9TH INTERNATIONAL DESIGN STRUCTURE MATRIX CONFERENCE, DSM'07
16 – 18 OCTOBER 2007, MUNICH, GERMANY

A SURVEY ON PROCESS COMPLEXITY MANAGEMENT

Carsten König
DaimlerChrysler AG, Germany

Keywords: Process Complexity Management, Complexity Diagnosis, Process Structure, Dependencies

1 INTRODUCTION

In the past decade the automotive industry has encountered significant changes within its competitive environment. Automotive OEMs are forced to offer an increased number of variant model ranges, to satisfy individual customer needs as well as constantly introduce innovative features within their products. Within the automotive industry the electrical/electronic/software (E/E/S) systems represent a domain with still strongly increasing complexity. These facts lead to a growing system complexity with a rapidly rising number of dependencies and interconnections between electronic control units (ECU). Hence, E/E/S development processes are moving into the focus of automotive OEMs. Organizations are increasingly faced with the challenge of managing business processes. Analyzing, modelling and improving processes are key aspects for OEMs to stay competitive in today's globalization. Synchronizing all development activities, relevant stakeholders and information is a major challenge. This is of key importance, as the E/E/S system represents a highly interconnected structure, in terms of process, organization and the product itself.
When an organization adopts a process oriented philosophy, process improvement can take place. For this a continuous process improvement, a business process redesign, or a business process reengineering approach can be taken, but methods need to be able to analyze the processes undergoing improvements. Complexity and random changes within complex processes, however, tend to create dynamic systems that have a tendency not to reach a balance. To achieve an effective process management it is necessary to explore the area of complexity analysis, diagnosis of processes, particularly within hierarchical and interrelated business processes. Based on this background the need for Process Complexity Management, especially within E/E/S development will be discussed. This paper illustrates lessons learned from implementing process complexity management within the E/E/S development. Key concepts for managing process complexity as part of a process optimization are then derived. The paper finally highlights added value of Process Complexity Management.

2 COMPLEXITY DILEMMA IN E/E/S AUTOMOTIVE SYSTEMS

The insertion of innovative features implicates an increasing number of functions and their corresponding ECU's on the one hand. Otherwise E/E/S systems concern a wide range of domains from marketing, engineering, procurement, to service. Hence, complex processes tend to be hierarchical and cross functional.
Business Process Modelling and Simulation enhance corporation's capabilities to achieve in-depth understanding of internal process performance. Moreover, systematic data collection and dynamic modelling and simulation of processes enable top management to examine potential scenarios such as radical reengineering of processes, prediction of the outcome of reengineering strategies prior to implementation, and the analyses of process reengineering at macro and sub process levels and their effects on the cross functional processes [1].
In this view, detail analysis such as systematic data collection and in depth structure analysis tends to be sustainable activities. Moreover, understanding the actual dependencies of processes, objective analysis of process model and complexity of hierarchical and cross functional processes creates recommendations for process optimization. The value of modelling and complexity management of complex processes is to understand the behaviour and means to identify missing information, rework cycles and duplication of activities. Understanding the behaviour of modelled processes under various perspectives can be instrumental in gathering causal connection within hierarchical and interrelated

processes. Process models can be built for a variety of uses beyond workflow- and project management and compliance with external standards.
Process- and project models are used to support understanding of and learning about processes and to enable analyses of potential process changes. The process for process complexity management has three distinct phases. First, the elements are specified and dependencies are defined [2]. Next, process models of the current workflow and provided information is developed and the static structure of the processes is represented. Finally, a structure analysis is performed and potentials are identified, including recommendation.

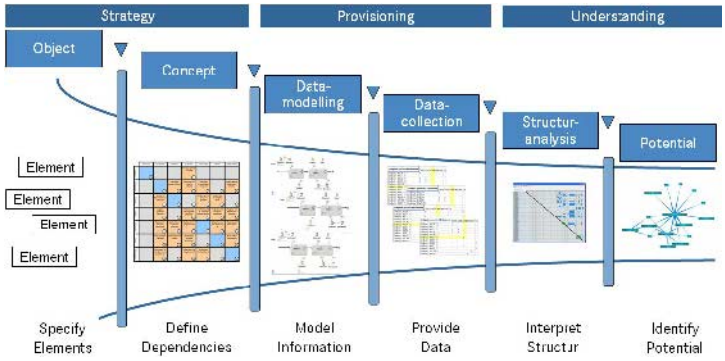


Figure 1. Process Complexity Management Process [2]

