IMPROVING THE DESIGN PROCESS AT NECSA

by

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Executive Summary

The key to a competitive advantage in any market is productivity. If resources are employed in the correct manner, a process can run at its most productive state. The design process at Necsa's Engineering Services department is currently very slow and expensive, thus implying that resources are not being used efficiently. A need has been identified at Necsa to improve the designing process, to make it more productive by using relevant methods. The main goal of these operations is to be able to compete in the nuclear manufacturing field and to deliver products at a cheaper rate and in time without compromising on quality. Tools such as best practices, benchmarking, business process re-engineering, concurrent engineering and configuration management can be used to achieve this goal.

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Introduction and Background

The project will be completed at Necsa (Nuclear Energy Corporation of South Africa). The engineering services department at Necsa consists of several engineering disciplines, for example mechanical, electrical, civil, etc. Engineering services designs products for Necsa who have their own manufacturing facilities. However they would rather like to break into the designing market and provide this service to companies other than Necsa. At the moment the design process is taking too long and is very expensive which means that they cannot really compete against the other more established designing companies. They are currently not sure where they lie in the market or if they would even be able to compete with other companies.

There is much room for improvement and through proper research of the designing activities that are currently in place it will be clear where time can be spared or costs can be cut without jeopardising the quality of the projects. Engineering services wants to find out what processes other companies follow when it comes to designing products to make their own process more efficient and less time consuming. This can be done by using tools such as benchmarking, best practices, business process re-engineering, concurrent engineering, configuration management and product Lifecycle Management.

Project Scope

Designing a certain product can involve more than one discipline of engineering, where one discipline is responsible for a part of the design and another is active in designing a different part of the product. Part of the design process is to ensure that the entire product's life cycle is taken into consideration. This includes establishing user requirements, propagating early conceptual designs, running computational models, creating physical prototypes and eventually manufacturing the product. The project will be mainly focused on the physical designing process and more specifically electrical design.

Project Aim

The aim of the project is as follows:

- Identifying and eliminating activities in the process that cause delays.
- Identifying processes used by other companies which can serve as a benchmark.
- Researching best practices in the industry and implementing them at Necsa.
- Reducing the time of the design process and making it more productive.

Current Design Process

Design Process for Electrical Projects

Procedure

(As described in EES-QUA- PRO- 0001)

1. **Needs Analysis and Quotation**
    - Clients request service from Necsa either written or verbally;
    - The request is processed in conjunction with the planner. Then the resource is allocated within EES to assess the client's needs and to provide a solution.
    - The assigned resource shall upon the receipt of the client's request, conduct a site visit in order to comprehend the customer's requirements. The feedback from the site assessment will either be used to prepare a preliminary quotation or alternatively used as an input to the mark up of drawings phase.
    - Based on information gathered, the designer shall issue a preliminary set of drawings and a preliminary material list to Maintenance Services (MS) for them to prepare a quotation for supply of material and erection of the installation.
    - Upon receipt of MS quotation, the planner shall compile a one stop service quotation for the client.
    - The one stop service quotation shall be sent for approval by the EES Chief Engineer and then forwarded to the client for acceptance.
    - The customer shall process the quotation by signing the quotation and or sending an Internal Works Order (IWO) or Purchase Requisition (PR). Subsequently, the project moves on to the project registration and planning phase, if not the job shall be cancelled and then the process ends.

2. **Project Registration and Planning**
    - Provided that the quotation is accepted and or an IWO is received from the customer, the project shall be registered on the EES project register.
    - Depending on the urgency and complexity, the planner shall assign resources to the project and compile a detailed project implementation plan (schedule) and send it for approval by the EES Chief Engineer or designated person.
    - Provided that there are no as-built discrepancies, the project will proceed to the design phase.
    - If there are as-built discrepancies the process then moves onto the ring-out phase.

    Allocation of tasks:

    The planner in consultation with the chief engineer will allocate the tasks to a designer for execution.

3. Ringing Out of circuits

- Drawings for projects with as-built discrepancies shall be issued by the planner to MS for ringing out.
- The design work shall be put on hold until marked up drawings are received back from MS to reflect the as-built status.

4. Update of Drawings

- Upon receipt of marked-up drawings from MS, the planner shall assign a task to the CAD operator to update existing drawings to accommodate changes; in order to do this the latest revision of the drawing is needed.
- Once the drawings are updated the designer shall review the drawings.
- The drawings shall then be submitted to the checker for final review and verification. Should the drawings not comply with the EES drawing standard, it shall be looped back to the CAD operator for revision and inclusion of changes added by the checker.
- If the drawings are accepted by the checker, they shall be taken to the Professional Engineer for approval. If the drawings/design does not comply, it shall be sent back to the CAD operator for revision and inclusion of changes made by the professional engineer.
- If all changes are implemented and the professional engineer is satisfied, the professional engineer shall approve the drawings.
- The approved drawings shall be sent by the planner to MS to confirm that the updated drawings do reflect the as-built status.
- If the drawings have been accepted by MS a request for a COC (Certificate oof Compliance) is sent out to SHEQ.

5. Design

- Design work shall be performed in accordance with ENS's design control procedure, ENS-QUA-PRO-0011. The principles of the design control procedure have also been incorporated into this procedure.
- Upon confirmation of the first COC of the affected distribution board(s) the design work shall continue.
- In conjunction with MS and the designer, the planner shall revise the project schedule and send it to the customer.
- The design shall be done in accordance with the applicable regulations and electrical engineering standards and guidelines and shall comply with the requirements of the customer.
- Upon completion of design calculations and compilation of the final design package, the design shall be reviewed and verified by the checker, and the n submitted to a professional engineer for approval.
- Design verification requirements shall be clearly indicated in the design package documents.
- If the design package is approved, it shall be issued to MS for acceptance.

- If accepted by MS, the approved design package shall be sent to Configuration Management Section for copying and distribution of all detailed drawings to the relevant stakeholders.

Conducting Electrical Design

In order to conduct electrical design, the following steps need to be followed:

(As stipulated in EES-INS-0001)

1. The designer shall confirm the client's requirements with the client or any designated person.
2. The designer shall conduct a site visit/inspection to obtain more information pertaining to the client requests.
3. The designer shall determine whether there is a need to ring out circuits. If there is a need to ring out circuits, the designer shall send a request to Maintenance Services to ring out circuits as per document (EES-INS-0004).
4. The designer shall receive the marked up drawings from the electrician, check them for completion, and then forward them to a CAD operator.
5. Upon receipt of updated drawings, the designer shall translate the client requirements into technical terms and develop a design philosophy.
6. The designer shall propose alternative solutions to the client and recommend the preferred solution. The cost, time and performance principle shall be applied when choosing the preferred solution.
7. The designer shall (if necessary) present alternative solutions to the client and discuss drawbacks and trade-offs thereof.
8. The designer and the client shall agree on a final design solution.
9. The designer and the client shall compile a detailed design for that particular solution using the following method:
   - 9.1.1. Conduct research/literature review and decide on the viable solution.
   - 9.1.2. Perform design calculations.
   - 9.1.3. Check for conformance to applicable statutory and regulatory requirements.
   - 9.1.4. If design does not meet requirements, the designer in liaison with the client shall make the necessary changes to the solution or re-evaluate alternative solutions.
10. The designer shall prepare a final drawings and material list including all work carried out in step 6.
11. The designer shall submit the drawings and the material list to the checker for review.
12. If there are no changes recommended by the checker, the designer shall submit the design to the chief engineer or a designated person for approval.
13. The approved design package (marked: Client Approval) shall be submitted to Maintenance Services (MS) for approval.
14. The design shall be revised to incorporate all changes (if any) and step 11 to 12 shall be repeated.
15. If there are no further changes, the design package shall be approved by the chief engineer or designated person.

