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Using the Decision Production Systems Approach to Improve Product Development

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Abstract

The decision production system perspective represents a product development organization as a network of decision-makers and information processors through which information flows. This representation can be used to improve product development processes by providing a deeper understanding of information flows and key decisions. This paper reviews the decision production system approach and provides an example of its use to improve product development.

1. Introduction

Product development organizations face many problems as they strive to become a market leader. Goals of attaining superior quality, rapid time-to-market, and low cost are often thwarted by poor decisions based on incomplete or missing information. For some product development organizations it is unclear as to who the decision-maker is in certain situations. Product development is particularly challenged by the need to incorporate information inputs from unrelated and remote areas of an organization into the decision-making process [1]. Important information can come from a wide variety of individuals. For example, a warranty unit may have data on a previously unseen battery defect, while the vice president for environmental affairs has a report on pending battery recycling legislation. Many other factors affect the passage of information to and within an organization [2]. For example, the status of an individual within a unit determines, to some extent, the scope of influence of new data introduced by that person. There is a rich legacy of heterogeneous research in information management within organizations that should be applied to product development enterprises [2]. In order to become a more efficient product development organization, appropriate information needs to be available to designated decision-makers when the decision needs to be made. In order to improve a product development organization, an understanding of the information flows and decision-making is necessary.

Busby [19] has identified common failures that occur during decision making in product development:

- Not involving others in decisions (which limits the information used to make the decisions);
- Not telling others the assumptions that they can make, the normal requirements, and the exceptional circumstances that can occur;
- Not considering other's goals or requirements;
- Not knowing the effect of one's action on another, not knowing the effect of a change on another;
- Not defining the scope of tasks allocated to others, and not determining the scope of tasks assigned to oneself.

Many of these errors stem from not understanding the information flow and decision-making in the product development organization and not seeing one's role in the decision production system. That is, they are failures to maintain information responsibility [20]. Simon [1] argues that systematic analysis of the decision-making in a product development process would be useful for implementing changes to the product development organization in a timely and profitable manner.

The decision production system perspective [3] is a unique way to view a product development organization. This perspective views product development organizations as a network of decision-makers, information processors, knowledge repositories (e.g, handbooks), and interactive databases (e.g., product data management systems) through which information flows. By viewing organizations in this manner, one can understand how information flows and who is making the key decisions. This representation allows for a deeper understanding of the organization than typical hierarchical charts or Gantt charts of product development projects. Understanding the real process (as opposed to the corporate guide for the design process) is a key step in improving product development. Furthermore, recognizing design as a "knowledge agent" and the designing activity as a crucial organizational knowledge process can improve an organization's ability to innovate within their competitive environment [4]. The need for research on new work practices [15] and the need for developing new representation schemes for product development [18] are additional motivations for the decision production systems perspective.

Section 2 of this paper provides a brief overview of decision production systems. Section 3 describes the benefits of applying decision production systems to a product development organization. Section 4 provides a real-world example of improving a process using decision product systems. Section 5 concludes the paper.

2. Overview of Decision Production Systems for Interpreting Information flow in PDP

The interrelatedness of product development activities led to the emergence of teams as a necessary mechanism for transferring of knowledge across a diverse organization [5-9]. The presence of teams has made product development organizations much more complex, since information flow and decision-making do not follow the hierarchical lines

of authority. Even within the team, communication and decision-making processes are not simple. Teams enable (and perhaps require) the need to communicate information sequentially (i.e., in an open and ordered exchange), a process prohibited by a strict hierarchy [10]. In an interesting twist, researchers on teams also note that sequential exchange of information has advantages but can result in undue influence of sequence, a phenomenon known as “information cascades.”

A decision production system [3] is defined as an information flow governed by decision-makers who make both design decisions and development decisions under time and budget constraints. Since decision-making requires information, generates information, and determines who gets what information, employees on different hierarchical levels will be exchanging information at different points in the product development process. Yet all are involved in the processing of information and knowledge at the same level. In this way they resemble operators on the same shop floor.