Strategy

The development of a Process Inspection Strategy is the beginning. A process is an organized group of related activities that work together to create a result of value [3]. Process models are typically activity network models, and interdependencies of activities, their results (in- and output), their assigned roles, and their tools that make business processes extremely complex, challenging to model and difficult to understand. To find the relevant dependencies between elements, we need to define which elements depend of each other. Information is anything produced, consumed, or modified by a process, it may be a document, a model, source code, data, etc. Precondition defines the activities entry criteria and its goal (often called a "milestone") defines the activity exit criteria.

Provisioning

Process models and project plans are an important variable in understanding the nature and interrelation among elements within firms. Building a process model takes time, and the most elaborate process models have taken a very long time to build. Product development and its activities can be viewed as process of information collection, creation, interpretation, transformation and transfer [4]. The process illustrated here is a collection of hierarchical, sequential and concurrent activities within one business unit and cross functional, in particular the information flow is regarded.

Understanding

Process models are usually too abstract and ambiguous for most process analysts' and workers' day to day use. In information intensive processes like product development, where activities depend on a number of inputs and provide a number of outputs, a causal approach to process modeling is insufficient [4]. As indicated earlier processes tend to be hierarchical, and can be analyzed at various levels of detail both cross functional and inside. Moreover, analysis of processes can reveal critical process structures. The structures are valuable to analysts in identifying remarkable patterns about activities, information, etc. In order to identify element allocations among various processes a dynamic analysis is necessary. The combination of elements tends to findings such as missing input, unnecessary output, activities at decision points, etc.

3 SUMMARY AND CONCLUSION

Managing Process Complexity is contingent on creating a process that enables us to analyze existing processes. As such, the behaviour of the processes can be appraised, and offer a systematic well defined way of representing different structures of a companies processes. Some added value of process complexity management.

Hierarchical processes also tend to have a negative influence on the selection of the right process to reform [1]. Sequential and interrelated processes are complex and necessitate greater coordination and support as the output of one process serves as an input for another.

- To enable "what if" analyses, process improvements (lean, reengineering, etc.) and to ensure good decision making by using the right information

Multiple roles interact or collaborate by exchanging information and triggering the execution, or enactment, of certain activities. The overall goal of a process is to bring a set of information (work products) to a well-defined state. A sustainable process should pay special attention to the interfaces among activities, information flow and milestones.

- To focus on value adding activities, not on figuring out where to get inputs and where to provide outputs [4].

Firms support and maintain greater numbers of hierarchical and interrelated processes over the process lifecycle. Since information flow runs up complexity and is the source of many process problems, the dependencies that establish the process patterns must be recognized and reengineered.

- To provide transparency and situation visibility to process involved person, so each is empowered to see their part and dependencies in the whole business process.

Within hierarchical business processes sub processes are nested within macro processes. A process Lifecycle defines the behaviour of a complete process to be enacted in a given project or program.

- In information intensive processes, where activities depend on a number of milestones and of inputs and provide a number of outputs, the process complexity management approach is helpful to visualise process structures. An Impacts dependency acts from one element to another element to indicate that the modification of a element could invalidate another.

Activities require and produce information. As such, other processes tend to use the process outputs as their inputs. The result of many development processes is just information flow. A process having a large number of activities and information is likely to have a complex network of feedback loops.

- In analyzing the flow of information and other elements I distinguish that this produces a complex not manageable distribution of information within product development process.

Understanding the behaviour of existing "as is" processes under various dependencies, however, can be instrumental in identifying process patterns. Process complexity management adds greater value to the understanding and identifying potential of processes. Important subtopics for future work should include process complexity metrics, evaluation of standard processes and effects on process complexity (process compliance), and process modelling quality assurance.