16. The approved design package shall be submitted to Configuration Management for copying and archiving.
17. An approved design package (marked: Construction) shall then be submitted to the planner for distribution to the relevant parties.

Identified Relevant Methods

Business process reengineering:

Introduction

Reengineering was developed to be used as a tool to rethink and redesign business processes in order to improve certain aspects of the process such as cost, service, production time and quality of products. Business process reengineering focuses on improvements in processes and not on specific jobs, workers or process tasks (Muthu, Whitman, & Cheraghi, 1999). BPR can be used to improve a process or to design a completely new process.

The aim of BPR and how it is relevant to the project

The aim of business process reengineering can be described as obtaining a sustainable competitive advantage (O'Neill & Sohal, 1999). Because of changing customer demands there is a constant need to re-evaluate processes in order to stay ahead in a competitive market. BPR can be used to evaluate the flow of processes and work in an organization.

Implementation of BPR

Techniques and tools used in BPR

Techniques have been developed to implement BPR. Examples of these techniques are listed below:

- Process and customer focus
- Process mapping/operational method study
- Change management
- Benchmarking
- Process visualisation

It must be noted that several techniques exist and no technique or tool is ever singled out. A combination of these tools and techniques can be used depending on the nature of the project and the application thereof. BPR must be incorporated with other parts in order to be successful.

The following methodologies have been developed to implement BPR. They have been summarised from techniques and tools listed in current literature. They can be viewed as possible plans of action.

Activity	**Methodology 1** (Underdown, 1997)	**Methodology 2** (Harrison & Pratt, 1993)
1	Develop vision & strategy	Determine Customer Requirements &Goals for the Process
2	Create desired culture	Map and Measure the Existing Process
3	Integrate & Improve enterprise	Analyze and Modify Existing Process
4	Develop technology solutions	Design a Reengineered Process:
5		Implement the Reengineered Process

Activity	**Methodology 3** (Furey, 1993)	**Methodology 4** (Mayer & Dewitte, 1998)	**Methodology 5** (Manganelli & Klein, 1994)
1	Set Direction	Motivating Reengineering	Preparation
2	Baseline and Benchmark	Justifying Reengineering	Identification
3	Create the Vision	Planning Reengineering	Vision
4	Launch Problem Solving Projects	Setting up for Reengineering	Technical & Social design
5	Design Improvements	As Is Description & Analysis:	Transformation
6	Implement Change	To-Be Design and Validation	
7	Embed Continuous Improvement	Implementation	

Table 1: Summarised BPR Methodologies

All of the methodologies listed above can be combined into 1 single methodology. Muthu, Whitman, and Cheraghi (1999) have suggested this methodology as the surest way to achieve success.

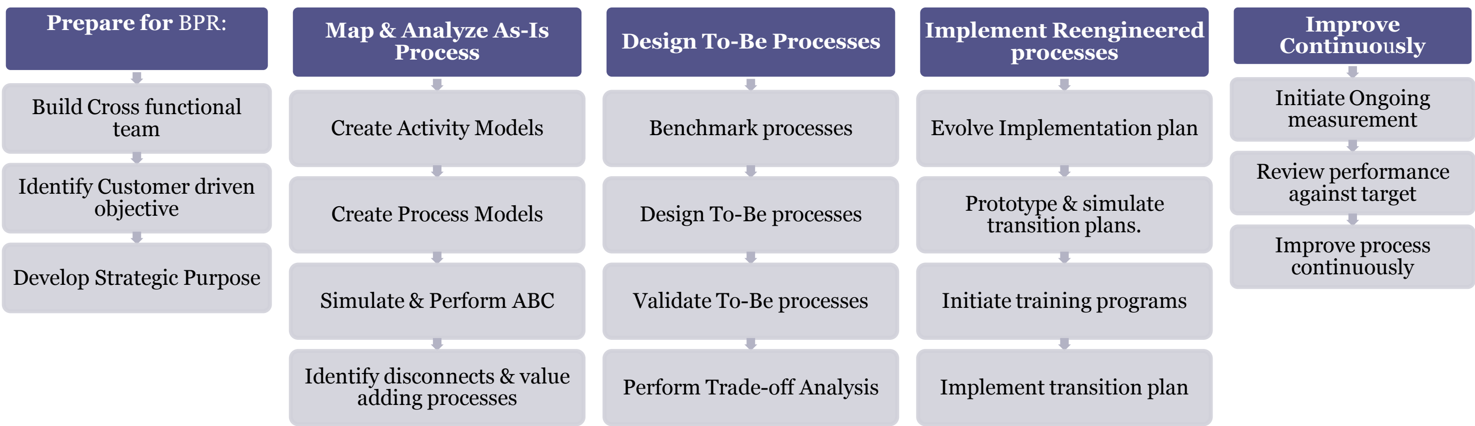

Table 2: Proposed Combined methodology

The steps of the combined methodology from Muthu, Whitman, and Cheraghi (1999) are described below.

Prepare for BPR

Planning and preparation is a very important part of any process in order to achieve success. We first have to know if there is a need for BPR. If a considerable need for reengineering can be established then preparations can begin. Goals must be set for the reengineering process through executive agreement on what needs to be achieved. A cross-functional team must be formed and the company must ensure that the process can continue normally without the presence of certain key figures. Reengineering is completely based on customer needs which imply that customer satisfaction must play a vital role when the goals of the project are determined. As soon as the customer driven objectives have been identified then the strategic purpose can be developed. The purpose consists of a vision, mission and what the company is looking to gain from the reengineering process.

Map and Analyse As-Is Process

It is very important to understand the current process before reengineering can start. The current process must be mapped out entirely in order to analyse the process. After the process has been analysed, improvements can be made and a new design can be created. An As-Is analysis plays a vital role in the reengineering process. Companies lean towards spending more time on the To-Be analysis and then there is a significant chance that they might miss important information regarding the current process which could cost them dearly in the end.

Design To-Be Processes

The first step in designing the To-Be process is benchmarking. Benchmarking is the act of comparing the companies' processes to processes in other relevant or related companies in order to see whether they have a better way of doing things. Once improvements to the current process have been recognized, the To-Be processes can be formulated using different available methods. Several factors of the process must be taken into account, such as cost, quality and the time available. The To-Be process must then be analysed and the best possible solutions can be chosen by using trade-offs.

Implement Reengineered Processes

Implementing the reengineered process is the most difficult step of all. Resistance is inevitable when there is news of change and because of this it is important to get the people involved in the process positive about the change. Once this is done a program that helps with the shift from the old process to the new one, need to be introduced. Training programs must be developed for the employees while the new process is being installed.

Improve Continuously

The process must be analysed constantly to see if any more improvements can be made. By analysing the system the performance is also measured which will reveal continuous room for improvement.

Risks of BPR

Technical risk

This is the risk that there is a failure in any technical aspect of the process. The risk that the process might not be implemented correctly or that it was the wrong tool to use in the first place. Any errors in the implementation or execution of the reengineering process can be described as technical risk (O'Neill & Sohal, 1999).

Organisational risk

This is the risk that the company does not accept the newly engineered process.

Concurrent Engineering:

Introduction

Concurrent engineering as defined by Concurrent Design Facility (ESA):

> " Concurrent Engineering (CE) is a systematic approach to integrated product development that emphasizes the response to customer expectations. It embodies team values of co-operation, trust and sharing in such a manner that decision making is by consensus, involving all perspectives in parallel, from the beginning of the product life cycle."

