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Building a Production Module for a Telecommunications Company

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Problem Description

Talens Plisman is a company that works in a telecommunication and service context. It has two ERP applications, external software and internal software. External Software is called Solupyme, it has the generic processes (invoicing, finance, collections, payments…) The Internal software is called Gestelecom, with company-specific processes. The task will be to build the Production Module of Gestelecom. This should be done in the framework of design science, i.e. the new module is the artifact and the need and relevance of the module (compared to e.g. buying an existing system) must be shown. A rigorous evaluation of the artifact should be performed

Assignment given: 15. January 2009
Supervisor: John Krogstie, IDI

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Abstract:

Nowadays the computer science is extremely important in business; thanks to it you can automate tasks, streamline processes and obtain information.

The best resource for the new companies is the information. I mean, today the information is very necessary with the new technologies. Employers who are responsible to decide in their companies, have begun to understand that the information helps their business and also can be one of the best critical factors that can show us if the company work is successfully or not. (1)

In recent years organizations have recognized the importance of managing key resources such as the working hours and the raw materials.

ERP applications are often used to standardize business processes and unify data; the importance of that software in the companies is growing every day. Although we also can say that in some cases the ERP software doesn´t solve some business problems because there are processes that aren´t standard or common.

Moreover, if we would create a module for our company it has to be usable .The usability is very important because that and the automation will help to increase the performance of coordinators.

This project is a study of a particular case of a telecommunications company in which it has found a problem with the production process; In This Project we will be able to solve each problem that will appear in various stages of construction our module.

These steps include: a study about if there are problems in the selected area of business, whether buying or building a new module, heuristic techniques and methods to improve the usability, quality of build module using polls, usability guidelines, use case...

The results have improved the production of the company and the system provides the necessary information to the coordinators but the coordinators want further improvement. The study of the usability helps users to be ready to use the software correctly.

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CHAPTER 1.-Introduction

In this report we will try to develop a study of a necessity in a company and we will define the steps to follow for solve each problem. Consider first the context of the company from its growing and the description of how the company has been growing and the necessities that have had. Also we will do a study of two types of ERP and we will define its characteristics.

If we take as reference the company, we will analyze the necessities within empirical data. We need to found if there is necessity to improve the production process of the current company. Once we decide what we need to improve, we will need to choose (we will make an analysis of alternatives that we will have) between buying or building a production module.

The chosen option is to build a module, because the production process in our company differs significantly with other companies, we can also say that the cost of the module in different ERP studied have been too high and required customization. Once we decide to build a module we will build the module, doing a first capture of requirements that will help us know what they have to build.

We have made the capture of requirements using the diagram BMPN that helps employers to know how to operate in their business and the analyst to know of an easy way and without ambiguity about what the employer wants. Once we have completed the BPMN diagram we have to realize the use cases based on it. To achieve the use cases we will build a template on which we will detail the requirements captured in BPMN diagram to make the restrictions on business and those we found. Once we have done the requirements capture and analysis, we have to make the system design. For this, we have done a study and a guide to improve the usability of our new module, because if we improve usability, we will improve the productivity of the coordinators. This guide also contains other aspects that the company needed (dual monitor, small monitor), so we have remembered these aspects when we have designed the prototypes.

We have decided that for the three-layered structure in which, we define in the GUI layer, the business logic layer in which all the restrictions business and database layer. Between the layers we will put the facade pattern, we will define all the required operations. I also have made object UML diagram to know what features the employees needed to know. The design also try how we will perform two of the use cases studied, the search for a component that provides a navigation map with satellite view and the search for a web service that allows us to know the weather forecast in a region.

Once we have completed the design we turn to the implementation that I've done through the design patterns (Facade, observer) to help us prevent errors. I made a brief explanation of how I have implemented the use cases, if we want to look more closely at the implementation I offer the source code of the application that you can observe it carefully.

Once I completed the project we carried out an analysis of the results of deploying the application, therefore, we have become used to the polls in which a user will think of the new module built.

Finally we will detail the possible improvements to be made using the polls to users of the application and other improvements proposed by the company. Due to lack of time to implement these proposals will be addressed in the next iterations.

CHAPTER 2.-Prestudy:

In the following chapter we will try to describe the company context and we will explain a study of the two ERP types that we have currently.

Company Context

Talens Plisman is a Spanish company of services that works in a telecommunications context. It has around 50 employees and works only in Spain. It is subcontractor of the main national operators (Vodafone, Telefonica, Ericsson, Siemens and Orange).

Figure 1Talens Plisman Logo

The company began in 1997 with one clear aim: to offer installations service with a very competitive price in the new technologies area. In the First years the company started mounting satellite dish to "Digital +" and only it did between 5 to 10 installations per week. Year after Year, the company had been expanding and changed the tasks for "Digital +" to another more complicated that requires one area responsible person who has to coordinate the tasks. The company began working in the Valencian Region. Today the company is bigger. Even it has one office in Barcelona. It is trying to take a strong position in the Spanish market.

Talens Plisman works in the following activities:

- Radio (PDH and SDH)
- Mobile telephony. (GSM / UMTS)
- Point / multipoint (LMDS)
- Solar energy installations
- Professional Services
- Work for the government: ethylometer etc
- Drive Test


Figure 2 Example of installation


Figure 3 Example: Solar Energy Installation

Types of Employees

The company has different types of employees:

- Management is responsible for the strategic decisions and every month they seek information from statistical reports: sales by area, by activity, sales by customer and sales by operator. They have the Strategic Plans for our company.
- Billing is responsible for the delivery invoice produced by Gestelecom and accounting of these invoices and receipts and payments.
- Coordinator is responsible for coordinate Projects. He usually receives a call from the customer and he decides whether to accept the work or not, according to the weekly or monthly charge. If he has not enough work for the week he can ask some customer. Another task of the coordinator is to organize the installers in the best way. The coordinator is the most important if we want to make production module. He has the Tactic and Operation Plans of our company.
- Installer: is responsible for to do the tasks that the coordinators assign to him to do. He must do the work efficiently.

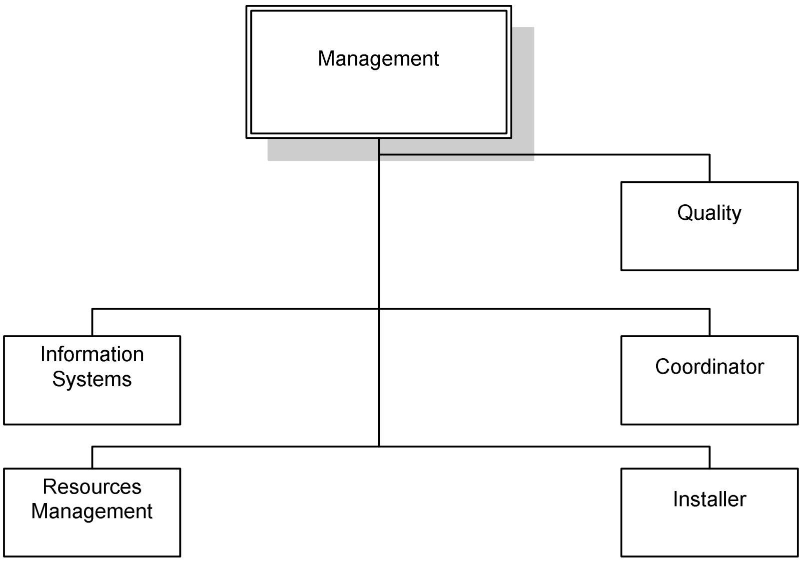


Figure 4 Employees Diagram

Information Systems Context

For the reason that the company is continuously growing the exchange of information is also growing. In the following paragraphs we will explain with details how the company has evolved from its early years to the problems of today in terms of information systems.