REFERENCES

[1] Fathee M. et al. The Effects of complexity on business processes reengineering: Values and limitations of modelling and simulation technologies. Proceedings of the 1998 Winter Simulation Conference

[2] König C. and Braun T. Process Complexity Management – Bottom up Prozesslandkarten verbessern. In 12. Software & Systems Quality Conferences, April 25-27, 2007, Düsseldorf

[3] Hammer M. Seven insights about processes. Process strategic power process ensuring survival creating competitive advantage, Boston 2001

[4] Browning T.R, Fricke E. and Negele H. Key Concepts in Modeling Product Development Processes. In Systems Engineering Journal, SE Vol. 9, No.2, Summer 2006

Contact: Carsten König
DaimlerChrysler AG
GR/ESP
Wilhelm Runge Str. 11
89013, Ulm
Germany

A Survey on Process Complexity Management

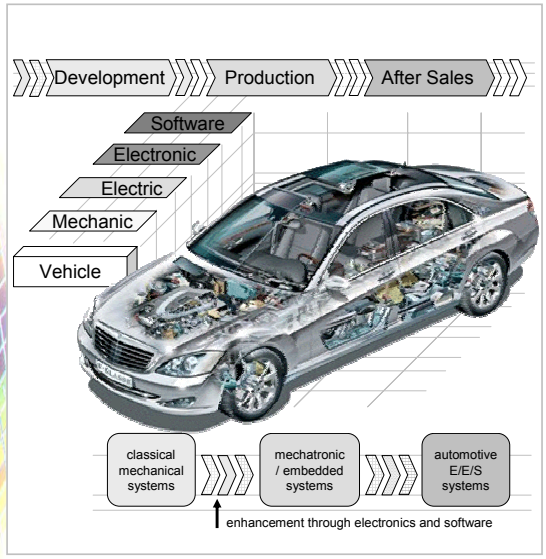
Carsten König

IN COOPERATION WITH BMW GROUP
CAPITALIZE ON COMPLEXITY
DAIMLERCHRYSLER

Objectives and Contents

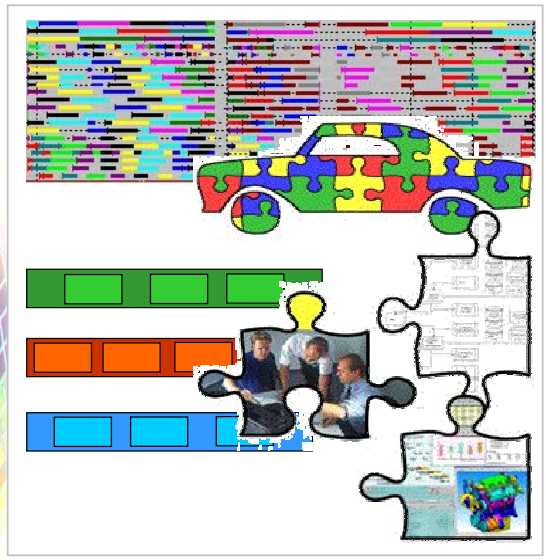
- Complexity dilemma in electric/electronic/software (E/E/S) automotive systems engineering
- Process Complexity Management Process
- Lessons learned and added value

Background on automotive electric/electronic/software (E/E/S) systems



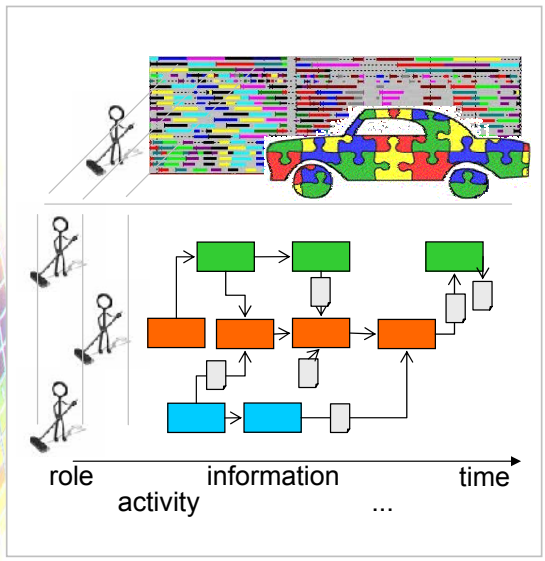
- For a long time, the automobile industry developed classical mechanical systems
- Today, engineers use electronics and embedded software to control and regulate mechanical components
- This complexity is driven by increasing efforts to network all components as well as by an increasing number of available product variants
- The networking of all a vehicle's components, subsystems and systems is a rather complex task
- This raises serious interdisciplinary problems, combining E/E/S components and integration of diverse domains