The decision production system (DPS) perspective looks at the organization in which the product development process exists and considers the decision-makers and their information processing tools (like databases) as units of a manufacturing system that can be viewed separately from the organization structure. As a result the hierarchical view (Figure 1) and decision production system view (Figure 2) of a product development organization are quite different. This was observed by Simon [1], who notes that an organization’s “anatomy” for information processing and decision-making is naturally different than the departmentalization displayed in an organization chart. The greater the interdependence between decision-makers, the less the DPS will resemble an organization chart.

There are similarities between a decision production system and a factory [1, 3]. With a factory, parts flow from one machine to another. This view is analogous to product development organizations since information flows from one decision-maker to another (or between information processors who transform data for decision-makers). But the simulation of a decision production system is much more difficult due to the iterative nature of a product development process, the preemption that occurs as engineers interrupt one task to work on another, the difficulties in identifying sources of knowledge within the organization [1] and outside the organization, and the difficulty of defining the scope of a design task. (There have been some initial attempts to gain managerial insight from theoretical models based on the decision production system perspective [16, 17].)

However, the decision production system perspective emphasizes the roles that individuals play and the information flow between them. This non-traditional focus allows what Simon calls a “fresh” look at organizations [1]. Research shows that knowledge transfer is facilitated when participants in any process know where to look for information inputs [2]. In addition, knowledge retention and transfer increase when the properties of the units using the knowledge “fit” or are “congruent” [2]. The decision-production system can be used to identify existing flows of information that can be exploited by their fit to a new set of knowledge learning activities. “Piggybacking” or “overlapping” or “overlying” new information flows onto existing flows of similar or

relevant information provides an opportunity to enhance organizational learning. This is especially true when a knowledge repository exists that can be expanded to accommodate a new set of transactions that will enrich its holdings.

Thus, a useful representation for an organization’s decision production system is a swimlanes chart [11, 12]. A swimlanes chart is “a special type of flowchart that adds more detail about who does which activities” [11]. The people that are responsible for activities are listed on the left-hand side of the chart vertically and are separated by lines (swimlanes). Tasks are then listed from left to right, usually in time sequential order, and are connected with arrows to demonstrate information flow. Figures 4 and 5, which are part of the discussion in Section 4, are examples of swimlanes charts.

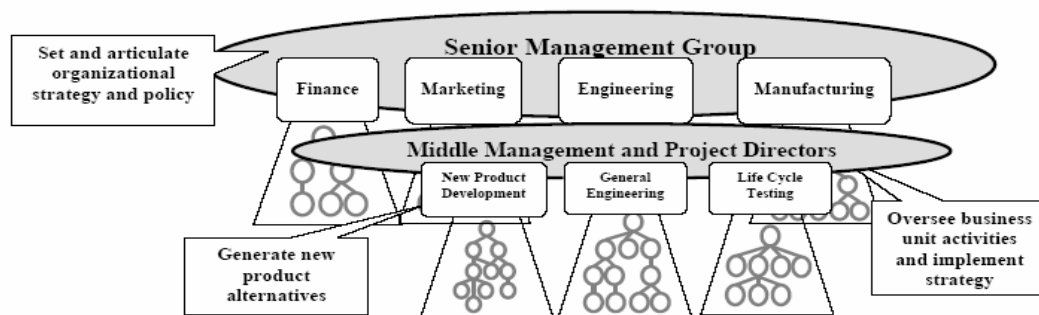


Figure 1 - Hierarchical Chart [1]

