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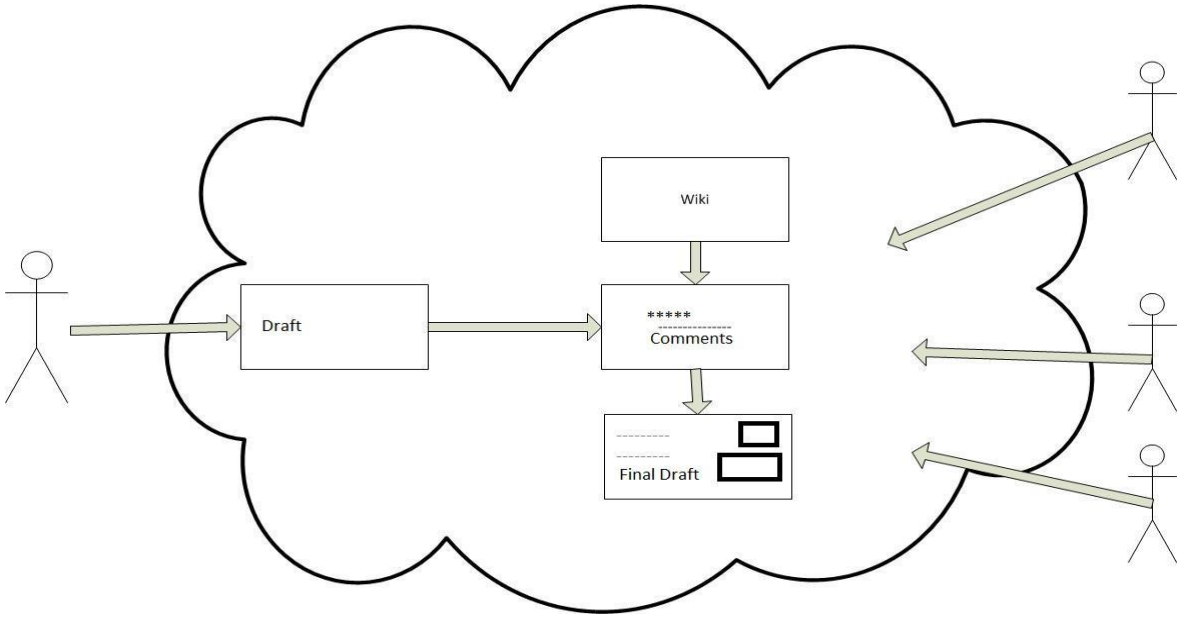

Electronic Proposal Box for Process Improvement

-An interactive communication through web

Master of Science Thesis, Software Engineering and Technology

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An Electronic Proposal Box for Process Improvement

Thesis Report

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Abstract

A rapid advancement in technology has influenced the manufacturing industry to make right decisions at right time for their growth. To maintain a steady market share in a competitive environment, companies have to focus on customer needs. Also they have to think ahead to be a leader in introducing innovative features with better quality product. To find out the key areas for improvement we have applied Lean thinking in a process of product development. A research is conducted in the manufacturing industry consisting of design engineers, process owners and research analysts with ten different manufacturing companies. The research pointed out the delays in communication between the design engineers and process owner at the time of process development. To communicate effectively a need for improvement in communication has emerged out with a simple and easy to use collaborative platform for design engineers and process owners. We performed a case study on one of the automotive company to find out the root causes of delays and then gather requirements for system development. A development phase started with three main parts; a WIKI to maintain the versions of the processes with a WYSIWYG (what you see is what you get) interface for effective communication, a profile card and a dashboard to give the overall picture about the evaluation and usage of a process to a process owner. A development step followed the extreme programming(XP) process for software development and an iterative way is used for process evaluation. This approach helped in evaluating a process during process development based on the results of a process when tested on a test bed. This evaluation step led towards the standardization of a process. Eventually it has reduced the response time of a process owner to give spontaneous feedback about the process to involved design engineers. A collaborative environment is not only provided with textual information but also with audio and visual information which are easy to understand. It also makes the communication more effective and efficient. A developed system has fulfilled all the baseline requirements and well appreciated by the customers as a first successful step towards process improvement. But a disinclination was found to learn a new system in a start which indicated some new requirements for future improvements in the system.

Keywords--Frequent communication, Lean, Standardized process, test bed, Agile, WYSIWYG, WIKI, XP

Introduction

To win the competition in the automotive industry, companies are focusing to improve the quality of their products and to handle the time constraint to develop them. This change of trend requires frequent communication between the workers, engineers and management. With this intention, our project suggests an online proposal box to improve the process development within the manufacturing industry. It involves an efficient and effective communication among the users and design engineers to develop a process. First, to study the problem domain, causes, effects and find out the areas for improvement in the current system. It discusses the detail analysis of the entities involved and collection of requirement from stakeholders for a new shift in their business domain. A developed product consist of a web-based application which contains three main modules; dashboard, profile card and wiki page. The modules were based on the defined requirement specification document and lean thinking to improve a process of communication in the development phase.

The problems raised by the delays in communication affects the business of collocated offices, as well as it affects more for the diverse located offices of the same company. Introduction of web technology in the business has overcome this problem by connecting all the people involved in it. Intended users are the method owner and design engineers. The method owner, who will evaluate the feedback provided by the design engineers involved in developing a process. Our developed web application is primarily acting as a feedback management system. The feedback is evaluated using defined set of rating criteria by the design engineers after testing the suggestions on the test beds and practical knowledge of the domain. The system also provides the visual information along with text for better understanding of the steps involved in following the process. It allows a two way communication between the engineers and process owners for robust communication.

Another module of the suggested system contains a profile card for a process evaluation. This provides the users an opportunity to give their feedback on a process. It tells the engineers and process owners about its usability in specific domain. The feedback in terms of like/dislike and rating is useful to estimate the importance of the process in that particular area. It also discusses the suitable area of its application with the overall cost of its development. Two way and lively discussion also considered as more productive in terms of time, cost and quality.

The third module of the system is to make a dashboard for process owners. It will give them a statistical view of the processes. The information like tracking of a process, which department and number of engineers has used particular process. This information is used to judge the importance of a process.