In the early years only it used an application done in Access, coordinators inserted every Project that they was doing, the company only carried out the accounting with specific software.

Gestelecom 1.0

About year 2002, Talens Plisman created a software that had two modules: the Delivery Notes management and the Project management called Gestelecom 1.0. It was a software that controlled the Delivery Notes Collected and the Delivery Notes not Collected.

The software was only a simple grid where all of Delivery Notes appeared and the coordinator searched these Delivery Notes using filters. The company had the same accounting software.

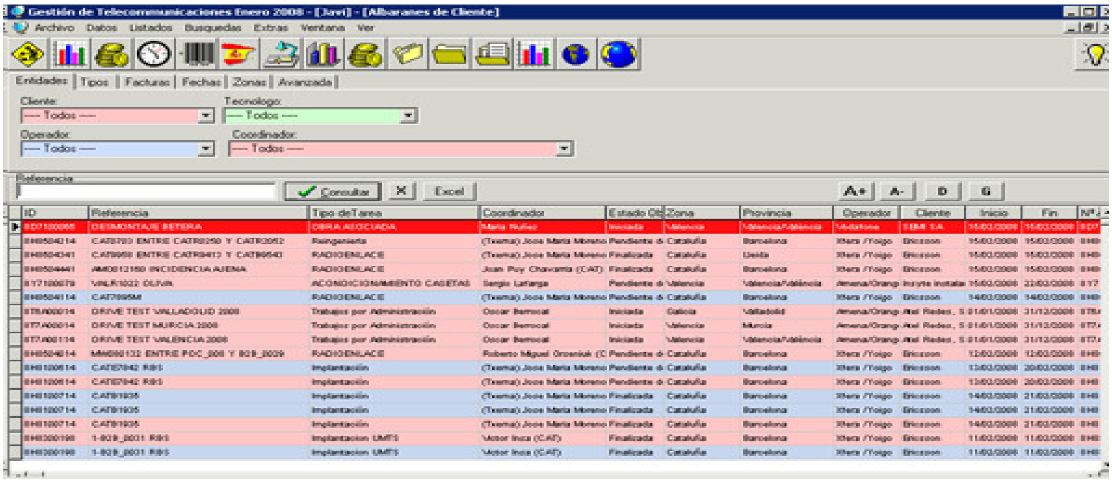


Figure 5 Gestelecom 1.0 Capture

Solupyme

In 2006, the company determined to purchase an ERP software, because due to the large volume of invoices and data to manage the company needed to unify all of its processes, this software is called Solupyme. The company purchased the modules that had common processes: Sales, Purchasing, Logistics, Finance, Statistics, Portfolio and for other modules that would be less standard, the company would decide what it to do. It did a quick update of Gestelecom 1.0 to enable delivery data transfer to ERP software.

Figure 6 Solupyme .Net Capture

The reasons why the company wanted software were because:

- It needed to optimize its business processes.
- To have access to all information in a reliable, accurate and timely way.
- The ability to share information among all members of the organization.
- Elimination of unnecessary data and operations reengineering

Gestelecom 2.0 Update

In 2007, after problems with "Gestelecom", the company decided to do the second version of it to facilitate the introduction of information to the workers. Even I made new modules that the old version did not contain.

- Customer Order Management: are the Projects that we need to do in the company. Usually when a customer needs to do some project, it calls us and we may accept to do this project or not.
- Human Resources Management: contracts, layoffs, holidays, renewals.
- Installers Management: We need to organize the installers in groups and to know where they are in each moment.
- Pricelist management: Customer fixes the sales price and Talens Plisman may or may not accept the offer. Usually, in another companies, they fix the sales price. This is another reason why the second version of "Gestelecom" is built. Furthermore, we need to compare if we can gain with the projects. For this reason we calculate the profit that we want to gain with a customer. In Pricelist management we can guess if an installer is productive or not, we compare his productivity with his expenses (salary, travel expenses).

Project context

The project is based on studying the need for a new production module for the company or the possibility of acquiring a software package that will solve the problems that the company currently has in terms of production. I will tell more about it in the next chapter.

Study of two Enterprise Resource Planning

In this section we will revise the main features of the two kinds of ERP that exists currently.

The first ERP is Open Bravo that is an ERP opensource software. Open bravo is installed in a web plataform. The cost for adcquiring this software is completely free, but because of the great complication of implantation of the application, there are companies that assist in the implementation of the software where we will need to pay it.

The second of these that we will analyze is SAP. SAP is not open source software and is a win32 application. The cost of acquiring this software is via annual licenses.

Openbravo: Main features. (2)

Its functional coverage includes all areas of an integrated management system.

Additionally, this same application seamlessly integrates the rest of the areas, starting with a management scope directly helping clients with its CRM (Customer Relationship Management), BI (Business Intelligence), and POS (Point of Sale).

Master Data Management

Products, components, bills of materials, customers, vendors, employees etc.

The correct management of the master data of your company (products, customers, vendors, etc.) is a fundamental aspect for guaranteeing the coherence and tracking of processes. Maintaining exclusive coding, avoiding duplications, and sharing the relevant information among all areas of your company is one of the challenges faced today by all types and sizes of organizations. Openbravo ERP helps you to organize and centralize the key data, facilitating the rapid and easy flow of information among all areas implicated in different company processes.

Procurement Management

Rates, purchase orders, goods receipts, invoice registration and accounting, purchase planning, etc.

Openbravo ERP's handling of the flow of supply guarantees the integrity, tracking, and homogeneity of the entire process. Each document in the supply process is based on the information contained in the previous document, so that repetitive introduction of data and human errors are avoided. In this way, it is possible to navigate through different documents that conform to a determined flow (order, goods receipt, invoice, payment) and know in real time the state of any given order (pending, delivered, partially delivered, invoiced, etc). The natural integration of this process with accounting guarantees that the finance department always has up to date and reliable data at its disposal.

Warehouse Management

Warehouses and bins, warehouse units, lots, serial numbers, packages, labels, receipts and deliveries, movements between warehouses, inventories, stock valuation, transport, etc.

The warehouse management processes built into Openbravo ERP allows the inventory in your organization to always be up to date and correctly valued. The possibility of defining the warehouse structure of your organization to unit level (storage bins) facilitates the exact localization of your stock at any time. Additionally, the capacity for managing product lots and the possibility of using serial numbers assure compliance with the tracking requirements imposed by the majority of industries.

Project and Service Management

Projects, phases, tasks, resources, budget, expenses and expense invoicing, related purchases, etc.

This functionality is orientated towards companies whose activities are based on the delivery of projects and services. With relationship to projects, Openbravo ERP allows for the management of budgets, phases, tasks, expenses and purchases related with each individual project. These projects may be related to monitoring construction projects or even sending out and sales and purchase related requests. The service component permits companies to define services and resources and control all activities. These activities may or may not be billable, for internal or external customers, and be monitored for incurred expenses at a detailed level.