The second definition is by Pennell and Winner, 1989:

> " Concurrent Engineering is a systematic approach to the integrated, concurrent design of products and their related processes, including, manufacturing and support. This approach is intended to cause the developers from the very outset to consider all elements of the product life cycle, from conception to disposal, including cost, schedule, quality and user requirements."

As can be seen by the definitions above, concurrent engineering is used to update and improve processes with the focus on customer needs. Concurrent engineering is a tool to help redesign manufacturing processes. CE involves the integration of all the different functions of developing a product. (http://en.wikipedia.org/wiki/Concurrent_engineering)

The aim of CE and how it is relevant to the project

The basic concept of concurrent engineering is that processes that occur before design should be done simultaneously. Grouping certain processes and completing them concurrently improves the productivity of the entire process. This enables the company to pick up errors earlier on and to redesign at the beginning of the design process (http://en.wikipedia.org/wiki/Concurrent_engineering). Implementing these ideas can ultimately save time and money.

By implementing CE Necsa can reach one of their main goals which is to decrease the design process time significantly. By combining their designing steps productivity can be improved.

Implementation of CE

The first step in CE is ensuring cooperation in the different departments of the company i.e. marketing, manufacturing, design etc. In the second step, computer communication as well as analysis tools must be developed to reach the set goals (Albin & Crefeld).

Techniques and tools used in CE

The Fast Concurrent Engineering implementation methodology is a much evolved methodology and it will be focused on in this report.

A workbook-style implementation of the methodology has been developed by Lettice, Smart, and Evans, (1995). The implementation of the methodology can be divided into three stages: preparing for concurrent engineering, implementing a pilot project, expanding project through organisation.

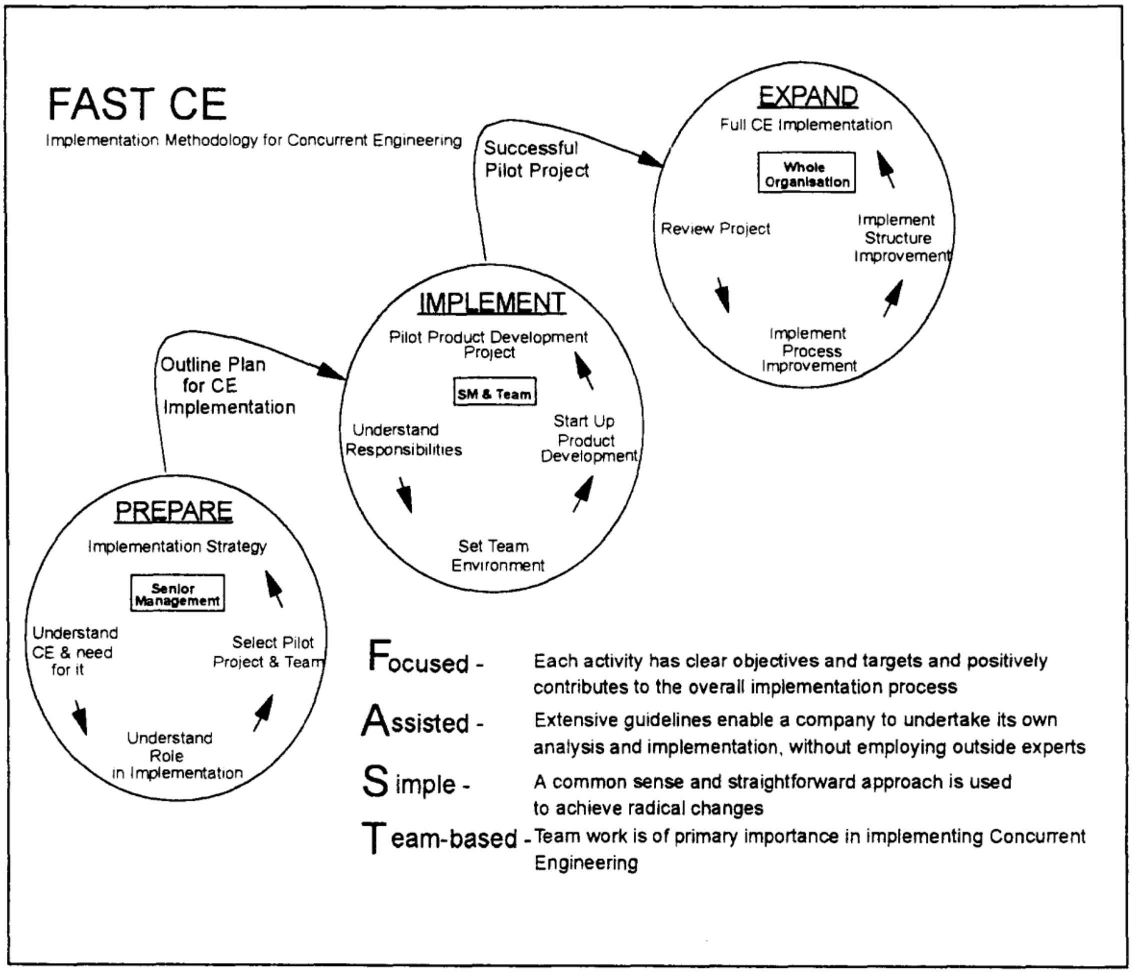

Figure 1: Implementation of fast CE methodology developed by UK engineers

Preparation for implementation

It is vital that the management of the organisation is fully supportive of and committed to the implementation of the process. Certain issues might occur during implementation that can only be handled by management. A Steering committee can be appointed and they will be responsible to ensure that the implementation is executed correctly and that everything is running smoothly. There must be a complete understanding of the costs and benefits involved in the implementation.

Concurrent engineering pilot implementation

Product development begins in this stage with the help of a pilot program. Clear goals must be set regarding time and cost and a detailed project plan must be drawn up. The key is to identify value adding activities in the process and to get rid of non-value adding activities. It must be clearly defined which activities are linked together and how they influence each other. Co-location of the steering team makes the sharing of information easier. All the activities that are involved in the stages of the design process must be identified as soon as possible. The team must fully understand what is expected of them and then the project planning can start.

Expansion

As soon as the pilot project has been launched CE can be expanded throughout the organisation. Training is a vital part of the introduction of the new system.

Configuration Management

Introduction

The designs that are generated at Necsa are often very complex designs involving several parts, equipment, tools, etc. Every part has certain processes which it has to complete during the design phase. Specifications cannot change during these processes and requirements must be met at all times. Because the products are complicated and there are so many different parts it is hard to keep track of the progress of each part to make sure that the product stays as-designed. Configuration management is a tool that was created to assist with the monitoring of developing products and it usually comes in the form of computer software. Designing involves several different people and disciplines that have to cooperate and configuration management software supports the collaboration during the process (Carnduff & Goonetillake, 2004). Software is used to assist in configuration management in order to avoid vast amounts of paperwork and time consuming administration (Crow, 2002).

Aim of Configuration Management and how it is relevant to the project

The aim of configuration management is to help with the collaboration of the different aspects and factors of the design process and ultimately fulfilling customer needs and design requirements. Configurations concerning the design can be stored and progress of these configurations can easily be monitored. Configuration management plays a vital part when it comes to meeting customer requirements and completing products according to design requirements (Crow, 2002). The implementation of configuration management will ensure a smoother running process and will decrease the total design time at Necsa therefore improving overall productivity.

Implementation of Configuration Management

There must be a structure in place to manage the changes and improvements made to a product design and also to control the availability of design information to the relevant parties (Santoyridis, Faulconbridge, Miles, Gray, & Carnduff, 2000). This can be achieved by implementing a suitable software package.

Techniques and tools used in Configuration Management

An example of a software package that Necsa is considering is the Teamcenter Express System.