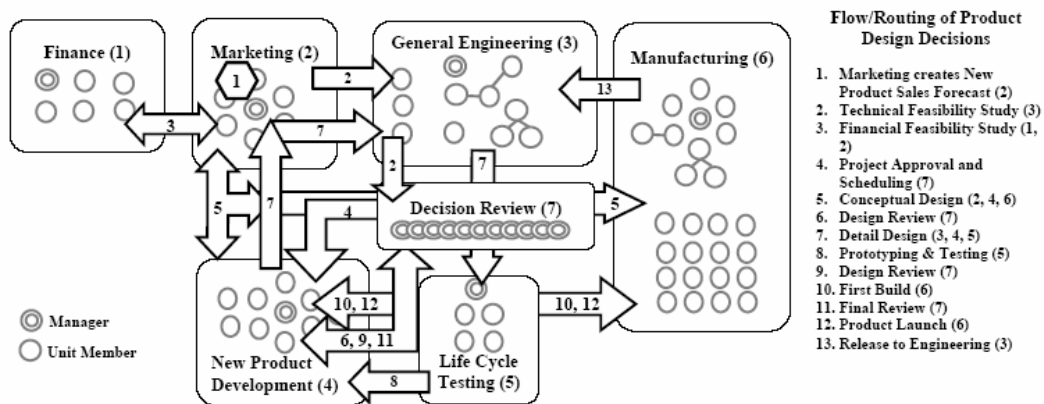


Figure 2 - Decision Production System [1]

3. Applying Decision Production Systems to Product Development Organizations

Within a product development organization, there is usually a predefined process in place that defines the tasks of the functional units from concept generation to the launch of the completed product. The process is set up in a timeline manner where tasks that occur in the beginning of the process must be completed before the project can move forward to the next set of tasks. There are usually gates that require managerial approval before a

project can move forward to the next stage. All of these tasks and signoffs are formally documented to define the organization's product development process.

When individuals outside of the product development process read the documented product development process, they may feel that they have sufficient knowledge of how the organization is run. But when they become part of the organization and are involved with the tasks of the process, it becomes apparent that what actually happens is much different. First, significantly more information flows between functional units than that which is documented. Second, decisions are made not only at key points in the process but within the tasks themselves. Typical organizational representations such as flowcharts of the product development process and organizational hierarchies showing superior-subordinate relationships do not (and cannot) sufficiently describe information flow and decision-making. If changes are to be made to the product development process, it is first necessary to understand what is actually happening in the process. A decision production system representation of the whole product development process or a critical subset shows information flows and the people involved (the decision-makers).

Consider, as an analogy, the system of sidewalks on a university campus. The paved paths that are laid out on the ground are the predetermined paths where students are supposed to travel to reach their classes. At first, one believes that all students follow the sidewalk paths until they reach their destination. Upon further inspection however, one will notice that there are pathways of dead grass that the students are using. Each is an additional actual path that the students are using because they have found it more convenient than the established paths. The university officials must then decide if this pathway of travel is appropriate. If so, then they will construct a sidewalk to reinforce the use of the pathway. If not, they will find a way (such as a fence) to divert the students from the pathway. With sufficient knowledge of students' actual walking process, it possible to make effective changes to the process.

To improve a product development organization, we use the four step process that is illustrated in Figure 3. The first step is to study the selected part of the product development organization, first by gaining an overview of the organization and its processes, and then by studying a particular set of activities in detail. This leads to the construction of a model based on the DPS perspective. There are many possible types of models, from flowcharts to value stream maps to discrete-event simulation. Visual models, like networks, are good because they support perceptual inferences [13]. We have found swimlanes to be particularly useful. Analysis of the model leads to the identification of desirable changes. Representatives from the organization can help determine which are the most feasible. Finally, the organization must implement the changes. Follow-up activities are needed to document the new procedures, to train individuals, to ensure that the new procedures are followed, and to determine the benefits and limitations of the change, which leads to further study in a cycle of continuous improvement.