Production Management

Plant structure, production plans, BOM's, MRP, manufacturing orders, job reports, costs of production, work incidences, preventive maintenance types, etc.

The production functions and plant management in Openbravo ERP allow a complete shaping of the productive structure of each organization (sections, cost centers and work centers) as well as the relevant data for production: production plans (operation sequences), and products used to make one another. Currently, the functionality provided by Openbravo ERP is orientated towards covering the usual necessities of a discrete production environment: production planning and requests related to procurement using MRP, creation of manufacturing orders, job reports (notification of times and consumption), calculating costs of production, notification of job incidents and maintenance reports.

Openbravo has the following features in the production module.

- Plant structures.
- Homogeneous Functional Groups or Cost Centers.
- Work centers and machines.
- Materials Requirement Planning (MRP) keeping in mind client requests, existing clients, stock levels, and minimum order quantities.
- Production plans, with multiple arriving products and multiple departing products.
- **Production orders.**
- Sequence creation and products for each order phase.
- Confirmations with data relating to the production plan and pre-filled sequence.
- Calculation of production costs with the possibility of adding indirect costs.
- **Work incidences.**
- Types of equipment and management of each piece of equipment.
- Preventive maintenance and maintenance types.

Sales Management and Customer Relationship Management (CRM)

Prices, rates, varying quantity sales orders, shipments, invoicing, volume discounts, commissions, CRM, etc.

The functionality of Openbravo ERP in the Sales Management module is expressly designed with the objective of allowing maximum flexibility and adaptability in its execution, needed in any commercial process. It is possible to link documents (orders, shipments, invoices) in any order that the company requires or even disregard any one of these that is not necessary. All this is achieved without sacrificing the coherence and integrity of information and guaranteeing the tracking of processes. The capacities of integration with order capture systems by PDAs extend the potential of the solution beyond the physical limits of the particular company.

For multi-store retailers, the system can be seamlessly integrated with Openbravo POS.

Financial Management and Accounting

Chart of accounts, accounts, budgets, taxes, general accounting, accounts payable, accounts receivable, bank accounting, balance sheet, P&L, fixed assets, etc.

The financial management and accounting functionalities are designed to minimize manual data input on behalf of the user, thereby freeing them from tedious, routine tasks and allowing greater focus on other, more value added tasks. This increase in productivity is due to the financial department acting as collector of all the relevant actions generated from the other management departments. This occurs in such a way that these have an automatic reflection in the general accounting, in the accounts receivable and accounts payable as soon as they are produced.

Business Intelligence (BI)

Reporting, multidimensional analysis (OLAP), balanced scorecards.

Nowadays, business organizations handle a great deal of data in the practice of their business activities. This does not necessarily mean that they have available to them the necessary information for the management of their enterprise. The BI component of Openbravo ERP, integrated into the management system, will help you to monitor of the state of your company, providing you with the relevant information for decision-making. The predefined balanced scorecard will allow you to verify, through the monitoring of a series of key indicators, if the defined strategy is being correctly implemented in your organization.

Other characteristics

Usability, security, easy of integration, modularity.

The system has been designed to ensure a superior and productive on-line user experience, while being securely accessible from anywhere. Integration with other solutions and extensibility by third parties is also possible.

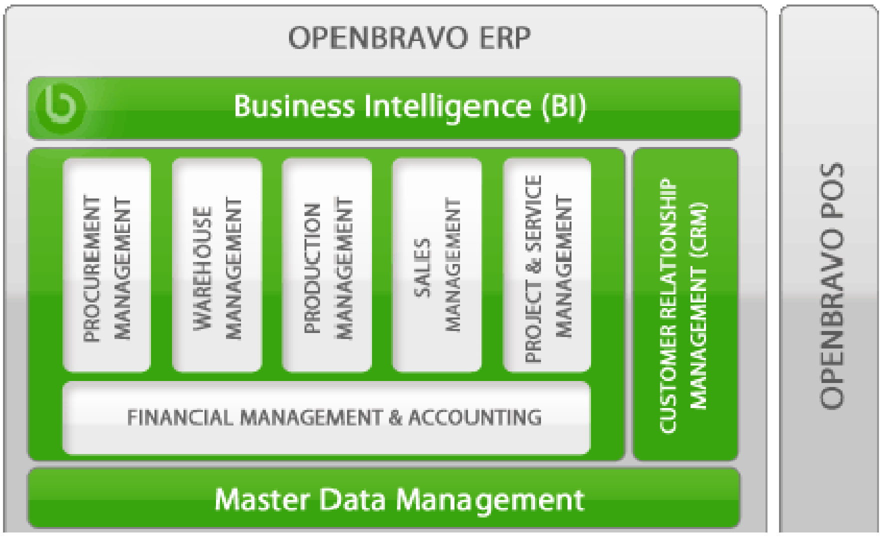


Figure 7 Openbravo structure, http://www.openbravo.com/product/erp/features/

SAP Main Features. (3)

SAP Business Suite is modular enterprise software that supports end-to-end industry processes. This means SAP can effectively coordinate business and IT strategies at the same time. Comprehensive business process support, with industry level specificity, helps to execute strategies that save operational costs or stimulate productivity, without the complexity of managing multiple technology platforms.

CRM

Business and IT decision makers can use SAP Business Suite applications to improve visibility into mission-critical business processes – and incrementally expand and innovate without disruption through proven, built-in best practices for access to information anytime, anywhere.

More than ever, in today's challenging business environment, best-run companies are staying focused on their most valuable assets – their customers. Companies seek to retain their best customers and maximize the effectiveness of every customer interaction – whether it's sales, service, or marketing.

Unlike other CRM software, the SAP Customer Relationship Management (SAP CRM) application, part of the SAP Business Suite, not only helps you address your short-term imperatives – to reduce cost and increase your decision-making ability – but can also help your company achieve differentiated capabilities in order to compete effectively over the long term.

- Marketing
- Sales
- Services
- Contact Center
- E-Commerce

SCM

You face enormous pressure to reduce costs while increasing innovation and improving customer service and responsiveness. SAP Supply Chain Management (SAP SCM) enables collaboration, planning, execution, and coordination of the entire supply network, empowering you to adapt your supply chain processes to an ever-changing competitive environment.

SAP SCM is part of the SAP Business Suite, which gives organizations the unique ability to perform their essential business processes with modular software that is designed to work with other SAP and non-SAP software. Organizations and departments in all sectors can deploy SAP Business Suite software to address specific business challenges on their own timelines and without costly upgrades.

SAP SCM can help transform a linear, sequential supply chain into a responsive supply network – in which communities of customer-centric, demand-driven companies share knowledge, intelligently adapt to changing market conditions, and proactively respond to shorter, less predictable life cycles. SAP SCM provides broad functionality for enabling responsive supply networks and integrates seamlessly with both SAP and non-SAP software. The application:

- Delivers planning and execution functions that are integrated by design
- Supports best practices and provides preconfigured software for enabling collaborative business, accelerating implementation, and reducing costs
- Is recognized by key industry analysts as the market-leading SCM application

Planning

Real-time demand and signal-based replenishment need to drive supply chains. Companies need to balance supply and demand and run their businesses based on actual-versus-forecasted demand.