Process Asset



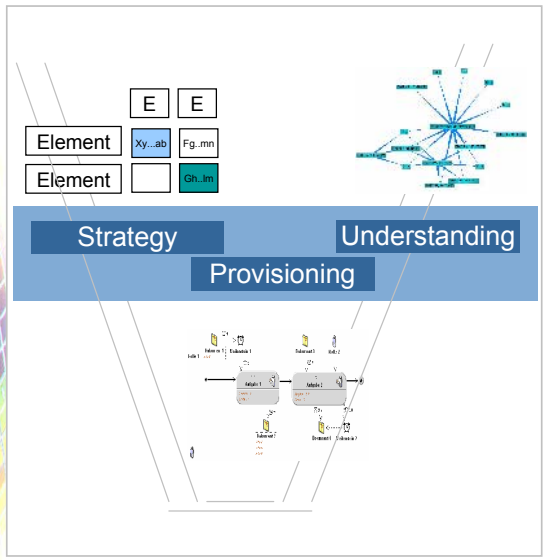
- The purpose of Process Definition is to establish and maintain a usable set of process assets
- Organizations are increasingly faced with the challenge of managing processes
- Sychronizing all development activities, relevant stakeholders and information
- Complexity and random changes tend to create dynamic systems, that have a tendency not to reach a balance
- It is necessary to explore the area of process complexity analysis, diagnosis and optimization

In depht understanding



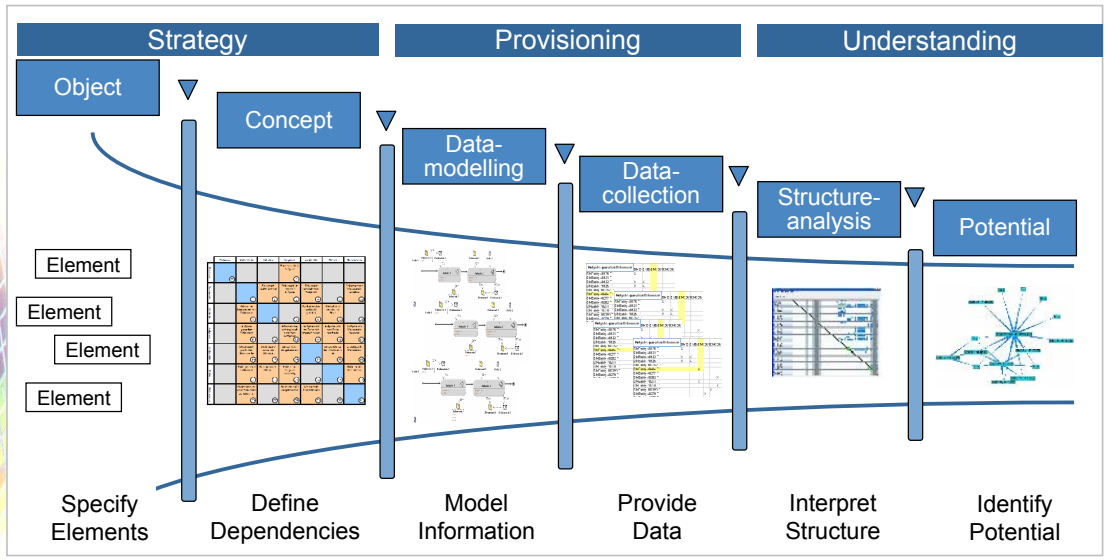
- Tend to be hierarchical, cross functional and interrelated
  - a lot of involved roles
  - a number of activities
  - a large number of interfaces and
  - a sophisticated flow of information
- Methods need to be able to analyze the processes undergoing improvements
- Organizations begin their process modeling in a decentralized fashion
- Relationships between processes may not be well defined
- Will lead to accomplishing a specific organizational goal
- A process is the answers to the questions Who? What? When?