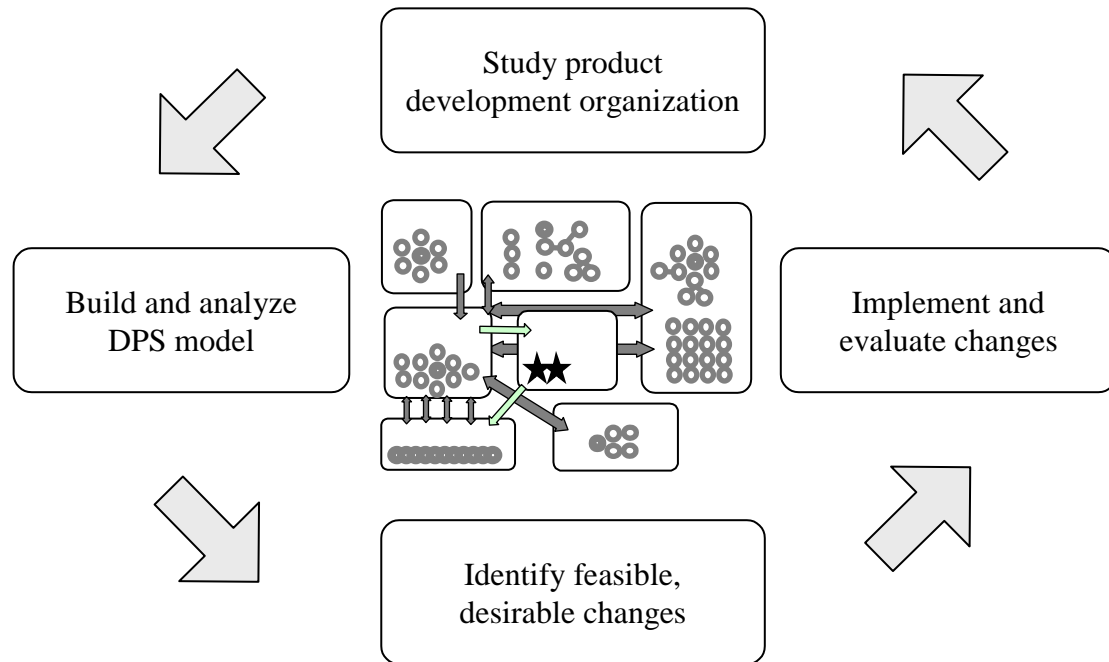


Figure 3. Product Development Organization Improvement Process

4. Example: Using an existing service process to implement a Design for Environment task

The new European Waste Electrical and Electronic Equipment (WEEE) Directive requires electrical and electronic producers to be responsible for the reuse, recycling, and recovery of their products [14]. That is, when a customer is finished using a product, the producer must either take their products back themselves to recycle or contract a third-party recycler. Most companies do not have the infrastructure to recycle their own products, however. Therefore, if a company decides to contract a third-party recycler, then they must provide a disassembly guide that describes how to disassemble the product and identifies the materials in the product's components and subassemblies. This guide enables the third-party recycler to sort the components and subassemblies for recycling.

The authors have been working with a leading power tool manufacturer who needs to create such a guide. After a careful study of the firm's product development process, the firm decided to investigate utilizing the technical support process for creating the WEEE disassembly guide in order to use the existing disassembly analysis from the technical support center. Swimlane diagrams were chosen as to model this particular DPS because swimlanes are widely used in company's internal procedural documentation.

Figure 4 shows a swimlanes chart of the existing technical service process for this manufacturer. In the current process, technical service personnel create a service bill of materials (BOM) and exploded view diagrams for each product. Authorized service centers use this information to disassemble and repair products that malfunction. Early in product development process, a trade-off analysis is performed to determine at what level

the product will be serviced. Some parts (such as the armature in a drill) will be serviced at the assembly level, while others will be serviced at the component level (such as adding lubrication). This trade-off analysis is based on cost of components, cost of labor, and the design of the product.