Teamcenter Express is a user friendly data management program that helps with the control of the collaboration that take place during the design process. The software helps with product lifecycle management and is designed to meet the requirements of companies involved in manufacturing. Capabilities of Teamcenter Express include:

1. Architecture—Teamcenter has a Service-Orientated-Architecture platform
2. Project/program management
3. Enhancements regarding productivity
4. ERP integration

(CIMdata, 2008)

Functions of Teamcenter Express

Teamcenter Express can perform the following tasks:

- Synchronization of manufacturing and design data and sharing of design models through collaboration of the different processes
- Integration of Solid Edge CAD and systems such as CAD, CAM and ERP
- Collaboration of multi-functional areas in a shared design process
- Improved communication between different departments such as engineering and sales as well as among members of the team
- Capturing of data of already designed products to improve the product lifecycle process of future designs
- Preconfigured access control – this function controls changes that are made on designs: when they can be made, by whom can they be made, on which items are changes allowed
- Search and retrieval of data stored on the system
- Managing check-in and check-out of data so that it is possible for simultaneous viewing of information
- Impact analysis can be performed to see what effect certain changes will have on the design

(CIMdata, 2008)

Advantages of implementing software such as Teamcenter Express

The functions listed above offer long-term benefits such as better quality, improved productivity, improved design for manufacturability and decreased product design cycle time. Implementing configuration management software also reduces the risk that Necsa has to take because more specific information is available during the course of the design process (CIMdata, 2008).

Certain areas of improvement have been identified:

- Product development
- Manufacturing
- Quality control
- Project management

UGS TEAMCENTER EXPRESS

Product Lifecycle Management

Introduction

Product Lifecycle management (PLM) controls the trading of information during the lifecycle of the product. Programs that are usually associated with PLM include Computer Aided Design, Computer Aided Engineering, Computer Aided Manufacturing and Product Data Management (Srinivasan, 2009). PLM can be seen as the tool that forms a link between the different phases of the product development process. PLM is used to integrate all parties that are associated with the design of the product. The design process is improved as soon as it is transformed into a collaborative process (Danesi, Gardan, Gardan, & Reimeringer, 2008).

Aim of PLM and how it is relevant to the project

The main aim of PLM is to improve time-to-market and quality as well as decreasing cost. If all of these factors are improved then the productivity at Necsa will be improved.

PLM tools

There are several tools available for the implementation of PLM. The most relevant ones are listed below:

1. Communication
2. Coordination
3. Collaboration

(Danesi, Gardan, Gardan, & Reimeringer, 2008)

The tool that is most relevant to the project is collaboration. There are three phases of collaborative design, namely

1. Distributed concurrent engineering environment
2. Visualisation and annotation tools
3. Simultaneous co-modelling tools

(Danesi, Gardan, Gardan, & Reimeringer, 2008)

Change Management

Introduction

Change management can be defined as the techniques, processes and tools that are used to manage the employee-side when change needs to occur. It is a method designed to reduce and manage resistance by employees to organizational, process or technological change. Change management plays an important part in the success of BPR and also to attempt continuous process improvement.

A change management team will have to be assembled.

Key factors of Change Management:

1. ***Communication:***
   Communication between managers, project leaders and employees is very important in change management. Communication planning involves the following:
   - Knowing the audience
   - Establishing the key message that has to be delivered

   The communication plan must adress the needs of all parties involved in the change i.e managers, draughtsmen, CAD operators and executives. Each one of these parties has specific information needs according to the role they play in implementing the change.

2. ***Manager Training:***
   Managers are also prone to resist change. It is important that the change management team gets the support of the managers to convince and motivate the employees. Managers must be informed about all the aspects of the change process in order for them to support and carry out the change.

3. ***Resistance Management:***
   Resistance towards change is normal but persistant resistance can lead to failure of the project. It is the responsibility of the change management team to identify the resistance, understand why there is resistance and then to manage the situation.

4. ***Feedback Analysis:***
   Employee feedback is an integral part of change management and promotes employee involvement. Feedback must be analysed and necessary actions must be taken based on the comments received.

Change Process:

The stages of employee involvement during the change process are shown below:

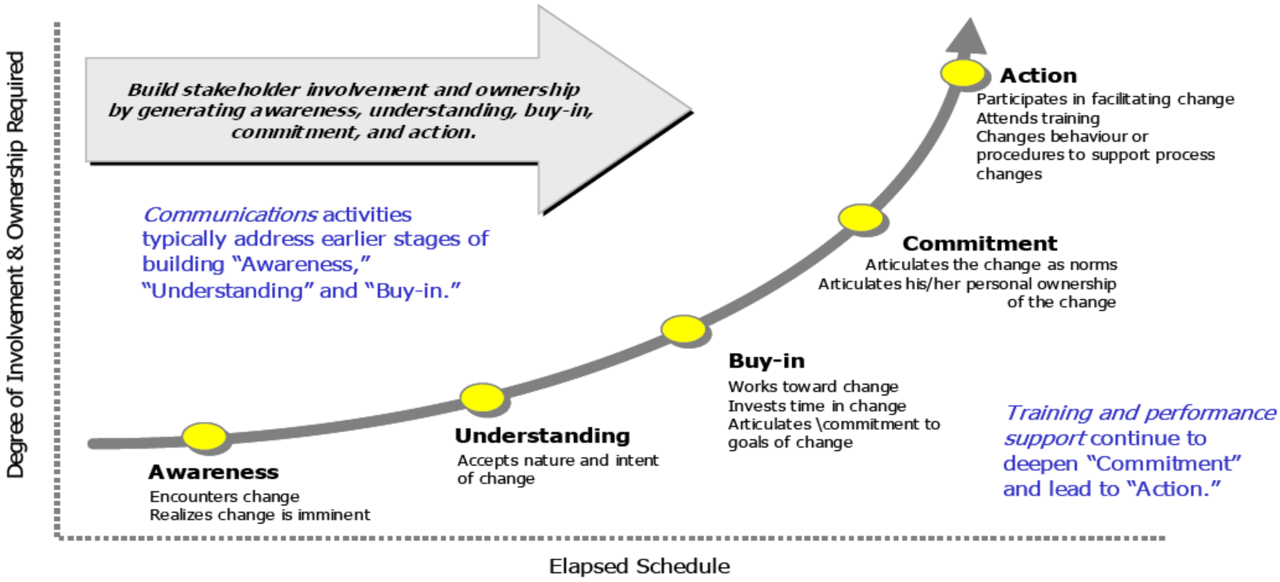

Figure 2: Employee involvement stages (Enos & Power)

The stages identified and described by Enos & Power are tabulated below:

Table 3: Enos & Power employee involvement stage:

Commitment Level	**Communication Activities**	**Expected Behaviour**
Awareness	- Kick off meetings - Newsletters	Acknowledges that process and technology changes associated with the project will have an unprecedented impact on current operations Realizes that the change is imminent Articulates what the project is at a high level
Understanding	- Management briefing sessions - Department meetings - Informal communications	States the benefits of the program Asks questions to clarify concepts Has accurate expectations about the program and its components will deliver

Buy-In	- Specific training - Coaching - Q&A sessions - One-on-One discussions	Understand the benefits the project will have for the company. Demonstrates positive support and endorsement Willing to test out new processes and provide feedback Articulates commitment to the goals of the changes
Commitment	- Performance support - Publicize “Success Stories”	Incorporates the new processes/technology as the normal way of doing business Articulates personal ownership of the change Demonstrates involvement Identifies the negative impacts if process improvement initiatives are not implemented Independently and proactively communicates the benefits of the program
Action	- Training sessions led by early adapters	Trains others on the system/processes Works to encourage others to use the system

Development of a Possible Solution

Analysis of Literature

After completing the literature study it is important to go back and examine which of the identified methods will be the most relevant to the project and yield the best results. All the identified methods were developed in order to improve productivity therefore all of them can be used to solve the current design problem at Necsa.