Reengineering recommendations

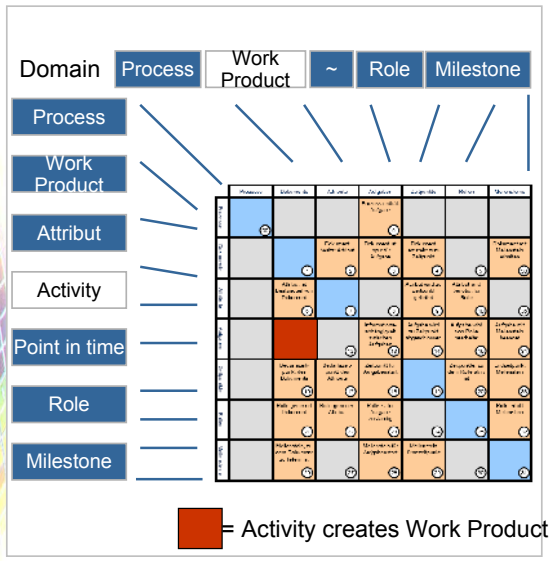


- Strategy
  - Find relevant elements and define in which manner elements depend of each other
- Provisioning
  - It is well worth the time and effort it takes to define and document processes
- Understanding
  - Identify element allocations among various processes to highlight pattern and give visibility into these situations
- No one can keep track of everything

Process Complexity Management - Process

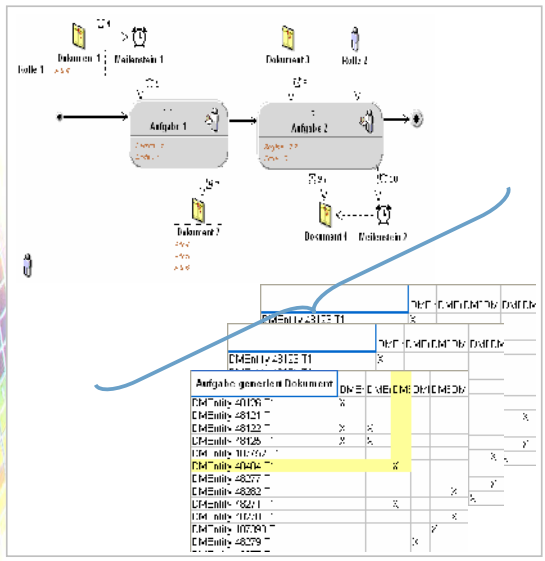


Strategy



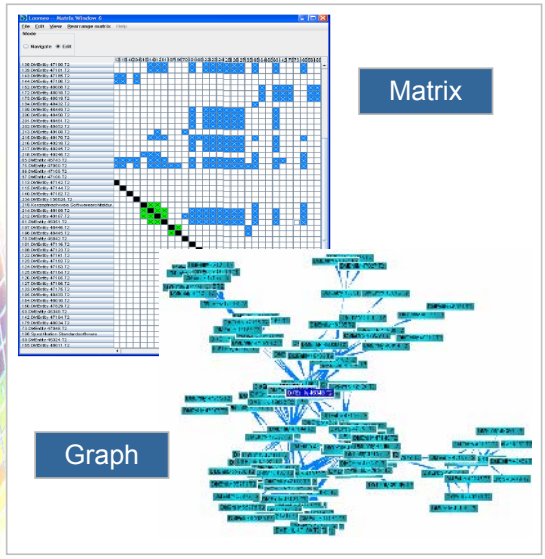
- A set of linked activities that take an input and transform it to create an output
- Elements, which are ordered in time
- The overall goal of a process is to bring a set of information to a well defined state
- A milestone is set of achievements that bind a phase, they are often defined in terms of availability of work products
  - How much time is wasted due to missing information?
- Understanding the behaviour of existing (documented) processes
- To focus on value adding elements, not on figuring out where to get inputs and where to provide outputs

Provisioning



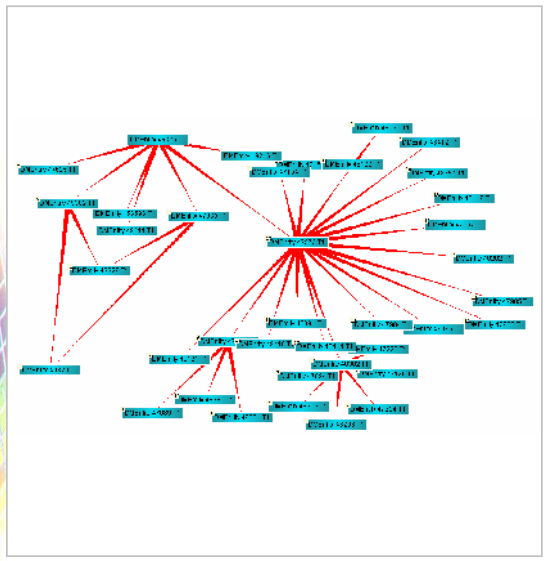
- An element is describing one aspect of a engineering process (activity, role etc.)
- Using existing process models
- and project models are used to support understanding of and learning about processes
- Interrelated processes necessitate greater coordination and support
- As the output of one process serves as an input for another
- Hierarchical processes tend to have a negative influence on the selection of the right process to improve