Next section discusses about the company's business and the current system for process development. Our proposed solution is mentioned in the methodology part. In the end, there is a section for discussion and then conclusion to conclude our findings. The last part contains the future work for continuous improvements.

Problem Statement

To support the work with process improvement, a suitable method for two-way communication between method owner and engineer needs to be developed. It is important that the software can represent the process and method visually with an easy to use interface that makes it easy to suggest improvements by modifying and updating the process.

1.1 Purpose

The purpose of the project is to fill in the communication gap and facilitate the stakeholders with efficient communication process using an online solution. The other aims are to take actions to change organizational communication process so that they meet organization's business needs and achieve its business goals more effectively. It will also explain system constraints, interface and interactions with other modules of application.

1.2 Scope

This thesis report details the following items.

- Requirements gathering and documenting SRS in IEEE format.
- Analysis of the problem using lean methodology and Ishikawa diagram.
- Prototyping using graphical aids.
- Study of alternate systems.
- Development of collaborative web-based system using extreme programming (XP).

Background

1.3 Information about Company Business

Company is an automobile manufacturer with a head office in Gothenburg, Sweden. It has approximately 2,300 local dealers from around 100 national sales companies worldwide, the US is its largest market, followed by Sweden, the United Kingdom, China and Germany.

1.4 Current System

Methods are published by method owners on the web portal for the design engineers. This portal serves as the library of processes which contains a collection of steps for following them. Design engineers download the published version of the process and follow them in their manufacturing plants. But when there is any uncertainty in understanding the process, design engineer writes his queries. He will get the response on the updating of the process which is done once a year, causing a delay in response. Another way of getting the spontaneous response between the entities is by making phone calls to method owners to resolve the misunderstanding or the problems in following the process but it depends on the availability of the method owner. Some of the processes are obsolete, incomplete and not standardized which eventually gives useless information.

Effective communication is necessary to carry out the visions of an organization to the people. Without a good communicate, there is always a possibility that organization could become isolated. Many companies around the globe are adapting lean manufacturing along with the agile methodology in order to remain competitive and sustainable however not many of them are successful due to lack of communication. In this study the emphasis is on effective communication among two stakeholders i.e. design engineers and process owners. [23]. Try to put this paragraph in the introduction.

1.5 Research Survey

A research survey is carried out in different product developing companies to investigate the need of improvement in a process of communication between design engineers and process owners.

1.5.1 Structure of Survey Report

There were three main questions in the survey which were asked to process owners:

- Problem Understanding: how design engineers express their problems?
- Concept understanding: How process owners understand and respond them?
- How it can be improved: if there is gap in communication, how this could be reduced?

1.5.2 Survey Results

This survey pointed out some of the areas which need to be improved depending on the opinions of different process owners. The areas are development of a collaborative environment, the standardization of approach, preparing the people involved in it, maintenance of the published process in relation to current issues. Some of the main problems which were identified in the survey are given below.

The problem faced by method owner was to track the results of suggested steps involved in a process. Problems were discussed in a meeting and but then manufacturing team perform the activities in their plants so all members of the discussion are not aware of results. No feedback is received about the suggested method or steps required to solve the problem that either it worked or not.

Certified concepts with base line are important in development projects as they make the problem simpler which improves development period. It allows the time to move further in the process to increase its quality. For faster development, tips and tricks along with the lively discussion and documentation will support the development process.

It is also important to consider the problems if the teams are geographically dispersed. Gap between the design engineers and process owners is because of their background, whereas process owner has to look after the business aspects and design engineers from a mechanical background.

Therefore a bridge is required between these two entities. There should be some platform on which they can communicate and align their thoughts so that the same interpretation of processes and steps involved in them, exist only. If the design engineers do not receive the feedback on their ideas, they lose their interest and do not use the system very often which increases the gap.

The contents are important to keep intact the both entities and also to ensure that the published methods are up-to-date. So if they communicate through some channel, more efficient will be the development of a process and result in to the better product.

Users of the current system are also looking for visual and textual information in their documents to get the opinions and follow the suggestions. They are looking to merge the feedback system with existing static feedback management system so that the design

engineers and process owner can communicate without leaving the tool that they are familiar with.

Lacking of horizontal and vertical communication for the process development is needed to be improved. Using internet, a web based channel can be prepared to solve the communication gap in the department and outside the department. Processes were updated in a year which also creates a lack of confidence in IT systems.

1.5.3 Analysis Based on Survey Report

It is important to document in a good way like it is clear to stakeholders that which thing is important under which circumstances and also it should be project specific. Some processes are dependent on other processes which might be expensive to follow as they will ultimately increase the cost of dependee process. It should be clearly mentioned in the documentation the overall cost of the process with recommendations like in which situation to go for such a process or in which it will be costly.

Improvement is an ongoing process which requires change in attitudes and responsibility. Documentation could be generic and changes could be done as per requirement of the product under development. Industry needs an example to follow before adopting new solutions and go for a change.

Challenges

From the study of the current system we found following problem areas and challenges.

1.6 Frequent Communication and Updates

Communication process in any product development company is recognized as a key element in product development [10] .In the current system the communication channel between process owner and design engineers lacks as there is only a one-way communication. A lot of time is wasted as design engineers do not get a response to their queries on time which result into delays in developing a process. There is also a lack of frequent updates.

1.7 Identification and Gaining Access to the Right Stakeholders

Adequate, timely and effective consultation of relevant stakeholders is of paramount importance [22] [13]. Due to company's policies and time constraints we faced the challenge of accessing the right stakeholder's on time, however we had couple of meeting in which we tried to get stakeholder's opinions.

1.8 Requirement Prioritization

Requirements prioritization is an important activity and a challenge in product development because of the reasons of high customer's expectations, short period of time and with limited resources [11]. This is handled by setting up a meeting with customers and ranking the requirements based on their importance using five-way priority scheme [8].

1.9 Unspoken and Assumed Requirements

It is always hard to get the complete and concrete requirements. Some requirements need to be assumed to set the complete functionality. In our case we assumed certain requirements to satisfy the stakeholder's needs [12].