With SAP SCM, you can model your existing supply chain; set goals; and forecast, optimize, and schedule time, materials, and other resources with these planning activities:

- Demand planning and forecasting
- Safety stock planning
- Supply network planning
- Distribution planning
- Strategic supply chain design

Key Planning Benefits of SAP Supply Chain Management

SAP SCM enables you to:

- Increase demand accuracy and order fulfillment satisfaction levels
- Reduce inventory levels and increased inventory turns across the network
- Increase profitability and productivity
- Integrate sales and operations planning process

Execution

To meet the challenges of rapidly changing market dynamics, your company needs to synchronize all logistics, transportation, and fulfillment operations in a 24/7, always-on, environment.

SAP SCM enables you to carry out supply chain planning and generate high efficiency at lowest possible cost. You can respond to demand through a responsive supply network in which distribution, transportation, and logistics are integrated into real-time planning processes. Features include:

- Order fulfillment
- Procurement
- Transportation
- Warehousing
- Real-world awareness
- Manufacturing

Key Execution Benefits of SAP Supply Chain Management

With SAP SCM, you benefit from:

- Improved order, production, and execution tracking with RFID-enabled processes
- Seamless integration and global visibility of different transportation process steps, and higher transparency
- Improved warehouse efficiency and extend real-time visibility and control of warehouse operations
- Reduced costs of goods sold throughout your company

Collaboration

To meet pressure to reduce costs while increasing innovation challenges, you may do business in regions and countries where costs are lower, develop and maintain relationships with global suppliers, or outsource nonstrategic activities to suppliers. To do so, you must foster collaborative relationships with suppliers, outsource manufacturers, and customers.

SAP Supply Network Collaboration, included in SAP SCM, helps you connect to and collaborate with:

- **Suppliers** – Give them easy and seamless access to supply chain information to facilitate your ability to synchronize supply with demand.
- **Customers** – Provide broad capabilities for replenishment, including min/max-based vendor managed inventory (VMI) and for exclusion of promotions and transport load building.
- **Contract manufacturers** – Provide easy, seamless access to supply chain information by extending visibility and collaborative processes to their manufacturing processes.

Key Collaboration Benefits of SAP Supply Chain Management

With SAP SCM, you can gain these benefits:

- Streamline collaboration with your suppliers, contract manufacturers, and customers
- Significantly decrease procurement, sales, and inventory costs
- Enhance supply chain visibility and increases overall speed, accuracy, and adaptability of your supply network
- Reduce inventory levels while managing variations in supply and demand
- Improve communications and reduces errors and processing costs

CHAPTER 3. Research agenda/focus/questions, and associated research method/process - with overall work plan.

In the following summary you can see the different stages through which the Project is compound (this stages are the same that the Process software (4)). End users are very important for to make a new application. They have to use it during their day and get used to. For this reason is very important to consider their opinion, so I will do it through with polls.

- 1.- Study of the need for a new production module
  Analyze with empirical data if the company really needs a new production module. Is it necessary to build one module or is it good to buy it?
- 2.- Is it better to buy or to build a new module? In this chapter I will investigate what is the best choice: to create a new module or to buy it?
- 3.- Analysis of the system requirements, What things do we want to improve? What is our final goal? Requirements analysis – Design: The most important task to create a software product is to analyze the requirements. First of all I need to investigate the module subject and his context.
  - To Acquire knowledge
    - To understand what needs to be done
    - What do I want to build? I have to use one model that makes the boss and the directors understand what module we want to create.
    - Why do I want to build?
    - I need to use the best practices (to minimize the error impact of the application)
      - Design Patterns (5)
      - GUI Study (6)
      - Production Process (7)

4.-Design (to apply the best practices in the problem context). How Will I create the software?

To do GUI prototypes (Best practices of GUI study)

- I have to make a poll where can be showed the users opinion and what are their wishes about the software.

- To do UML diagram (Using design patterns)
- To do user cases (Using Production Processes, and Requirement analysis)

5.- Problem solving (Implementation)

- Construction of the application through design
- Possible design corrections
- Unit testing, Application testing and Performance testing.

6.-Application Implantation

- Installation Instructions
- User Manual

CHAPTER 4.-Requirement specification/Problem elaboration

As I have said in the last chapter we want to study if we preffer to buy or to build a new Production Module.This task should be done in the framework of design science, i.e. the new module is the artifact and the need and relevance of the module (compared to e.g. buying an existing system) must be shown. A rigorous evaluation of the artifact should be performed. We will define the requirements that we will build in our project.

The module should have among other things:

- A graphical user interface that fits perfectly with the coordinators. This GUI will help to streamline the management process.
- A module that the coordinator knows what he is doing at all times.
- A module that attempts to consolidate all the common tasks that a coordinator can do.
- A module that is based on standard production processes.
- A study of whether it is better to build or buy the new module
- Get a high level of satisfaction by users.

For do this we will use a research about, if is interesting to acquire a module due to the problems of the company. We will use the historical data that we have in our company to evaluate if the coordinators have necessity to automate the production of the company. We will compare if is better to build or to buy a new module of the company, we will use empirical data and another researches.

Once we have the decision we will build new software and for do this we want to study the necessities of the coordinators, we will use polls. Then when we will do a BPMN diagram to standardize the production process of our company and we will do the user cases basing in the BPMN diagram.

To do the design we will define the layer structure of our application, we will find about usability guide. Then we will do the prototypes in paper and then when the coordinators are satisfied we will build the prototypes in Visual designer. Then we will study the ways to take a map component and we will find a web service that help us to take the weather forecast.

Once we have finished the design phase we will build the software using the user cases and we will put the software in the company. Finally we will take a poll to evaluate the improvement of the module.

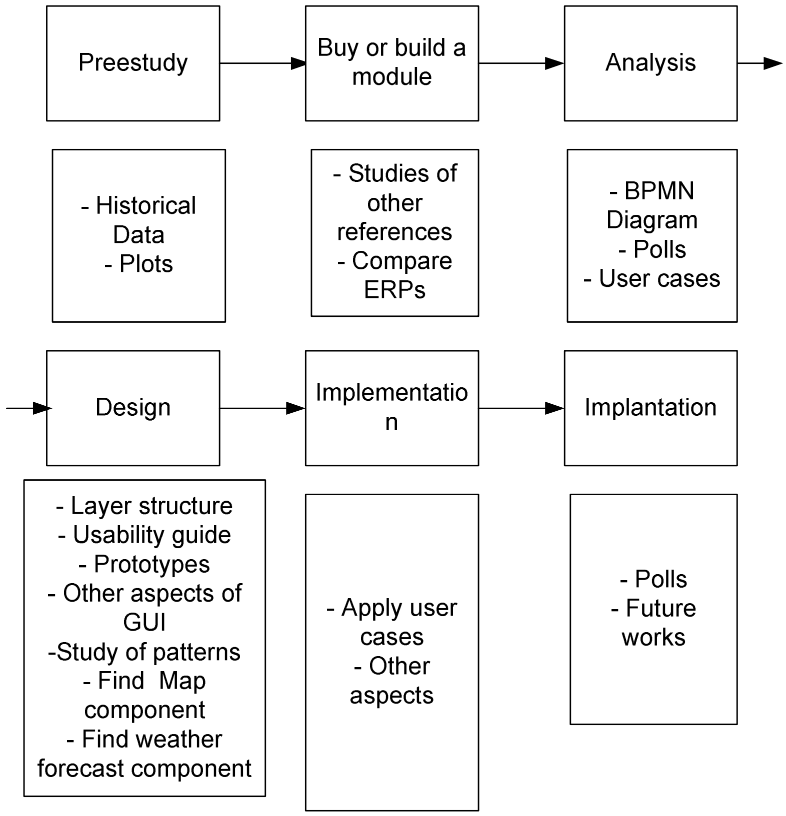


Figure 8 Scheme of the each phase and the artifacts associated

CHAPTER 5.-Study of the need to build or to buy a new production module in the company

In the next chapter we will discuss the need for the creation of a new production module in the company. To do this we will observe in reports that contain the historical data of the company dating back to late 2002.

