course added when new products are to be introduced as well as categories are changed if new models are to added or old models to be removed. But also categories are changed according to changes in products, legislation, standards, etc. The specification of the product key is the result of intense discussions and negotiations at scrutiny meetings throughout the product development process. Often it is the documentation technicians who question the composition of the product key because the using product key classification scheme is crucial to the composition to many different documentation types. As shown in the example the Special Version X sub-category is a reflection of the practical problems involved in classifying products. This sub-category makes it possible for the people involved to classify irregular product variants which it otherwise would have been impossible to fit into the classification scheme. Using the drawing index is though not without problems. The interface to the system is in itself rather complex as is the procedures for making cross-references. Furthermore searching for a proper product key among several documents can take some time. Given the number of drawings in each single document a considerable amount of time has to be spent categorising drawings.

5. Discussion

Facing the complexity in the production of technical documentation reuse of various forms of symbolic objects, and especially reuse of drawings, is a distinct category of activity. The objective of the design of the computer-based drawing index was to facilitate reuse of drawings. But the articulation of drawing reuse is a complex activity in itself. The drawing
index was applied when it became clear that the articulation of storing and retrieval of drawings in the local drawing archive became to complicated. By using the product key classification scheme as a mean to categorise entries in the index it became possible to reduce the articulation complexity and thereby better to support reuse of drawings. As such the scheme can be categorised as an example of a mechanism of interaction, i.e., it reduces complexity and cost of articulating distributed storing and retrieval of drawings by mediating and stipulating the articulation of the distributed activities. Also it was found that the scheme is constantly changing due to changes in the work settings, e.g., changes in products, legislation, standards, etc. This means that standardised taxonomies for classifying and indexing of information objects necessarily must have dynamically and manipulative boundaries, which makes it possible to adapt these to the ever changing circumstances and conditions in the work domain. Furthermore changes to the scheme are negotiated and discussed to reach a form of consensus among members of the cooperative ensemble manipulating the scheme as well as the responsibility to bring different professional perspectives into play are distributed among the members. As in the case of the Product Classification Scheme (Borström et al., 1994) and the ICD (Bowker and Star, 1991) the people engaged in the discussion tries to sort out the appropriate degree of ambiguity of the product key classification scheme. Hence the classification schemes must be able to capture and display a certain degree of ambiguity, which is a reflection of the actual circumstances under which they were produced and in a clear and consistent way define the degree of ambiguity.

Providing a conceptual structure for the articulation of distributed storing and retrieval of symbolic objects in shared public repositories makes it possible to interdependent actors indirectly to engage in cooperative activities at “arm’s length” so to speak. This is in line with K. Schmidt (1990) who points out that cooperative work does not solely have to rely upon any form of direct communication within the cooperative ensemble. In this way users are engaged in cooperative activities regarding adding to, modifying, searching in, inquiring, retrieving from and restoring to a more or less shared sphere or “stock” of informational symbol-objects. Given the classification tools needed to articulate these activities can be considered as a direct reflection of the dynamics of the conceptual structure and apparatus of the work-setting in focus, it becomes clear that taxonomies, thesauri and other forms of articulation tools can become objects for system-design in order to be implemented in computer-systems as to make these mechanisms of interaction available for users to manipulate in a cooperative way. Furthermore the mechanisms must be malleable to support changes to, e.g., classification schemes.

6. Conclusion

Through the empirical analysis of the complexity of technical documentation production it was found that access to manipulate and articulate distributed inclusion and retrieval of technical drawings in a shared public repository reduces the complexity of the articulation work needed. In archiving drawings, using a computer-based drawing index, a product key classification scheme was used. The classification scheme can be conceived of as a mechanism of interaction, i.e., stipulates and mediates articulation of distributed storing and
retrieval of drawings. The prospect for future work is to try refine the findings of the field study in order to relate these to the problems of developing and constructing notations to support articulation work providing users with facilities for distributed manipulation of mechanisms of interaction which recently has been taken up by the research field Computer Supported Cooperative Work (Schmidt et al., 1993).

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