1.10 Technology Change and Lack of Awareness

To introduce a new technology and trend is always a difficult task. Research has shown that people always show resistance because of the learning curve. In our case it was a challenge as design engineers and process owners were not used to of working with new technologies. We tried to resolve it by making the application simplest as much as possible.

1.11 Lack of Standards

From the study of current system we identified that there was no defined standard or process of information sharing. The communication and information was more informal because of having no proper documentation.

1.12 Incomplete Processes

There are many incomplete processes in the current system, some don't have their results and some are not valid for the current problems which increase the responsibilities of process owners.

1.13 Functional Requirements

The requirements are gathered through having semi-structured face to face interviews with the stakeholders. The project is divided into three different sub-modules: Dash Board, Profile Card and Wiki. Functional requirements are listed according to IEEE Recommended Practice for Software Requirements Specifications [2].

Some of the important requirements which are prioritized high by the stakeholders include implementation of collaborative environment using the WYSIWYG editor, commenting and rating feature, PDF conversion of published processes and track history. With the help of WYSIWYG editor stakeholders could easily enter the textual as well as pictures and videos based process details using many available formatting styles. Comments feature is another important feature; by using this feature user could be able to make comments on any of the available processes. A process owner is informed by the email that a comment has been made on the respective process. This helps a process owner to improve deficiencies in the process during its development. With the help of rating feature design engineers will be able to rate any process during the development whether it is helpful or not and the importance of the specific process. To create similarity with the current system, a feature is created to convert the published process to a PDF file to be used by design engineers. To store the history and for check and balance a 'Track History' functionality is added, by using this feature the admin could be able to track what changes have been made by which user with the time stamp and IP address.

Research Methodology

The major aims of this qualitative study were to bridge the gap of communication among stakeholders and to shed light onto best practices to provide suggestions to industry on how to achieve efficient communication and collaborative environment.

Our research questions were:

RQ1: How to meet challenges in effective communication?
RQ2: What are the other potential ways of effective communication among stakeholders?
RQ3: How the suggested approach will affect the business?
RQ4: How to solve the communication concern using software based technology?

In order to answer these questions, this research was designed as an exploratory study. The following sub-sections discuss the data collection and analyses steps.

1.14 Data Collection and Analysis

In order to collect data we were provided an industrial survey report on identification of current communication problems in a manufacturing Industry. On the basis of analysis on report, we organized several brain- storming sessions to discuss problems with their possible solutions. From brain storming and survey report, we have created a structured list of questions to discuss in a meeting with design engineers and process owners to investigate the problems. We have conducted a semi-structured interview to gain more insight of current system and their future needs. After the interviews different inter-team brain-storming session were conducted to create a draft of a proposed solution. We have used the sequence diagrams, prototypes and mock-ups when discussing the system in order to increase the outcome of the meeting and to make the understanding between our team and the customer better. For in depth analysis of the problem domain we have used Ishikawa diagram [7] within our team to identify the root causes for delays in product development.

1.15 Root Cause Analysis

We performed the root cause analysis to identify the causes which do not add value to the product development. Fish bone diagram or Ishikawa diagram is one of the seven basic tools of quality to perform root cause analysis [7]. It involves the identification of causes affecting the product development process.

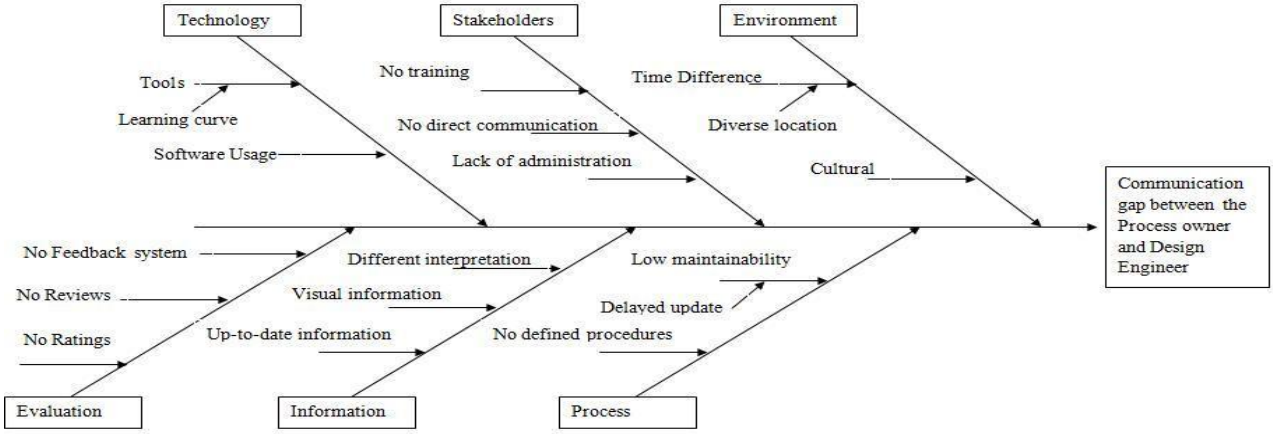

Fig.1 Ishikawa Diagram used for root cause analysis

1.15.1 Ishikawa Diagram

Fish bone diagram is created by brainstorming, information received through the interviews with customers and research survey report. First, we have drawn a main horizontal line pointing towards the problem under discussion. Identified six different categories in rectangular boxes and joined them with main arrow as branches. In the next step, we drilled down to the factors which cause these problems by asking "WHY, this thing happened?" and added them as branches to the categories. In the last step, we asked the same "why" questions for the identified branches of categories to go into the root of the problem and joined them with the specific branch as its sub-branch [7].

1.16 System Requirement Specification Document

Considering the problem areas discussed in the interviews, brain storming sessions and root cause analysis, our next step was to create a system requirement specification document for a new system. To move into the development phase, we have finalized the requirements with mutual understanding between the customers and development team. This document was created according to an IEEE recommended practise for Software Requirements Specification IEEE std. 830-1998[2].