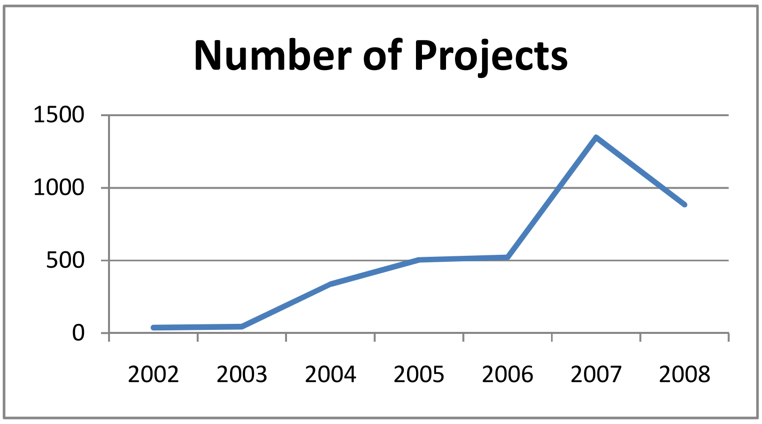
The main reason for creating the new module is due to the existence of a very high repair rate and problems when coordinators are controlling the Projects. We have extracted the following reports which we will consider in the following lines:

- Number of works created each year.
- Number of employees who are in the business year to year.
- Number of repairs (impact) conducted annually by the Projects.

The following diagrams we will explain the data presented.

Year	Number of Projects
2002	40
2003	46
2004	338
2005	505
2006	523
2007	1347
2008	885

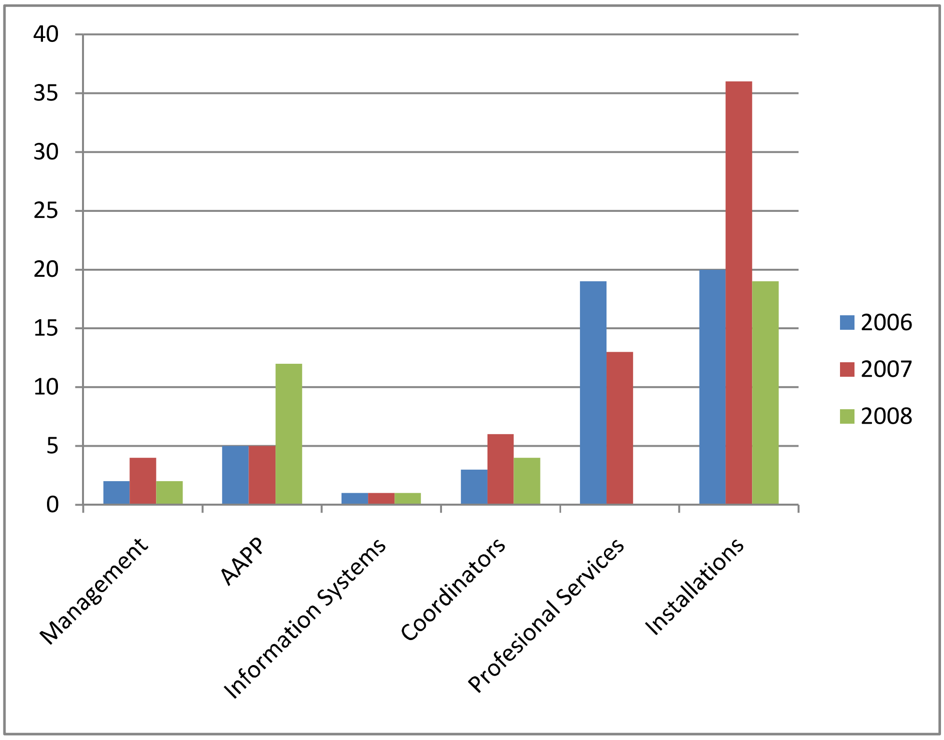
Table 1 Number of Projects per Year



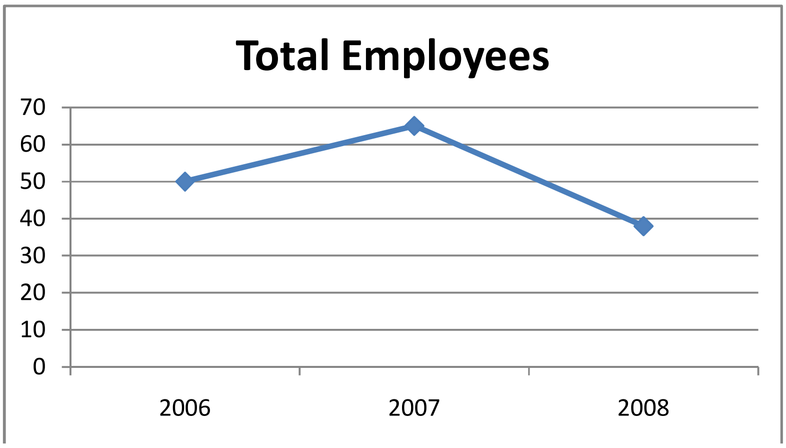
Plot 1 Number of Projects per Year

Year	Total Employees	Management	AAPP	Information Systems	Coordinators	Professional Services	Installations
2006	50	2	5	1	3	19	20
2007	65	4	5	1	6	13	36
2008	38	2	12	1	4	0	19

Table 2 Number of Employees per Year and per Type



Plot 2 Number of Employees per Year and per Type



Plot 3 Total Employees

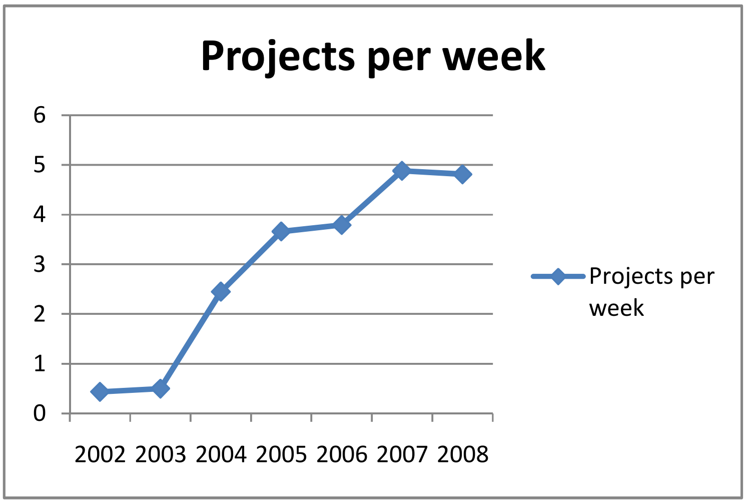
As you can see the company has been expanding year after year with strong growth since 2006. It has also been increasing production, therefore the number of employees each year. We can also observe in the 2008 charts (due to the serious world crisis) that the company was smaller than before and lost production in the Projects.