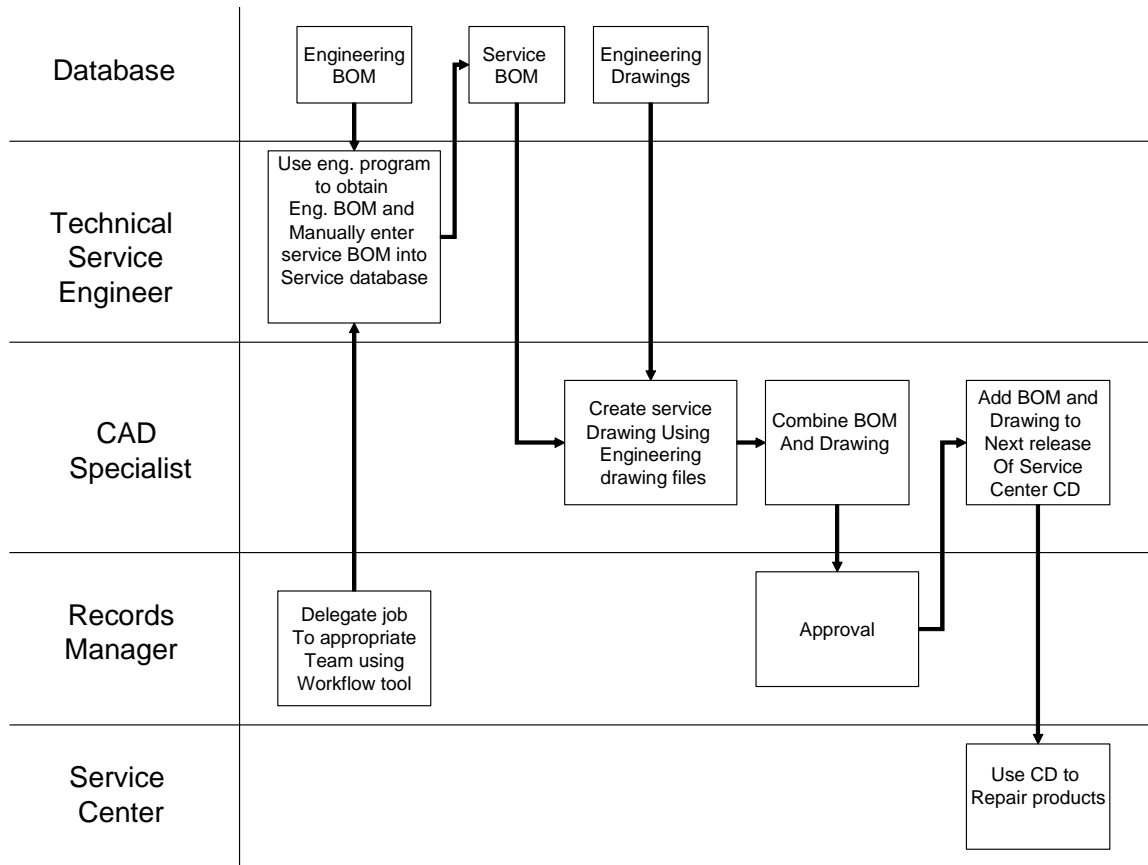


Figure 4. Technical Support Process (swimlanes chart)

With the technical support process accurately represented, an important question appeared: who would be responsible for producing the WEEE disassembly guide? Either the technical support personnel or the project team would be responsible.

Upon examining this process and reviewing it with experts in the firm, it was determined that it was not feasible to use only the technical support process to create the WEEE disassembly guide due to several problems:

- A limited number of technical service personnel
- Material information gaps on the engineering BOM
- The service BOM does not change when material changes occur since the service BOM is separate from the engineering BOM
- The service part numbers do not always coincide with engineering part numbers

Therefore, the project team would be responsible for creating the WEEE disassembly guide. Understanding the current technical service process allowed us to propose a WEEE disassembly process that still utilizes the disassembly analysis completed during

the technical support process although the technical service personnel are not ultimately responsible for the new process. Figure 5 is a swimlanes chart for this proposed process.