1.17 System Flow Diagram

The underlying system flow diagram is describing the steps involved in the development of a process. The oval shapes represent the starting and finishing point in the process. A process is initiated by the process owner represented as an actor in the system. After initiation step, an email is generated to concerned design engineers to participate in the evaluation of a new process. The next is a standardization step in a flow contains three intermediate steps which includes a testing of a process in test environment, evaluate the process by rating their usefulness and provide feedback on the developing process.

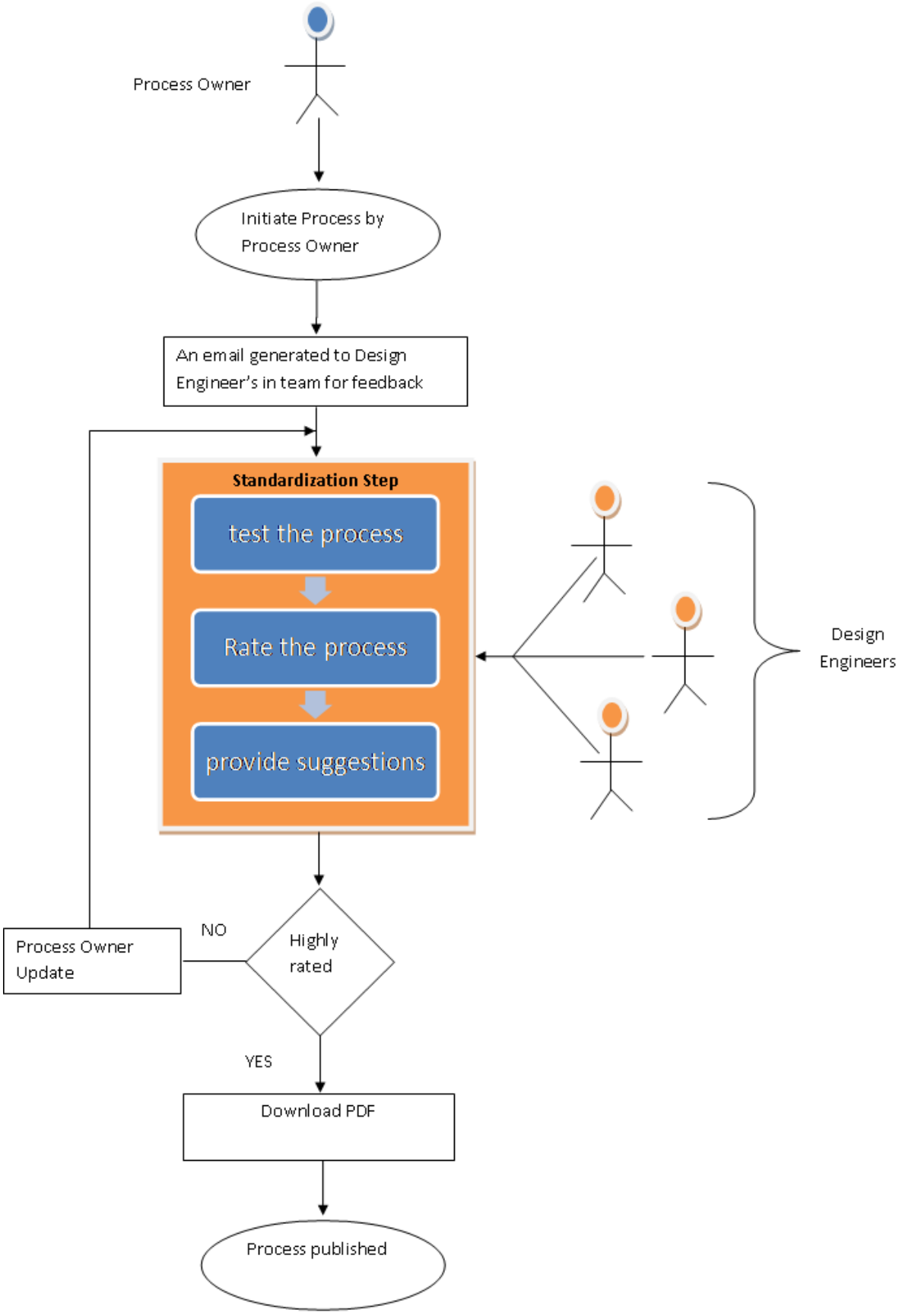

Fig.2 Flow diagram of a system

The next step is the decision step, depending on the ratings and provided feedback; if a process needs to be improved then design engineers provide their suggestions to process owner and the developing process remains in this step iteratively until it gets highly rated by the design engineers. It flows next to the word document creation of the newly developed process and finally it gets published in the process catalogue to be used by other design engineers.

1.18 Extreme Programming in Theory

Extreme programming (XP) was born during a project on payroll system at Chrysler Corporation which was started in 1995-97. XP is a software development methodology which is intended to improve software quality and responsiveness to changing customer requirements. It is a discipline of agile software development based on values of simplicity, communication, feedback, and courage [24]

Some of the core practices of XP are given below.

1.18.1 Whole Team

One of the key values in agile software development is the focus on the human-involved in the project. XP focus more on people. In XP everybody involved in the project working together as one team. Everybody in the team must be present in the same workplace. The motivation behind this value is the frequent communication and information spreading.

1.18.2 Pair Programming

All program code is written by two programmers working together, working in this manner has many positives which include better code quality, information spreading and skill spreading in case of one is senior and other is junior. Pair programming is also a most effective technique for finding and removing bugs in code review.

1.18.3 Test Driven Development

It is also known as Unit testing. In principle, it is about writing test before program but in consequences it leads the software engineer to first think about how to use and then how to implement. In Agile development NO single line of code is ever written without first writing a test that tests it i.e. unit test. All tests are written in a test frame work called JUnit [24].

1.18.4 Customer Tests

The customer or the representative of customer writes test that is used to verify that program fulfils the requirements.

1.18.5 Continuous Integration

One risk or problem when several people work together is integration, many of the subtle and hard to find problems in a program code arise when different newly build modules interact

with each other. To resolve this concern the XP teams keep the system fully integrated at all times. A working new version of the complete system software is released internally every night to avoid large code integration problems.