Preferred Methods

The preferred methods that are most relevant to the project are Business Process Reengineering, Configuration Management and Change Management. These methods were chosen according to the aim of the project.

Final solution

The steps in the combined BPR methodology proposed by Muthu, Whitman, & Cheraghi, (1999), will be used to formulate the final solution.

BPR Process:

1. Prepare for BPR

Develop cross- functional team

The first step when preparing for BPR is to develop a team to plan and execute the re-engineering. This team must consist of members of all the different departments involved in the process to ensure cross- functional cooperation. Strategic direction is needed from management when planning takes place.

The cross- functional team can consist of the following:

- Head of Engineering
- Head of Electrical Engineering Services (EES)
- EES draughtsmen
- EES CAD operators
- A functionary from Industrial Engineering Services (IES)

Identify customer driven objectives

The following objectives have been identified:

- Decrease time from job request to final detailed design
- Decrease cost of projects
- Improve overall productivity of design process
- Create a competitive advantage in the nuclear manufacturing market

Develop strategic purpose

Mission:

The mission of the reengineering is to ultimately decrease the cost and time to market.

2. Map and Analyse As- Is Process

Create process models

Design process

Current design process for Electrical Engineering Services:

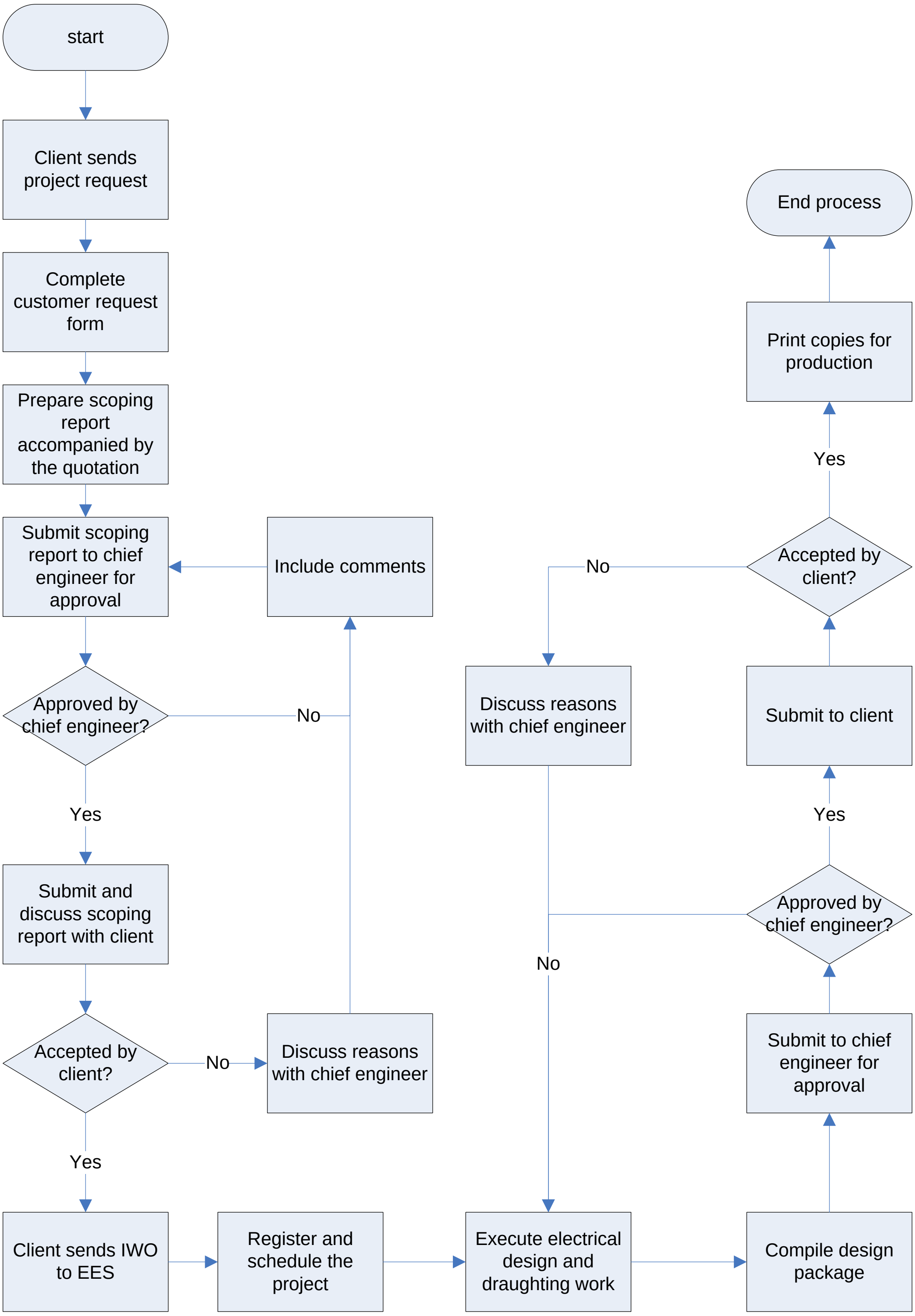

Figure 3: Current EES design process

Problems Identified in As-Is Process

a.) Quotations

Preparing quotations:

- Of the project time, 80% is spent on preparing quotations.
- Clients do not place orders after receiving the quotation because of insufficient funds.
- Time is wasted on preparing quotations that will ultimately be rejected by the client.

Requests for quotations:

- Any staff member at Necsa can submit a request for a quotation from EES. No approval from line management is necessary.
- As soon as the quotation is issued, management of the employee who placed the request is notified and normally they inform EES of unavailability of funds.
- 35% of all completed quotations are rejected.

b.) Outdated drawings and Certificates of Compliance (COC)

Outdated/missing drawings:

- Drawings of the buildings at Necsa are either outdated or missing.
- Changes have been made in the buildings over the past few years and these changes were not always marked on the existing drawings.
- Drawings must be updated before new work can be done.
- In some cases, drawings have gone missing and new drawings must be made.
- Updating the old drawings or creating new drawings for the existing building can take five times longer than the time spent on completing a new work order placed by the client.

Certificate of Compliance (COC):

- Each drawing must have a COC before any work can be done.
- Of the 2667 distribution boards, only 27% have their original COC.
- Most drawings are outdated and they are not certified.
- Before new designs can be made, the distribution board in the building must be checked to see if the drawings of the board is up to date and has a COC.
- Locating drawings and COC's is a time consuming process.
- The drawings are kept in a storeroom because most of the old drawings are only available in hard copy.
- As soon as drawings are updated, an inspector must check the drawing and issue a COC. After the COC has been issued, new work can commence.
- At the current rate it is expected that creating COC's for all of the remaining distribution boards will take up to eight years.

c.) Customer approval

- Designs have to be sent to the client for approval. Normally clients do not understand the designs because they do not have a background in electrical engineering.
- Designs can be in possession of the client for several months before they are sent back to EES with the client's signature.
- These outstanding designs create a problem because EES cannot carry on with new work orders in the same building. They use one design as a reference for a respective building and if that design is awaiting client approval then it has to be returned before they can start working in other parts of the building.
- It can take six months to a year before the client returns the design.
- There are 10-15 designs that are currently awaiting client approval.

d.) Filing of existing drawings

Records room:

- Hard copies of drawings are stored in the records room. Most of these drawings are only available in hard copy, making it very difficult to locate a specific drawing.
- Two employees are currently busy with the process of scanning the drawings to create digital files, but there are thousands of drawings that still need to be scanned.