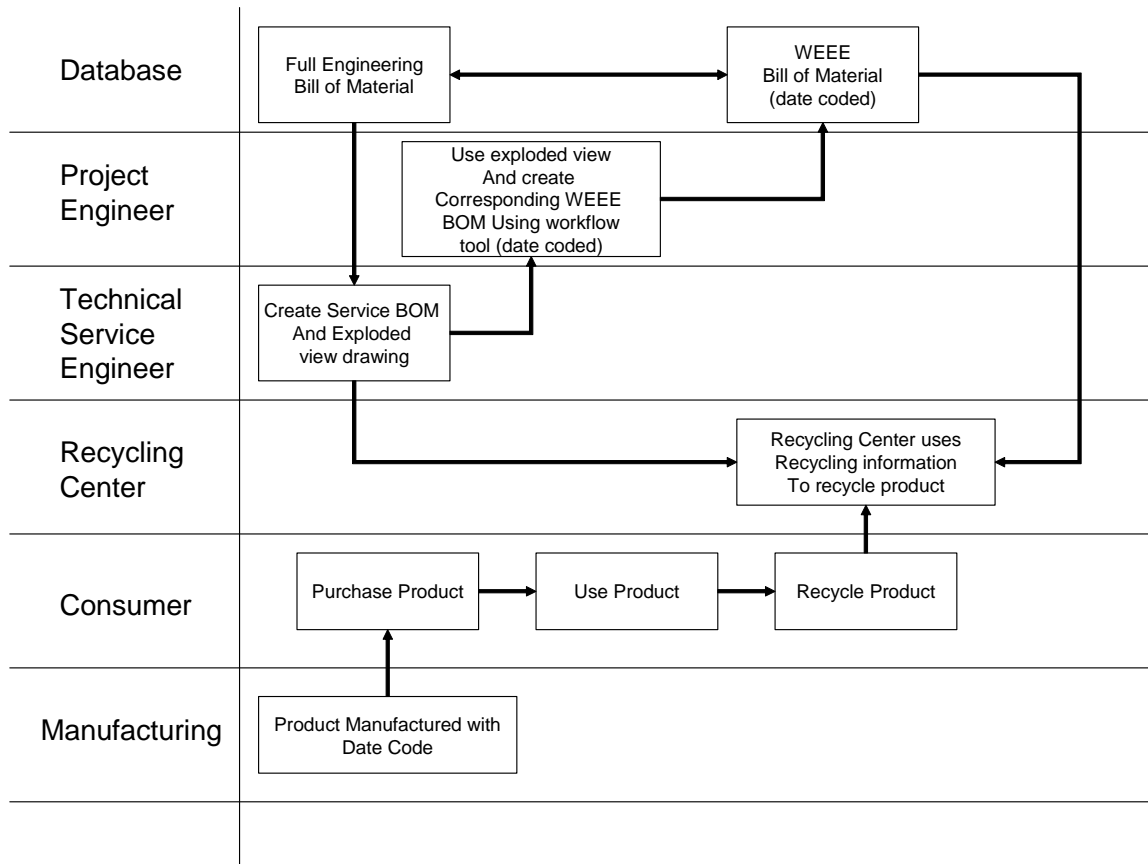


Figure 5. Proposed WEEE disassembly guide process

In the proposed process, engineering is responsible for creating a bill of material associated with the WEEE disassembly guide (the WEEE BOM). This BOM will correspond to the exploded view created by the technical service engineer instead of using the non-responsive service BOM. Any engineering material changes that are made after the first version of a product is introduced will be automatically updated in the WEEE BOM since they will be located within the same database. The WEEE BOMs for a product will have a date so that recyclers can match the appropriate WEEE BOM with the appropriate version of the product they receive since all products contain manufacturing date codes. With an understanding of the information flow and decision-making within the product development organization, we were able to create an innovative WEEE disassembly guide process utilizing existing processes where possible.

5. Conclusion

This paper demonstrates the applicability of the decision production systems perspective to improve product development organizations. A brief overview of the decision production system perspective is provided. The paper then describes the general

applicability of the decision production system perspective to product development organizations and activities. Then, a specific example of how a decision product system helped with the creation of a new product development activity.

The authors found that time, effort and iteration are necessary to get the information needed to create a representation that accurately models a decision process. Appropriate time needs to be devoted to developing accurate process representations or the perspective will not be helpful. As the old saying goes, “Garbage in, garbage out.” Many meetings, e-mails, and phone calls were necessary to understand the process thoroughly. After the process was accurately represented, the process could be then analyzed and improvements could be made.

The decision production system perspective can be applied to any product development organization or activity. This versatility combined with the level of understanding it provides combine to be an innovative tool for creating effective processes.

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