1.18.6 Small Releases

In classic software engineering one used to build software in big chunks, this is how the waterfall model worked. One visible downfall of this methodology is adaption to change, a lot or rework is required to accommodate change, this is not a good way of working. So to accommodate and adopt changing requirements small releases is efficient way of working. In XP typical interval time is about 3 months.

1.18.7 Collective Code Ownership

In XP there is no sense of individual's code. All team is responsible for all software code, hence work on same bulk code.

1.18.8 Coding Standards

This value is closely related to collective code ownership. In order to have a code base that is readable and understandable by everybody the team have to use the same coding standard or style.

1.18.9 Sustainable Pace

XP motivates sustainable pace, work pace should be constant throughout the project and at such a level that people do not drain their energy reserves. In XP the typical time period is 40 hours per week. Overtime is not allowed in XP.

1.18.10 Simple Design

XP don't have any upfront design. In XP design is created during the implementation. The motivation behind is No finalize requirements are present in the beginning and it would be costly to change the whole design in case of requirements change.

1.18.11 Design Improvement

Extreme programming process involves a process of continuous improvement in the design of the system. This continuous improvement is known as refactoring. It helps in improving the performance of the system as well as makes the design simple. Eventually this practise adds a value to the product or to the business.

The purpose of refactoring is to remove the duplication of a feature or a part of a feature. It is used to remove the conflicts occurred due to the integration of different parts, added by different developers. Therefore, it is recommended to commit changes to the repository after

making any change in a system under development. It helps a team to find design problems on the fly. This is the reason where XP team starts and move with a small and simple design. This leads to a sustainable development speed and improves the design quality.

1.19 System Development

A web-based collaboration environment was developed to eliminate the identified root causes of delays in process of communication of product development. It has provided better communication as compared to previous Qualiware system. We have customized a pre-built system according to our requirements and added new features according to our requirements rather than re-inventing the wheel. Collaboration was achieved with a Wiki approach which contained what you see is what you get (WYSIWYG) editor with features like adding, updating and deleting a process information, along with a version control to track a history of changes in the process. Issues of communication were resolve by subscribing for a process and receiving RSS-feed whenever anyone apply some changes on the process. It also helped in maintaining the updated repository of processes. Evaluation of a process was handled by testing a process on separate test beds and feedback was gathered through comments of design engineers, polling and rating stars. Finally, when a process was published, it was ready to download as pdf files for design engineers to follow it. A fully functional system was tested before it was presented to the customer to satisfy the requirements. Below are some screen shots of the developed system:

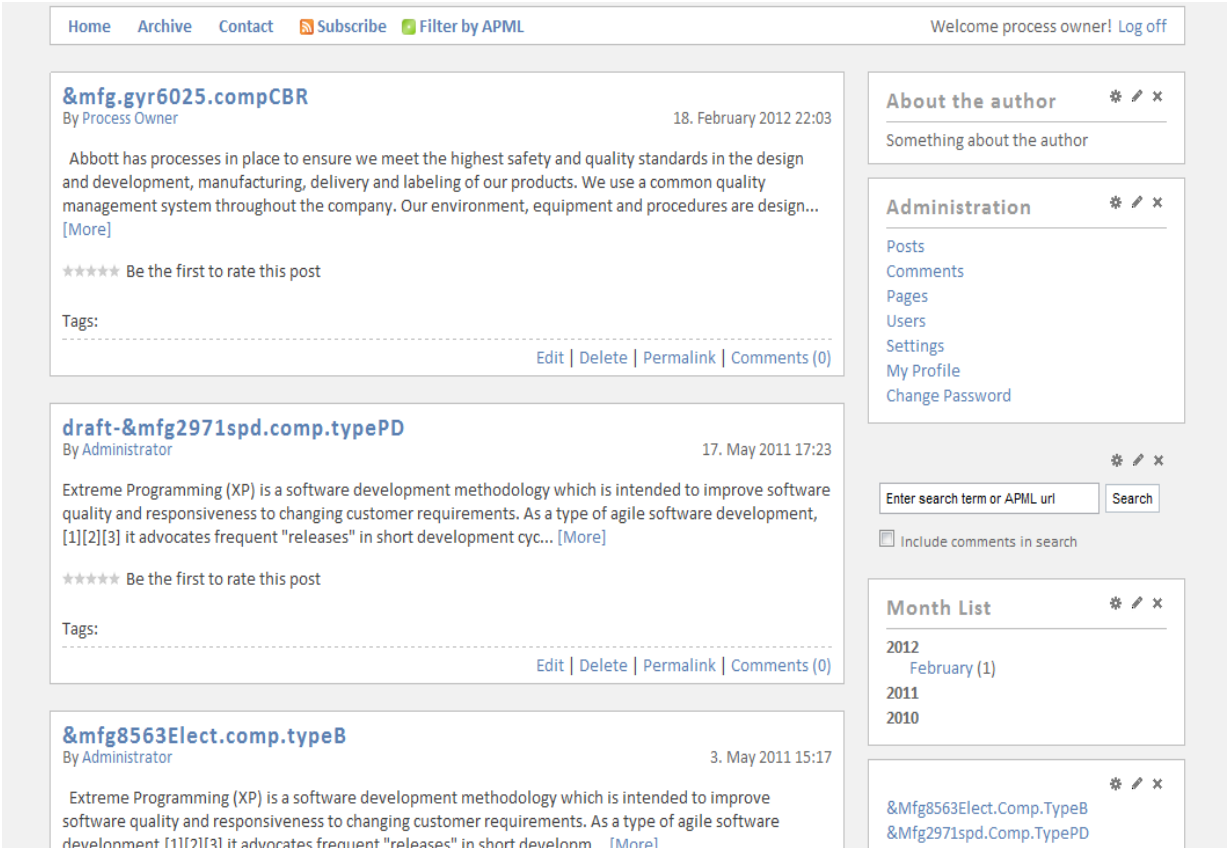

Fig.3 Home Page

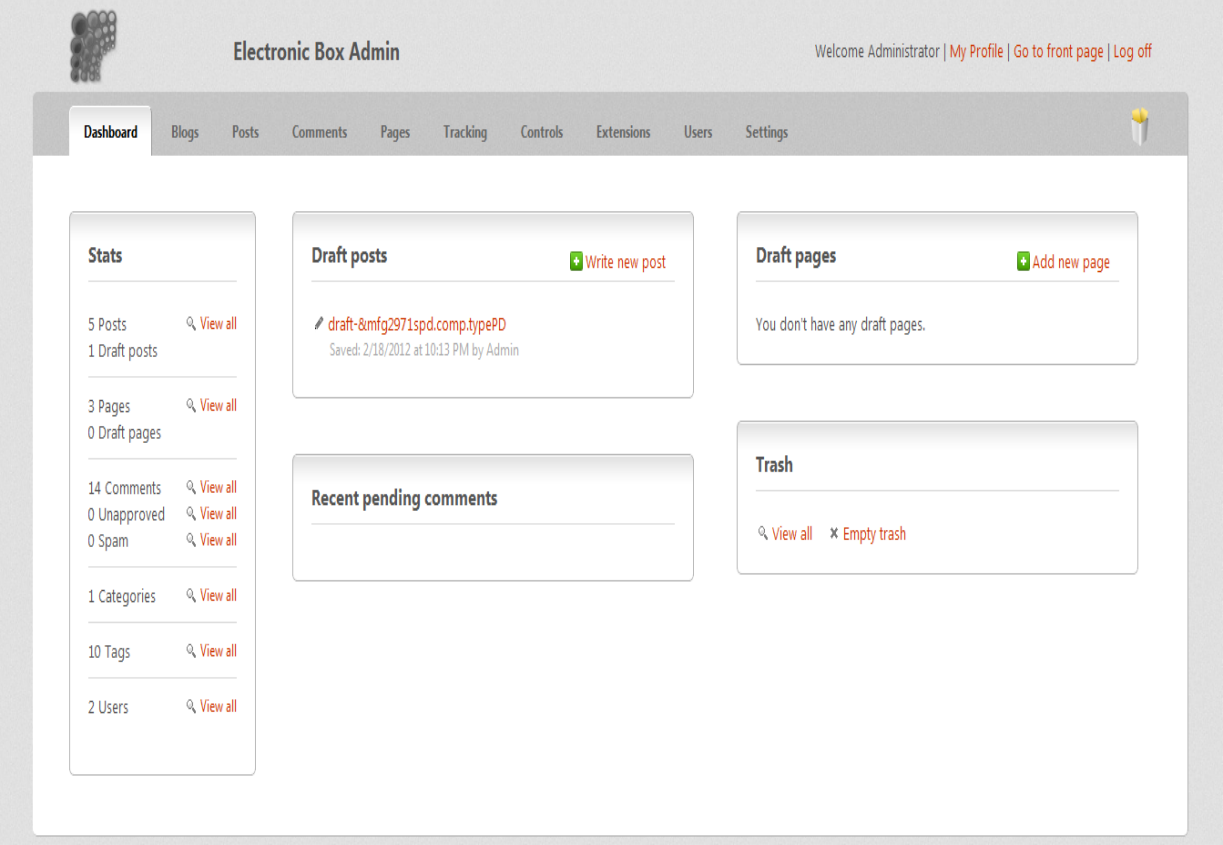

Fig.4 Dash board page

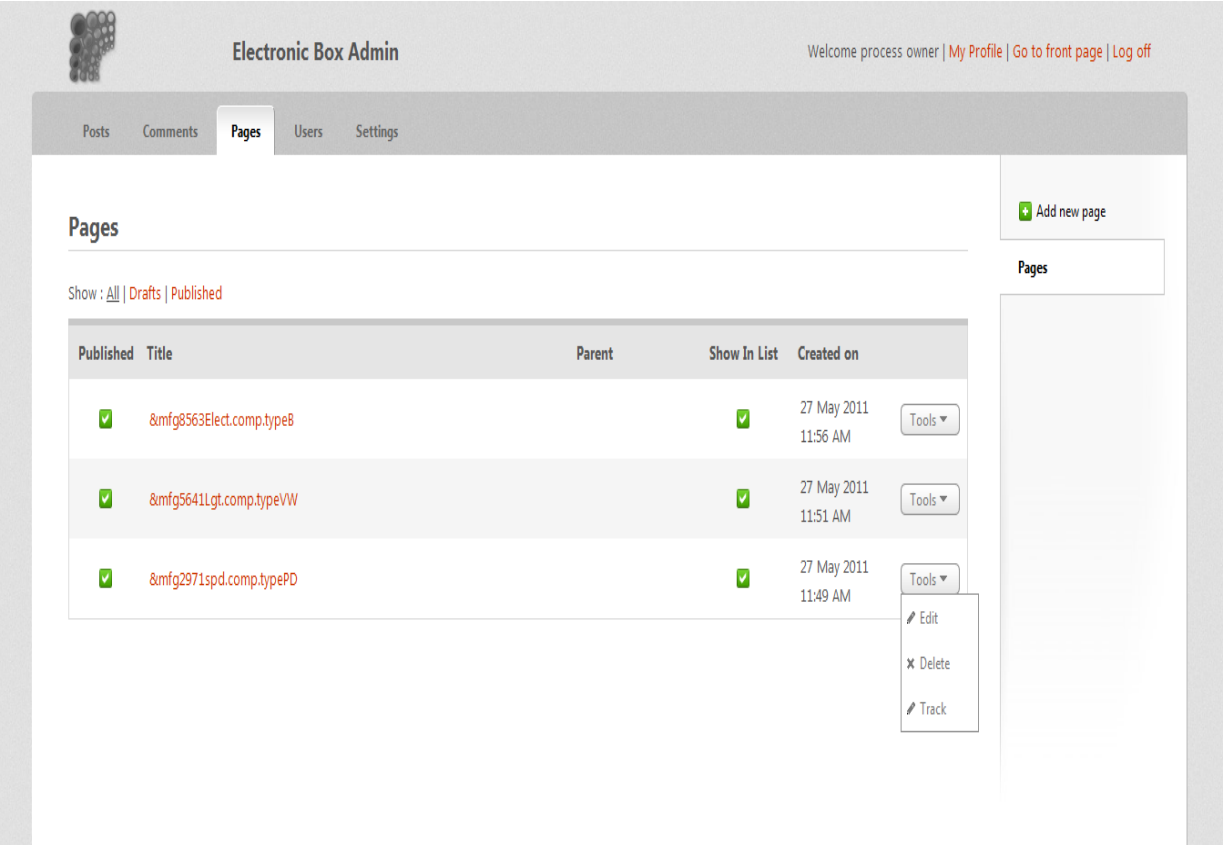

Fig. 5 Process listings page

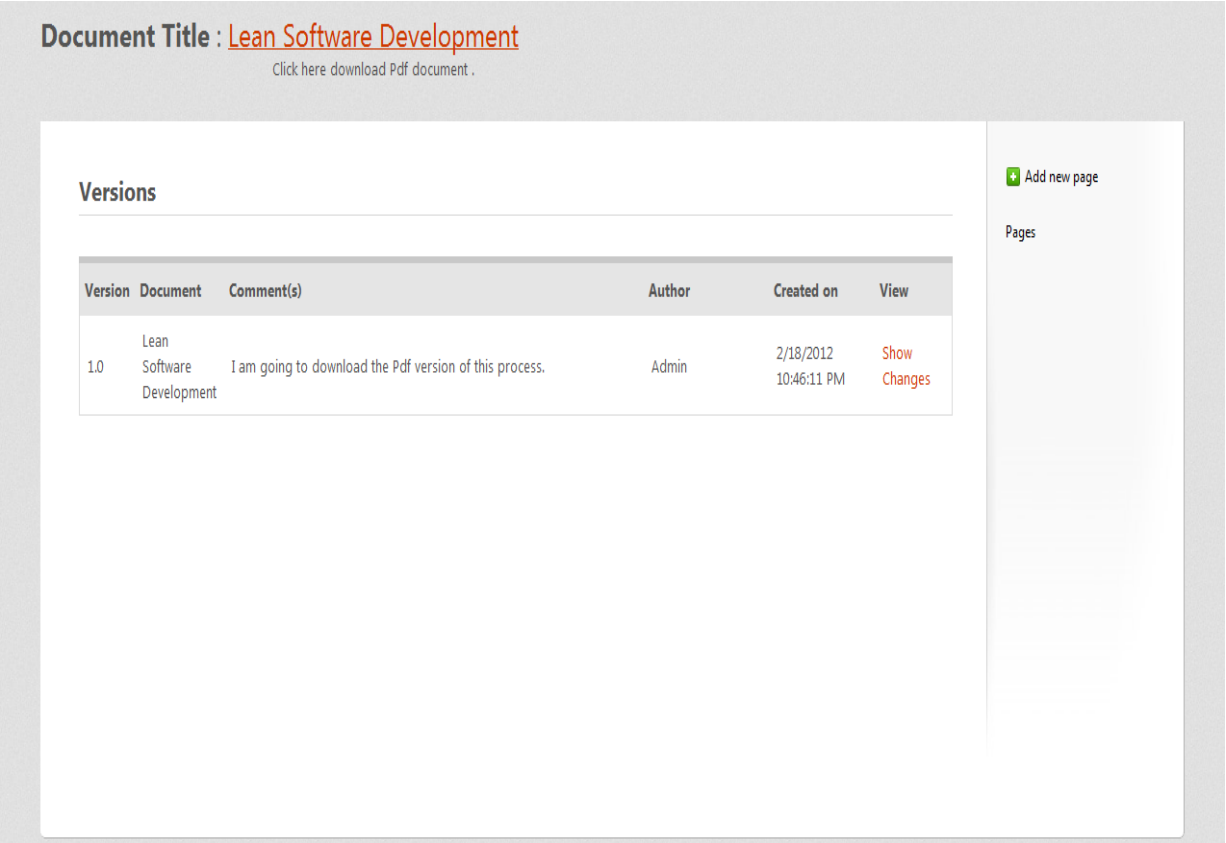

Fig.6 Download pdf and versioning page

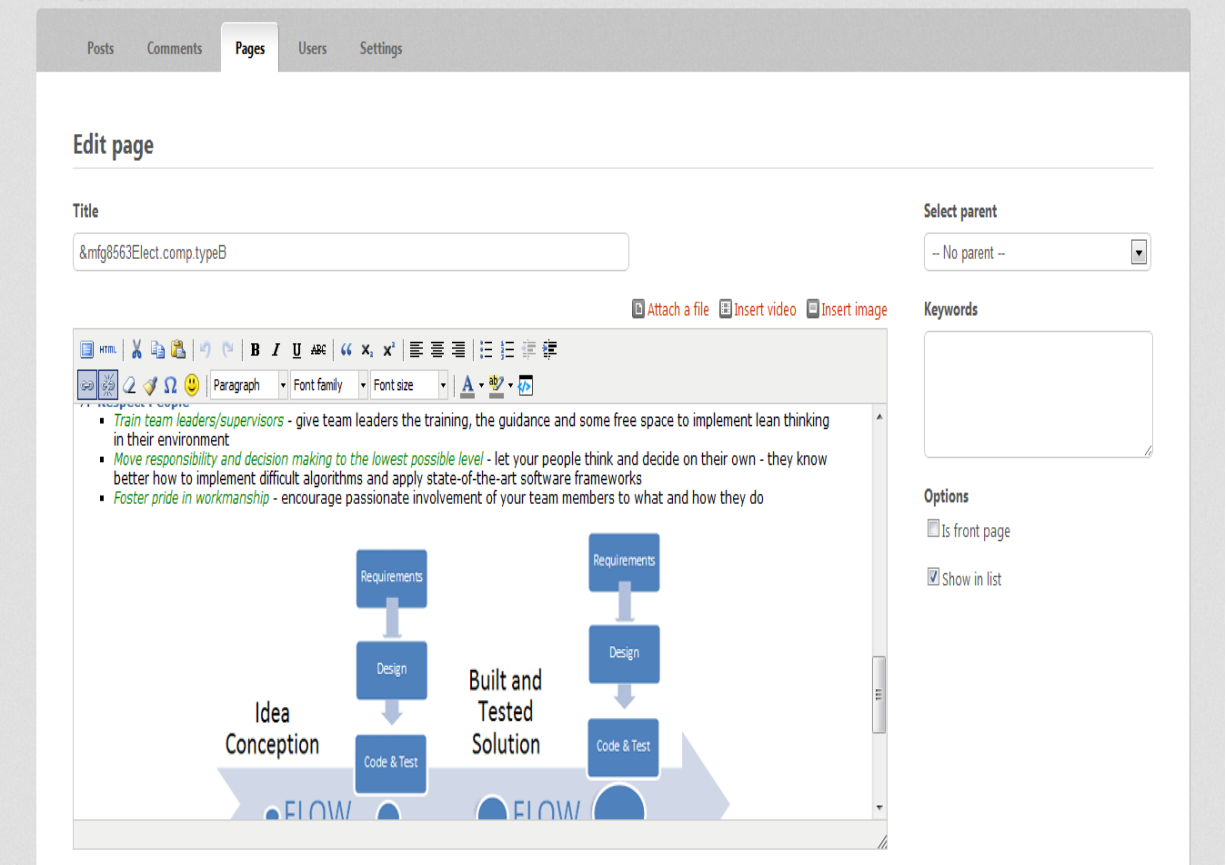

Fig.7 Process editing page, WYSIWYG

Discussion

Process development is an ongoing process. It needs to be developed and improve continuously with time [5]. Also to meet the needs of business and the stakeholders involved in it. Practical experience and researchers found that, process improvement is required to avoid the mistakes and learn from the history or others experience [5]. According to research survey, processes are developed but poorly implemented which ultimately not adding value to the business. In some cases, organization do not move towards the improvement because they do not realize the potential and overall effect, so they were confused about the paying back of a process to organization [4].

There are different thoughts exist in the industry, some realizes the communication gap as a challenge and some think it as a matter of following the right process at the right time [6]. Keeping both of the thoughts we found lean thinking as a best possible approach to deal with the situation. In the initial stage of improvement, we created a list of problems which are not adding value to our customers [18]. This waste can be of several types like depending on the feedback from experts, waiting for other process to be finished before going for the next one, re-inventing the wheel etc.

In the next stage, we try to find out solutions to the problem list that we created in the initial phase. This step was critical as we need to eliminate waste depending upon the baseline created in our meetings with the customers by keeping in view the expectations and goals of our customers.

The challenging part was to gather the requirements because of lack of our direct access to our customers. Along with that we have not seen the current system they are using because of confidentiality of the data and business rules. Both of the above points made the requirement elicitation as a challenging task which we managed by having multiple interviews with method owners.