Drawing database:

- Currently one computer at EES is used as a server. All of the digital drawing files are stored on the computer. The other EES employees have access to the files. If something were to happen to the computer all the digital files will be lost.
- There is no control over the drawing files which means that two people can work on the same revision of a drawing without realising it.
- At the end of the week all the files must be brought back to the database.

e.) Traceability

- In the nuclear manufacturing field there are strict regulations and each project must be controlled in such a way that the origin and path followed of each part is clearly traceable.
- Each project must adhere to specific standards to be certified as a functional nuclear project. Traceability is one of the most important regulations that has to be in place to receive certification.
- Currently there is no system that controls the electrical design process which makes traceability almost impossible.

f.) Unavailability of resources

- EES is currently understaffed. The workload is too heavy for the current employees to handle.
- Six resources are currently available to do design and draughting work.
- Backlog is occurring because on all the Internal Work Orders (IWO) received.
- 77 IWO were received in the first half of 2010 and only 20 have been completed.
- 67 job requests that were registered have not yet been attended to.

Identify value adding processes

The following activities in the MES design process were identified as value adding activities:

- Preparing quotations.
- Updating existing drawings/ replacing missing drawings.
- Physical designing of project.
- Reviewing design output and process requirements:
  - EES checker
  - Customer
- Printing design for approval and stamps.
- Updating records.
- Filing records in record system.

3. Design To- Be Process

Design To- Be processes

a.) Implement new software

Teamcenter Express

Teamcenter Express is software that is able to control and monitor the complete design process if it is implemented and used correctly. Teamcenter Express can be seen as a form of digital lifecycle management.

Teamcenter Express allows the synchronization and collaboration of design data across a digital environment. These capabilities will improve the quality of designs, reduce costs and decrease the product lifecycle time.

Teamcenter will adress the following identified problems:

- Filing, search and retrieval of drawings
- Control over revisions
- Approval of drawings from checker and client
- Traceability

Teamcenter Express Features:

1. *Access Control:*

Teamcenter Express has an access control model with user control roles and their associated control rules. This determines which action can be taken by whom on what and at which stage of the product lifecycle.

The following actions are controlled:

- Finding
- Viewing
- Modifying
- Authoring

The control rules change throughout the product lifecycle. This ensures a secure process where only the responsible person is able to execute a specific action.

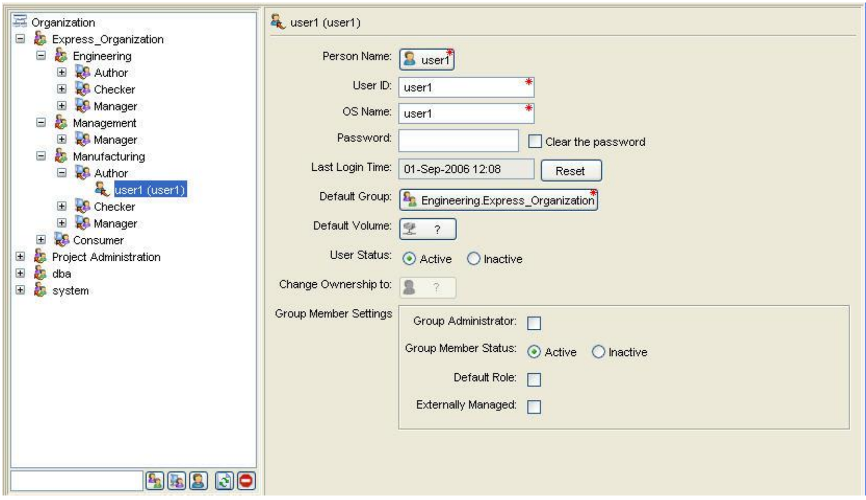

Figure 4: Teamcenter Express access control interface

2. *Search and Retrieval:*

Data searching and retrieval is a very important aspect of data management. Teamcenter Express is more than capable in areas of search and retrieval. Preconfigured queries are available to assist in finding the desired information. Custom queries can also be defined by the system administrator through a graphical user interface and then presented to the users.

Results from searches are stored on tabs in the data panel, which provides easy access to already retrieved information.

A selection of criteria is available to narrow the search.

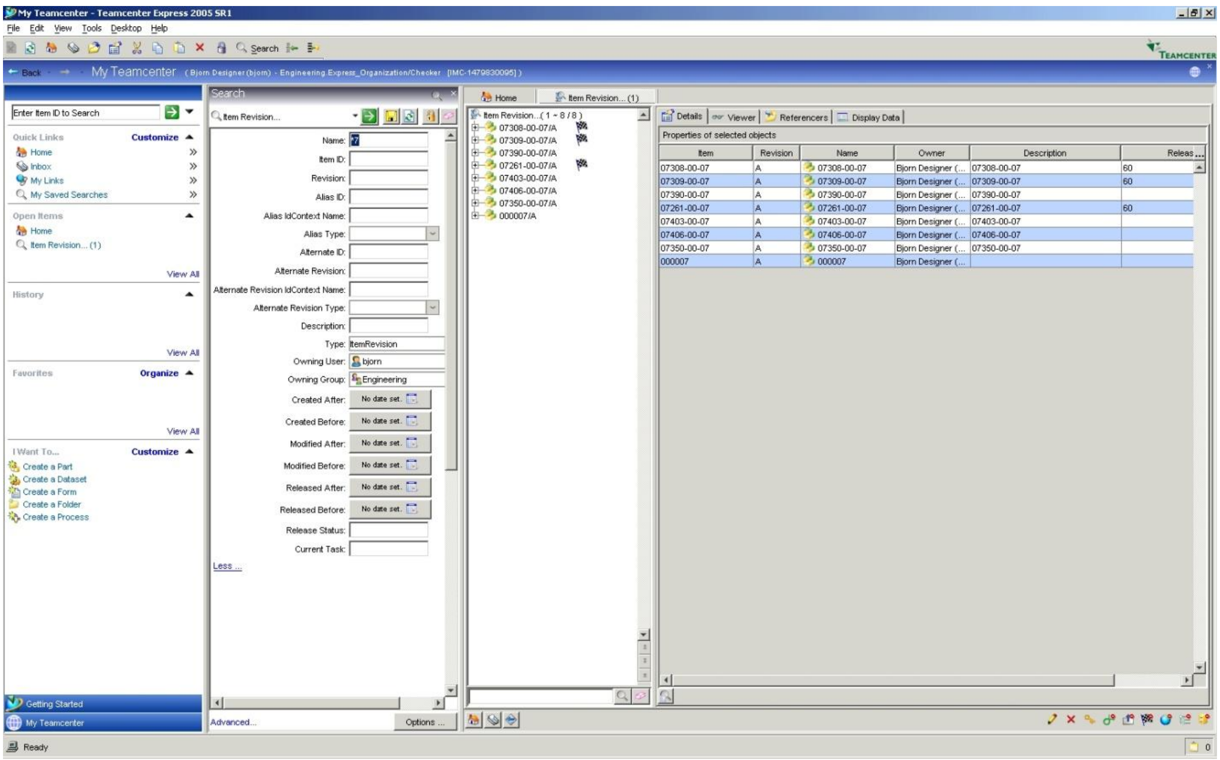

Figure 5: Search interface

3. *Revision / Version Control:*

Versions and revisions of data can both be managed by Teamcenter Express. Teamcenter Copies of data are referred to as revisions and they are managed by the rules and conventions of a specific company. Teamcenter Express uses the conventions of the company for revision control.

Teamcenter Express is also able to follow and manage versions of data. During the development stage of the product lifecycle, the user makes changes to the document and will save multiple times without changing the revision of the data. These saves can be tracked by Teamcenter up to a set number of times as specified by the company. The user can then return to previous versions of data, even if the application has been closed. This application eliminates the time consuming process of searching on a backup device and also makes it impossible for two employees to work on the same revision simultaneously.