For example if we calculate the number of works that each coordinator has assigned each week we will have the following information in the next table.

Year	Coordinators	Projects	Working Weeks	Projects per Week
2002	**(2)***	40	46	0,43478261
2003	**(2)***	46	46	0,5
2004	**(3)***	338	46	2,44927536
2005	**(3)***	505	46	3,65942029
2006	**3**	523	46	3,78985507
2007	**6**	1347	46	4,88043478
2008	**4**	885	46	4,80978261

Table 3 Projects per Week/Coordinator

* This data is asked to Management



Plot 4 Projects per week/coordinators

That table above shows that each coordinator during 2002 and 2003 had only a project per week at least, after that, the company has had two projects a week and finally the company has 4 Projects per week. For this reason there are some problems to control the projects.

On the other hand in the following table are showed the tasks that the coordinators have done in the last years. You can see that as the management as the work has been increasing year after year.

Year	Tasks				
2002	Project Management	Install Projects			
2003	Project Management	Install Projects			
2004	Project Management	Install Projects			
2005	Project Management	Install Projects			
2006	Project Management	Install Projects			
2007	Project Management	To Do Project Report	Project Search		
2008	Project Management	To Do Project Report	Project Search	Customer Management	Application

Table 4 Coordinator Tasks Per Year

In the following table you can see the Projects that have been done for Ericsson. Ericsson performed us a quality control and we are rewarded or penalized according to the percentage of clean projects. We said that we had clean projects when these projects don't have repairs. We can see that we has been improved in 2007 compared to 2008 but this is not still enough since there are customers that penalize if we have more than 5% of not clean projects.

Year	Projects without repairs	All Projects	% Projects without repairs
2007	121	145	83,4%
2008	224	248	90,3%

Table 5 Projects without repairs

We also discussed the new contract of a customer requirement in terms of quality measures, in which selecting a specific period, we currently lose money due to penalities that we would have if we have this not clean project's rate.

Questionnaire

Nowadays the company decides to realize a questionnaire (you can see the template in the appendix) that asks to employees what stuff needs to improve in the company and what modules would improve each employee, due to the growing explained before.

Questionnaire results.

Number of respondents: all main stackeholders.

Provided data:

- Four respondents indicate that we must improve the production department.
- 100% of respondents said that they have information problems.
- As for other weakness it detects lack of communication between departments and lack of planning.
- The 66% of respondents assessed the current situation of the company as good but can be improved in the aspect of information and the 33% assessed as normal and need an improve of reports and information.
- Only the staff not directly involved (finance) believes there is no need for the building or acquisition of module with this features.

The company proposes some solutions. One of this is that there is communication by email from each of the decisions made that are interdepartmental, another solution is to build or buy a production module that can solve the existing problems between HHRR and Production (holidays, renewals).

Conclusions

In the last year coordinators had so many problems since they needed to know information. They needed to control where is each installer, what was each installer doing or if a customer called them to do some work they needed to know if they had enough free slots to put this work. Other problems were when the installers should take holidays or how I can measure if an installer is better than another or if an installer never works. Probably, Talens Plisman has lost much money and prestige of their customers because of these problems.

Due to the large growing of the company and the problems outlined above, this company wants to have under control the production.

After having carefully studied the historical data of the company, I conclude that it is very urgent for the development or acquisition of a new production module that fits as closely as possible to the policy of our company and work for the following reasons orderly most to least importance:

1.-New demands from customers: Due to the global crisis there is much competition between the companies and customer demand increases, therefore customer requires Projects perfectly done so we have to be controlled production through a module all the Projects done.

2.-Excessive work of the coordinators: the work of the coordinators has increased steadily over the years and today it is impossible to memorize all the projects, for this reason has become impracticable by the coordinator and he has led so many problems when he wants planning a task or to do project management.

3.-Improving the quality of the company: the company wants to increase the workload and the quality of their work, so the company needs the creation of management elements that help us to find where is the problem and who is responsible of the problem.

What must be developed, what does the company want to do, if it bases on the above conclusions?

- The Talens Plisman management wants to know if an Installer is productive or if an installer needs to improve her knowledge in a numeric measure or Key Performance Indicators. I need to seek the algorithm or procedure to calculate these Keys.

- The Talens Plisman coordinators want to make a weekly plan about what each installer is doing and where is them and view in a picture each organization. It is connected with Human Resources Module (Contracts Management, Holidays...)

The following figure shows an Example Form that coordinators want to view. The green and Purple Squares are tasks (e.g. installation).

	05/01/2009	06/01/2009	07/01/2009	08/01/2009	09/01/2009	10/01/2009	11/01/2009
Installer 1	OBRA0036	OBRA0070					
Installer 2	OBRA0070	OBRA0070	OBRA0070	OBRA0070	OBRA0070	OBRA0070	OBRA0070
Installer 3	OBRA0085		Holidays	Holidays			
Installer 4	Holidays	Holidays			Holidays		

Figure 9 Coordinator's timetable

CHAPTER 6.-Build a new module or buy a module?

In the next chapter I will try to decide whether to create a new module or buy a new software module always knowing that we have the following elements:

ERP Software has the standard modules of the company: Sales, Purchasing, Finance, Costs, Logistics.

Development software and components: Visual Studio 2005, Devexpress.

Firstly, we will discuss how a production module should operate in the company; therefore we rely on several aspects:

- This company is a service company. These are not manufactured articles but these are installations which include possible external factors that must be taken.
  - The installation is paused due to a complaint by neighbors
  - The installation is paused due to a weather
  - The installation is paused due to a lack of material by the customer
- It is very difficult to perform a short-term planning without having to change after the planning due to some problems.
- The company has a slightly different way of operating compared to other companies. The customers are who provide articles and decide the prices to our company and finally it decides whether or not to sign the contract.
- As a service company is extremely difficult to measure the productivity (7) of its workers.

Polly S. Traylor (8) in an article published on February 13 2006 at InfoWorld, which has been discussing in various scientific texts such as "T*he Factors to consider before building your own DAM* Cheryl Scheer", wonders whether it is better to build or buy IT applications. "Should you license a commercial enterprise application that will meet 75 percent of your needs, or would it be nobler to build your own application, one that will track as closely as possible to the task at hand". The Polly s. Traylor's answer is clearly defined, "Buy when you need to automate commodity business processes; build when you're dealing with the core processes that differentiate your company".

We will collect and analyze the advantages and disadvantages of buying and building and we will do a study of what would be the best option.

Buy

- Advantages
    - We have less time in implementing the software
    - Applications that use standards, if we decide to purchase the software using standard processes, we will help reduce the workload of the processes. “Everybody knows that the more standardized you are and the more you buy off-the-shelf, the more cost effective it will be for both” (9)
- Disadvantages
    - Cost. If we buy the software we would have to pay expensive licenses every year.
    - For Large organizations is needed but for small organizations is impossible due to process complexity and cost.