The objective of the project is to minimize the cost in terms of time by offering an efficient two way communication between engineers and process owners. Companies with in the automotive industry like Toyota, Ford and also from other manufacturing domain like Motorola have achieved large market share by adopting lean methodology [17].

The expected outcome has increased the productivity of the production line with direct communication with method owners and engineers by having textual and visual information about the methods. This has also reduced the response time from method owners to give spontaneous feedback about the methods to its engineers. The results of the pilot project are used as a base for the recommendation of future design and enhancing the current system.

Conclusion

An efficient and effective communication plays a significant role in the business; either it is between all the stake holders or the external factors involved in it. Reading the market trends with upcoming technological shift and react to those needs intelligently and on-time is important to gain the market share [3]. Process improvement is not just picking up a single process for improvement; it requires a change for organization, shifting from current method to new one.

Another important aspect for improvement is to connect all the concern people to the same motivation of expected gain in the business by using new steps involved in it [1].

Engagement of the development team during the development phase of a process leads to standardization in shorter interval of time. Lean approach helped in identifying the wastes in the current process and eliminating them.

The problem statement is very well achieved with the help of base-lined requirements i.e. collaborative environment however there is a need of improvement in the usability of the system. The interface needs to be simple so users can search the required process easily which makes the system more efficient.

Future Work