Understanding



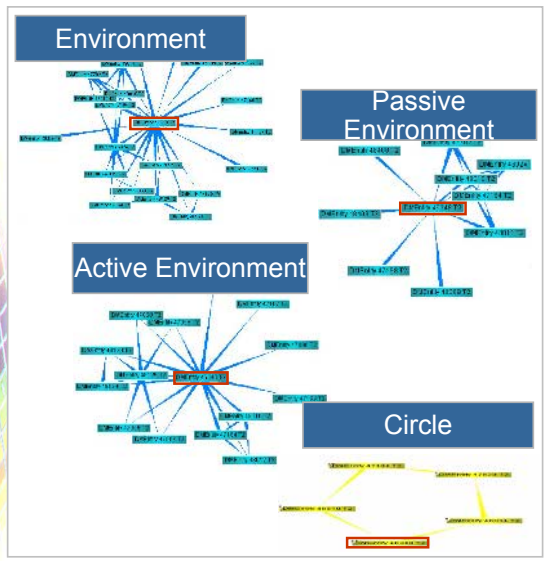
- Understanding the behaviour of processes under various perspectives
- Gathering causal connection within hierarchical and interrelated processes
- Uncover patterns in existing processes
- Enable analysis of potential process changes
- Influence of complexity analysis on reengineering recommendations

Bridges



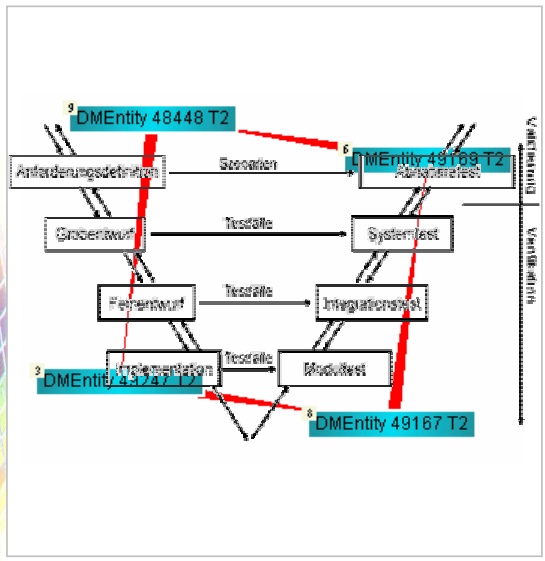
- Processes occur at all levels of an organization's activities
- Information flow runs up complexity
  - And is one source of many process problems
- The dependencies that establish the process pattern must be recognized and reengineered
- A role pattern of responsibilities of an individual carrying out activities and responsible for certain work products
  - that shows how roles relate to each other
- A work product pattern of a piece of information produced or used by activities
  - Reflect work product dependencies

Distribution



- A diagram that shows packages of model elements and their relationships
- Activities require or depend on input
- Activities produce or provide work products
- Impact dependency
  - Diagram that shows the activities and work products, for which a particular role is responsible
- Generated process pattern are easy to analyze
  - Empower transparency and situation visibility to see dependencies
- Highly interlinked clusters of nodes and only loosely linked to others

Document Circle



- Multiple roles interact or collaborate by exchanging and triggering the execution of certain activities
- The diagram shows how work products within a process relate to each other
  - Is likely to have a complex network of feedback loops
  - Provide checking the consistency of processes
  - Checking the compliance to references such as …?
- A sustainable process should pay special attention to the interfaces among activities, information flow and milestones

Conclusion

- Covers activities performed by organizations to manage and, if necessary, to improve their business processes
- Analyze and change processes in response to data, rather than accidentally
- The activities which constitute process complexity management can be grouped into three categories: strategy, provisioning and understanding
- Generating any graphical diagram for a chosen part of a process model to analyze
- A sustainable process should pay special attention to the interfaces among activities, information flow, roles and milestones
- In information intensive processes the process complexity management approach is helpful to visualise and to interpret process structures
  - Adds greater value to the understanding and reengineering the processes