Build

- Advantages
    - If the software that we want to deploy is very different from the standards is a good option
    - The cost may be lower than if we decide to buy the software and in many cases they must pay an expensive annual license
    - “Where we tend to invest is where we can get incremental revenue or competitive advantage”.
- Disadvantages
    - Development time: the need to create the module can require more time.
    - The use of standards depends on the developers and in many cases without a previous study they often perform unnecessary operations in the processes that lead to unnecessary tasks.
    - Possibility of losing a business opportunity because of development time. Developing an application takes time and perhaps the company change it business throughout this period have lost an opportunity.

In the state-of-the-art section we have seen two ERP, and in the following section we will analyze two ERP, an open source ERP (Openbravo) and one of the most important moment, SAP, and three ERP that is currently used along with the proposal to build a new module, we will define the characteristics of each option and we will draw a summary table with the conclusions.

Conclusions

In the following table we can see a summary of the costs of each ERP. If we consider that we already have an ERP software installed it seems risky to reconsider the change of software. Anyway here you can see the study of the costs.

Software	Cost	Description
Nefepyme (10) **(Openbravo)**	34000€+customization	It would take all the modules but the standard production modules should suffer a severe customization.
SAP	Inaccessible cost	It would take all the modules but the standard production modules should suffer a customization and adaptation.
Current Software (Solupyme + Gestelecom)	12000€ + Gestelecom (2340€)	It involves having all the standard modules and is necessary to build the production module.

Table 6 Summary cost of the diferent types of ERP

CHAPTER 7- What Do I Want to improve? SYSTEM ANALYSIS

First contact

After we decided to create the production module we have to think about what things we should manage and improve in the company. We relied on the following tasks to perform system analysis, in the left column you can see a description of each task and on the right column the name of the artifacts (documentation). (4)

Task	Artifact
List candidate requirements	Features list
Understanding the context of the system	Business model or domain model and system approach. (BPMN model)
Capture functional requirements	User case model GUI Prototypes
Capture non-functional requirements	Supplementary Requirements

Table 7 Artifacts and tasks in system analysis

List candidate requirements

Firstly, we have made a list of individual improvements made to the people involved in the module. In this list there are details about what is good to improve and the likely problems that can be when there is not enough information. After this, is good to organize a meeting to argue and try to make a brainstorming together about the new production module.

The following is a summary of the problems what the coordinators have following the data polls:

- Problems with the week planning.
- Problems to know where are the sites
- Problems with planning the installers projects
- Problems to know when who have holidays
- Problems to know the workers productivity
- Problems with planning external factors like the weather (the rain can suspend the task)

We have detailed the coordinators problems, so now we need to show the requirements that the new module would have in our system. For this reason is very important to expose the requirements of the new module.

Requirement Engineering, Business Model, System approach

The consequences of not capturing requirements are detrimental to all actors. Analysts do not know what the customer wants and they cannot know delivery deadlines and customers spend so much money.

Requirement engineering has an important role in the process of software production, with focus on defining what we want to produce, generate accurate specifications that clearly describe unambiguously the system and consistently the behavior of this.

I need to know exactly what the company wants. I also need to know the software requirements for to build our artifact. This type of requirement (functional requirements) specifies something that the delivered system must be able to do. Another type of requirement, Non-functional requirements, specifies something about the system itself, and how well it performs its functions. Such requirements are often called, or 'performance requirements' or 'quality of service requirements.' Examples of such requirements include availability, testability, maintainability, and ease-of-use.

A collection of requirements define the characteristics or features of the desired system. A 'good' list of requirements generally avoids saying how the system should implement the requirements, leaving such decisions to the system designer. Describing how the system should be implemented may be known as implementation bias or "solution engineering". (11)

Therefore we need to capture the requirements in the analysis phase to ensure the production module as well as possible.

How will we capture the requirements?

In recent years several authors (12) (13) (14) (15) (16) (17)have recognized the importance of modeling the organization before to elicit the requirements of its information system. Among the different languages and notations that appeared to define business processes we highlight BPMN. BPMN was developed by BPMI currently integrated within OMG. Due to the wide support he is receiving in the industry, BPMN has positioned itself as the future standard for modeling business processes.

The primary goal of BPMN is to provide a notation that is easy to understand for all users of business processes. This includes analysts' organizational processes that create the initial versions of business models, the developers responsible for implementation that will accommodate these models in the form of information system, or those responsible for directing and managing the processes. Thus, BPMN creates a bridge between the standard business model and its implementation. The notation is basically a diagram, called BPD (Business Process Diagram), which is based on techniques for creating flow charts of operations models of business processes. Se puede ver en el apéndice cómo usar la notación con BPMN.

A BPD is created from a set of graphic elements that make development possible diagrams that are easy to understand both the business analysts to the system. This set is divided into flow objects, connection, pool items, and artifacts (18).

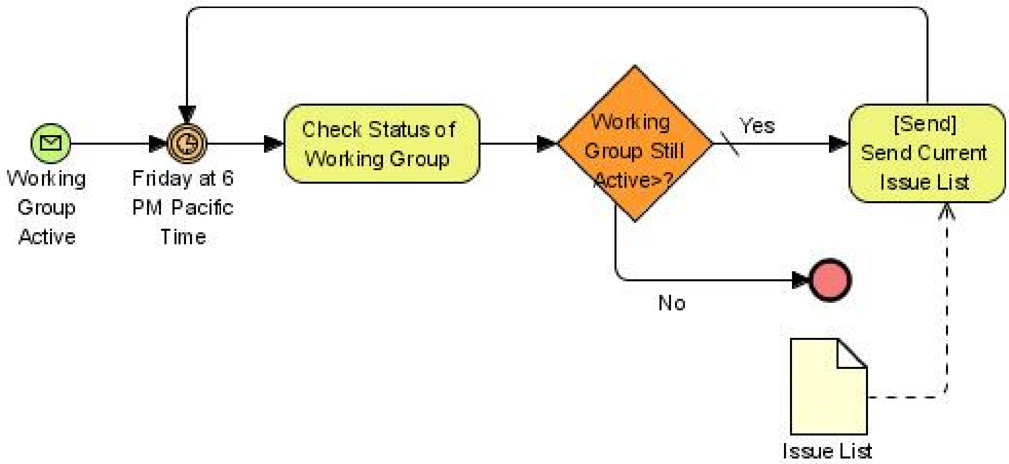
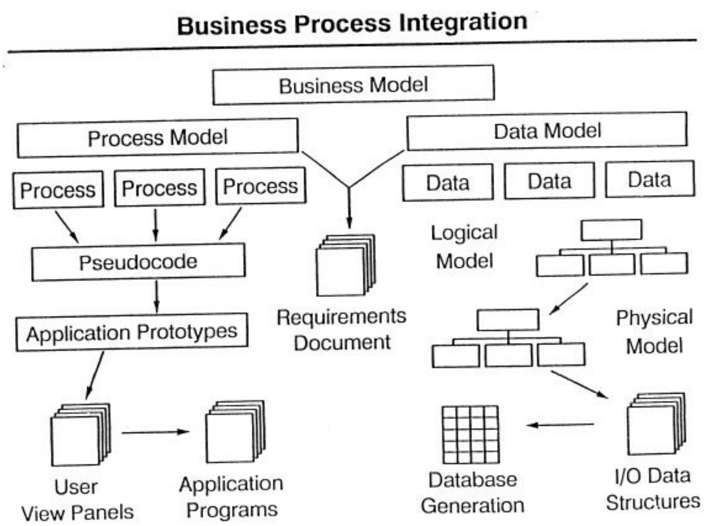


Figure 10 BMPN Example

In the following figure you can see the interaction between Process Model, Data Model and Business model.