Process improvement is an ongoing process which needs to be improved continuously [20]. A system is developed successfully with smaller set of requirements because of time constraint. There are more functional requirements which need to be developed in the future release for an electronic proposal box. As it is a research project with fewer people working on it, so it is preferable to do data manipulation using XML files, which could be enhanced to a relational database for larger set of users. Opportunity also lies in the integration of existing network of documentation with the system. For collaboration, it maintains the history of last editing which could be enhanced by maintaining the history of all editing done by all of its users during the development phase. In the evaluation meeting, another demand came up for future development, which is to equip a system with fast searching algorithms for the specific process down into the tree.

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Glossary

Term	Definition
Design Engineer	Someone who uses the processes and provide suggestions
Proposal Box	A repository of suggestions
Process owner	The owner of the process, who evaluates the suggestions of design engineers
Production system	An assembly line for manufacturing products
Stakeholder	Any person who has interaction with the system who is not a developer [25].
Waste	Anything which does add value to customer's business
Dash Board	The main landing page, which gives the overall picture of the draft process, comments and activities
Profile Card	A page which contains feed backs and rating from design engineers
Wiki	A page used for editing/managing purpose of the processes
WYSIWYG	What you see is what you get, approach used to structure a layout of a page
SPICE	ISO/IEC 15504 (Software process improvement and capability determination)
IEEE 610	IEEE standard glossary of software engineering
Process	A sequence of steps performed for a given purpose [IEEE-STD-610]
Process Improvement	A set of activities, method and practices used in a production and evolution of a software [SEI CMM, Humphrey ,1989]
Baseline	A specification or product that has been formally reviewed and agreed upon, that thereafter serves as the basis for further development, and can be changed only through formal change control procedures [IEEE 610]
Certified Concept	Suggestions which are evaluated and become standardized