4. *Process Management - Status Manager:*

Teamcenter Express has a simple Status Manager utility which indicates the different statuses of the product throughout its lifecycle. There are preconfigured sets of statuses as shown below. As soon as a workflow is completed, the status of a product will automatically change.

The user is constantly aware of the status of the design currently in the workflow.

Status	Icon	Description
None	-	In Process
10	10	Check Rejected
20	20	In Checking
30	30	Development Release
40	40	
50	50	
60	60	Production Release
70	70	
80	80	
90	90	Obsolete

Figure 6: Product status indicator

5. *Traceability:*

The Teamcenter Express package enables the user to follow each action taken and the reason for that action throughout the entire project. Each path taken in the project is fully traceable.

The requirements that have to be followed to ensure the quality of the design can be programmed into Teamcenter to indicate where steps were taken because of a specific rule that has to be followed thus the reason for the action taken can be traced back to the rule/requirement.

Traceability is an important aspect of a design process and will be improved through the configuration management that Teamcenter Express provides. Improving the traceability of the design process leads to the improvement of the credibility of Necsa as a nuclear designing and manufacturing company.

b.) Adjust quotation workflow

Currently there is a general work order request workflow. This workflow applies to all departments that provide a service at Necsa. Necsa's intranet provides a user interface where work orders can be requested. Any employee of Necsa can place a work order and there is no managerial control over the work orders.

The manager should approve job requests because he knows the financial situation of the department and the employee placing the request does not necessarily know whether there are funds available.

An extra field must be added to the existing workflow where the manager of the specific department has to approve the job request before it can be sent to the service provider. This will eliminate unnecessary job requests.

The following problems will be addressed by adjusting the job request workflow:

- Decreasing the time wasted on preparing unnecessary quotations.
- Decreasing the number of job requests that have to be attended to by EES.

c.) Establish dedicated COC program team by hiring additional electrical designers

The most time consuming part of new work orders is to get COC's for the existing drawings.

This problem can be addressed by doing the following:

- A team must be established that is only dedicated to the COC program. This team will have to consist of experienced EES employees.
- Additional draughtsmen and designers will have to be employed to handle the new work orders.

- The current layout of the drawing must change to accommodate the new EES employees.

Presently there is not enough space in the drawing office to employ more draughtsmen and designers for EES. The floor plan has to be changed to accommodate new employees.

Current position of the EES desks in the drawing office:

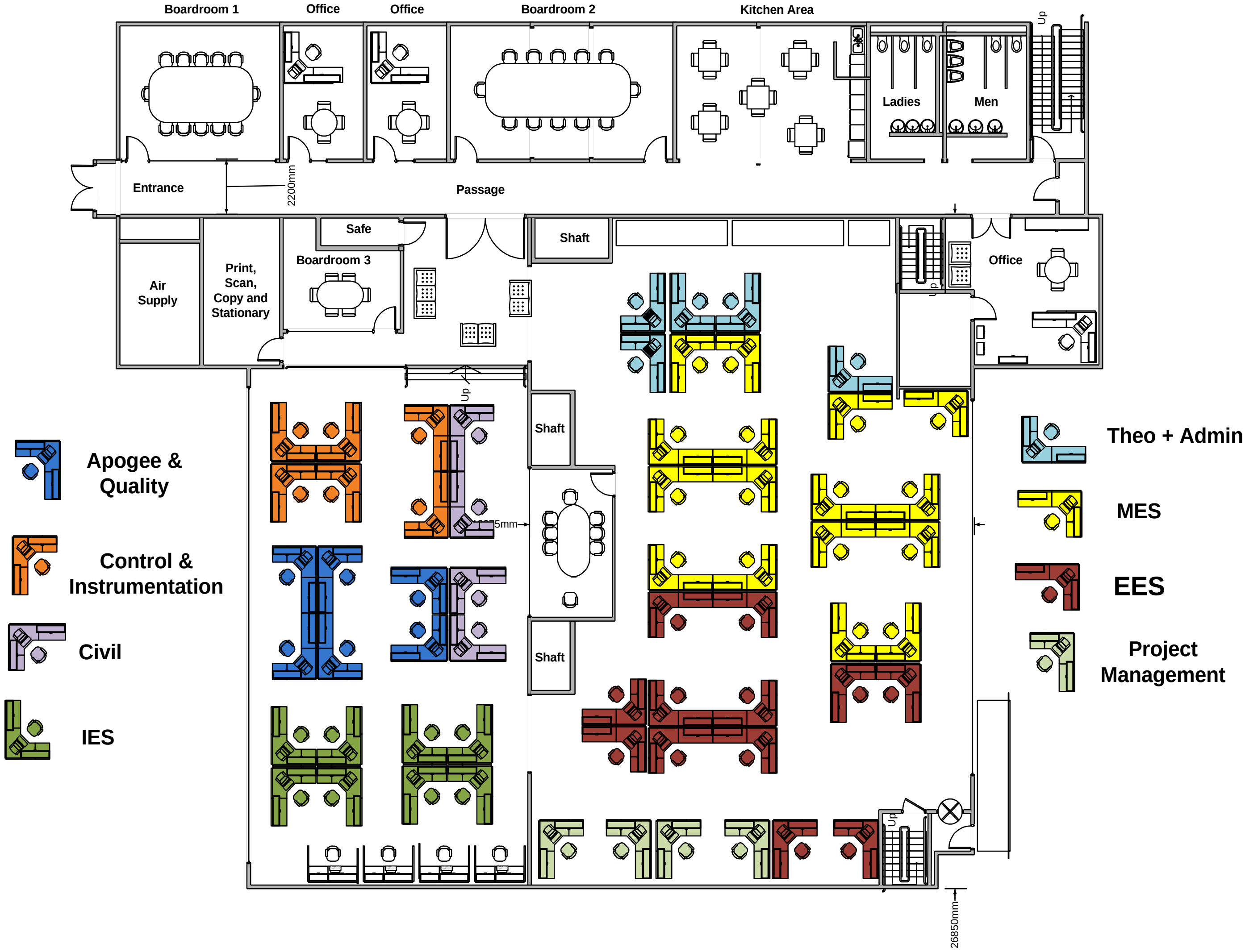

Figure 7: Current layout of drawing office

Proposed change in layout:

IES (Industrial Engineering Services) moves to floor one and MES (Mechanical Engineering Services) moves to where IES is currently sitting.

Floor plan for proposed layout:

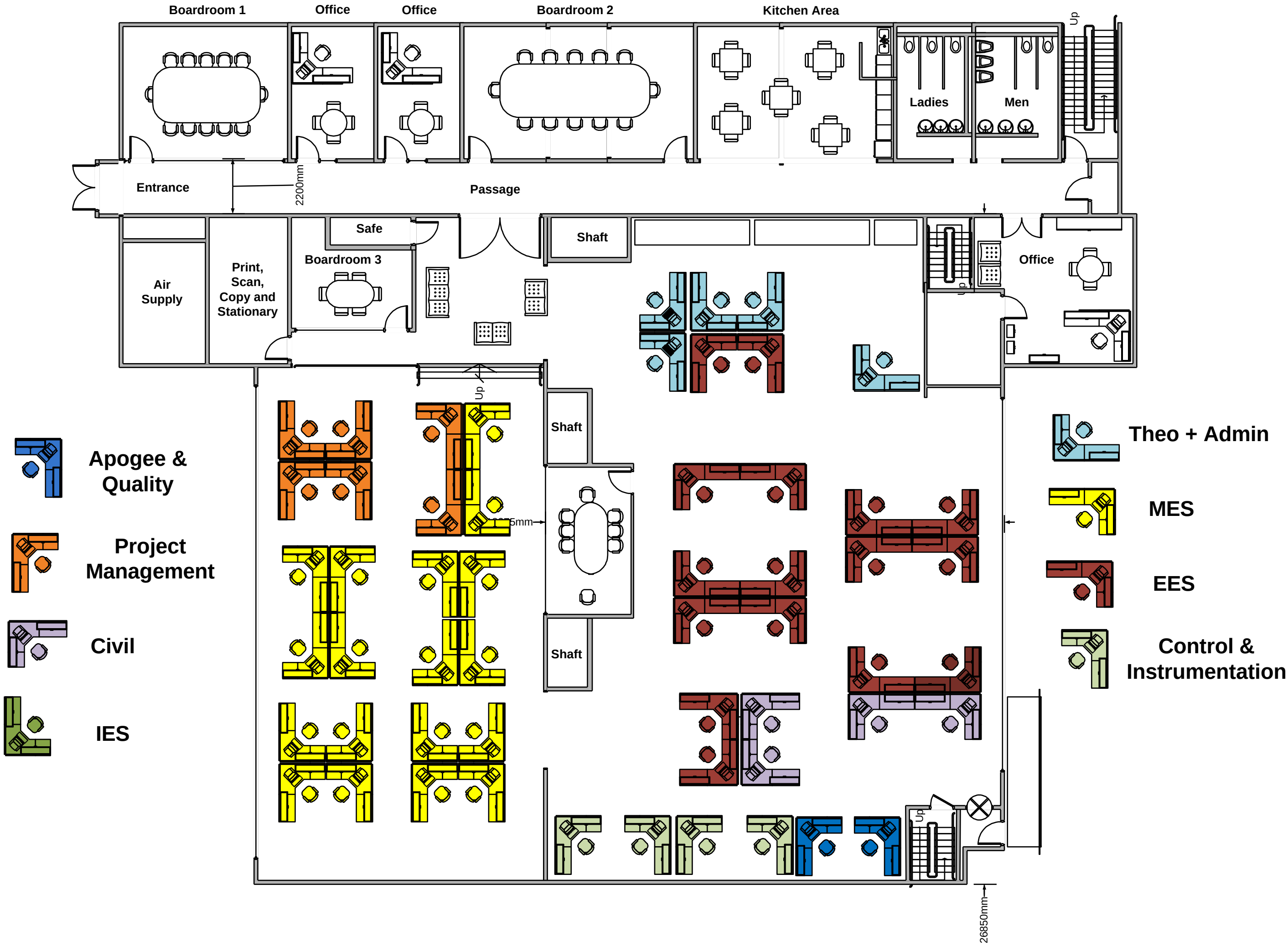

Figure 8: Proposed layout for drawing office

The following was done in the proposed layout:

- Apogee's desks have been added to MES and EES.
- Four extra desks have been added to EES.

Advantages:

- EES will have space to hire more people.
- More tables can be moved into the vacant spaces where MES was sitting.

d.) Implement new client approval policy

A new policy regarding client approval must be instated. Instead of sending the drawing to the client for approval, the client must be notified to come and view the design at the drawing office. A designated person must available to explain the design to the client and if the client is satisfied, the design can be signed immediately. This will eliminate the time wasted by waiting for the approved design to be returned by the client.

The following problem will be addressed by a new approval policy:

- Waiting for approved designs to be returned.

Validate To- Be processes

Teamcenter:

All of the abilities listed below contribute to the validation of the To-Be process.

Process management abilities of Teamcenter:

- Integration of several different design teams.
- Synchronisation of data.
- Easy accessibility, decreasing time- wasting searches which improves overall productivity.
- Quick retrieval and classification of designs that already exist.
- Reduction in design process cycle time by operating in a multi-CAD environment, eliminating CAD translation cost.
- Constant viewing of changes in design, reducing review time.
- Decreased time to market.
- Reduction in design changes.
- Increased quality.
- Increased overall productivity.

Quotation Workflow:

Changing the workflow will have the following effect:

- All work order requests that are not authorised by management will not be sent to EES
  = Work order requests will decrease with 35%
- No time will be wasted on useless quotations
  = more time will be available to complete designs for already accepted quotations

Hire additional electrical designers:

The change in the layout of the drawing office will allow the employment of four new employees.

Current situation:

- 154 work orders received per year
- 6 available resources
- 40 work orders completed

40 work orders completed/154 work orders received = 0.259

= 26% of work orders received per year are completed

Proposed situation:

- 4 new employees
- 10 available resources
- 40 work orders were completed by 6 employees
- 4 employees can handle 66% of the work that 6 employees do

40 x 66% = 27 extra work orders

40 + 27 = 67 completed work orders

67 work orders completed/154 work orders received = 0.435

= 44% of work orders are completed with 4 extra resources

44% - 26% = 18%

The number of work orders completed per year will increase with 18% if 4 new employees are hired.

Client approval policy:

- Projects can only be finalised when designs are returned with client approval.
- 10-15 designs are currently in the possession of clients and can not be finalised.
- The new client approval policy will ensure that EES will not have to wait for client approval.

4. Implement Reengineered Process

Initiate training program

a.) Teamcenter

Training will be the responsibility of ESTEQ, the company selling Teamcenter Express, and the employees of Necsa.

ESTEQ will train a group of eight Necsa employees who in turn will be responsible to train the other users. Training costs will be kept at a minimum if done this way.

Administrators of Teamcenter Express will have a 3 day training course.

b.) New employees

New employees of will have to be trained by the current EES employees so that they will be able to take over the new work orders.

Implement transition plan

The transition between the current process and implementing the software is a crucial part of the implementation plan. Employees normally resist change in the process that they are familiar with. Change management will play a significant role in the transition plan.

A change managment team must be established to control the change process. The same people that are in the cross-functional team can be used to form the change management team.

The change management team will be responsible for the following key actions during the change process:

1. Communication
    - The need for for change must be communicated to the employees.
    - An information session must be held to explain where the change will be implemented and how it will affect the employees.
    - The advantages of implementing a program such as Teamcenter must be communicated to the employees.

2. Manager training
    - Managers must be informed of the actions that have to be taken to install Teamcenter.
    - Managers must be trained to use the program so that they are able to train other employees.
    - Managers must be convinced to support the change and to motivate the other employees to support it as well.

3. Resistance management
    - Any signs of resistance must be identified.
    - The reasons for resistance must be eliminated by proving that the change is indeed necessary.
    - Employees must be assured that the change will improve the current process.

4. Feedback analysis
    - Short-term targets must be set.
    - Feedback must be given targets to establish if they were met.
    - Feedback must be analysed to establish whether there has been improvement.
    - Feedback will serve as proof that the change has improved the process.
    - Feedback from employees must also be analysed to see whether they have adapted to the change.

5. Improve Continuously

Initiate ongoing measurement

A quality management system must be implemented to ensure that the delivered products are up to standard. EES has its own quality management system in place.

Internal audits must be performed regularly to make sure that the correct procedures are being followed. These audits will indicate in which areas problems still occur.

Review performance against target

The monthly output must be measured against set targets to see whether productivity is improving. These targets must be a required minimum which the process should produce in a specific time.

Improve process continuously

The process can improve continuously by identifying the following:

- Improved best practices
- New technology

The process must constantly be reviewed to see whether it can be improved in any way.

Cost Implications

Summary of Costs for Proposed Solution

Teamcenter:

	Software	**Annual Maintenance**
Software and maintenance	R 574 980	R 117 110
Implementation and Configuration	R 100 000	
Training	R 43 000	
Totals:	**R 717 980**	**R117 110**

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