(19)
Figure 11 Business Process Integration

For this reason, we are going to start to define together what artifact we want to build in our company, we will work in BPM.

In the next sheets I'll present the diagram and I will describe how the diagram is.

The customer has the need to do a project and it calls to one of our coordinators. Also the coordinator (if he has availability) can ask to the customer if he has projects available. The coordinators will call with the customer and they will check if there is availability. If the customer and coordinator are agree, the coordinator will create the project. From that moment on the coordinator will do two tasks, the first (production task) will be to assign employees and tasks to the Project. When the coordinator assigns tasks to the project indicate the employees to perform the task and the start date and end date of the task. In the second task (invoicing task) the coordinator will do a budget of the cost using the customer item list. The customer will respond if the budget is correct or not. Once the budget is done, the coordinator will make a delivery note and he will send it to the client, the client will respond if the delivery is correct or not. While the installers are doing the work, they have to take photos. After, the installers have to send the pictures to the coordinator when the work is finished, because they have to demonstrate both customer and company that they are doing the works correctly. Finally, when all tasks have been completed, the coordinator will end the project and he will send a notification to the customer. The customer will do assessment of the work and if there are repairs he will notify to the coordinators. The project won't end if there are repairs to solve. Once the project is finished the company will send an invoice that the customer must pay.

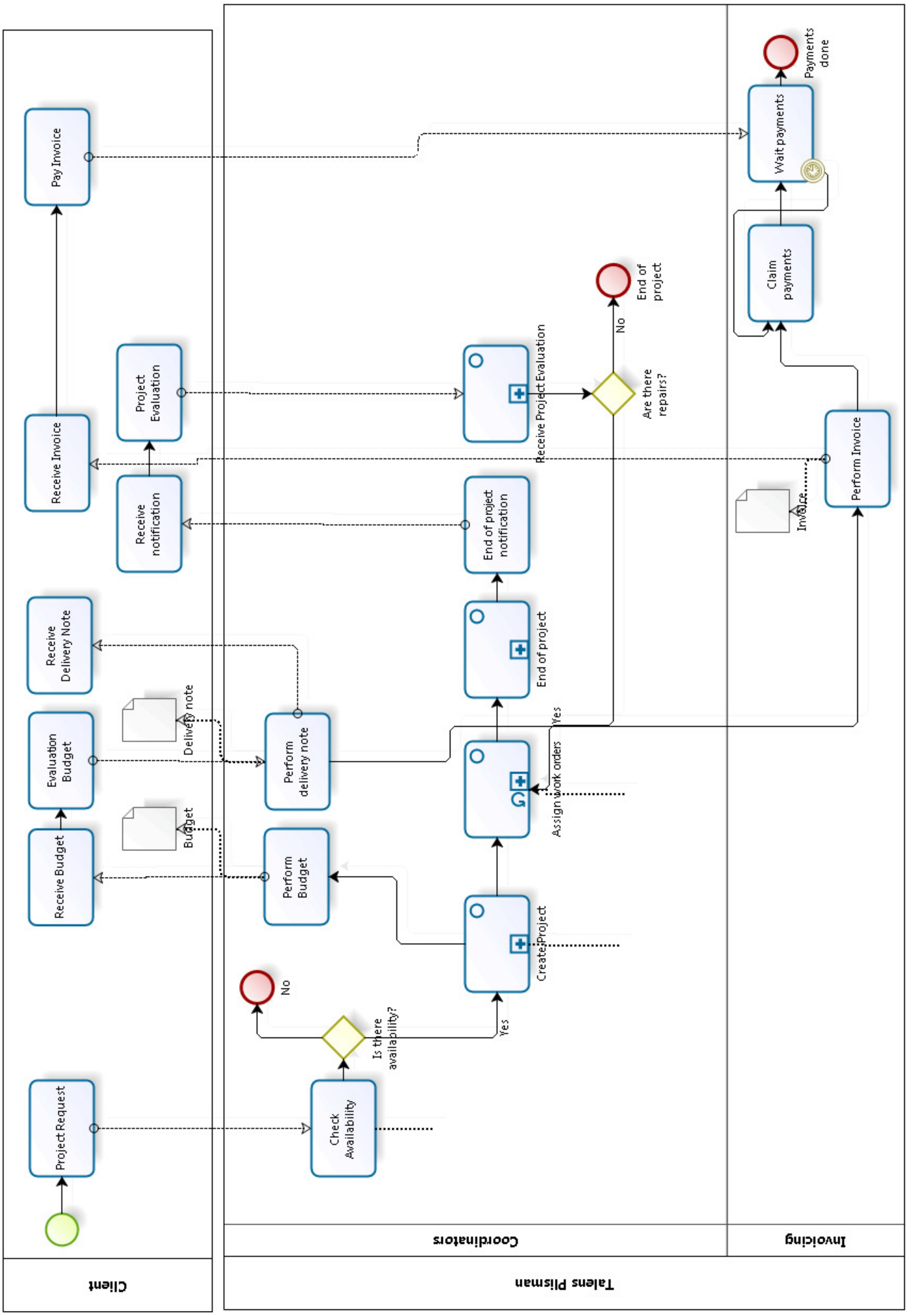

Client
Talens Pilsman
Coordinators
Invoicing
Project Request
Check Availability
Is there availability?
Yes
No
Create Project
Perform Budget
Budget
Receive Budget
Evaluation Budget
Assign work orders
Perform delivery note
Delivery note
Receive Delivery Note
Yes
End of project
End of project notification
Receive notification
Project Evaluation
Receive Project Evaluation
Are there repairs?
No
End of project
Receive Invoice
Pay Invoice
Perform Invoice
Invoice
Claim payments
Wait payments
Payments done

Figure 12 BMPN Diagram (Production Module)

Capture functional requirements

Once we have made the BMPN diagram we met the company and I to try to capture the requirements system. We used the use cases to perform the capture of requirements, as we had the BPMN diagram we had the requirements but in a generic way.

The diagram of use cases will provide us to describe in detail way each of the requirements that we will perform with the company, to enable this task we performed a table (4) in which with the help of the company draw up every feature that may contain each requirement.

We show the model table.

RI–01 Requirement name	
Associated requirements	
Precondition	
Description Requirement	
Actors	
Specific Data	
Business restrictions	
Post condition	

RI–01	Check Availability
Associated requirements	--
Precondition	--
Description Requirement	The coordinator must find out if there is availability in the week in which the client wants to do the project. If there is availability and the project can be done, the coordinator will say that they can accept and do the project to the client. Otherwise he must say that it

	cannot do the project or renegotiate with the customer.
Actors	Coordinator, Customer
Specific Data	$\frac{Worked\ hours}{Working\ hours}$ (Worked hours will include holidays hours.)
Business restrictions	---
Post condition	---

RI–02	**Create Project**
Associated requirements	RI-01
Precondition	There is availability
Description Requirement	The coordinator must create the project. To do this the customer must send via email or telephone the project data. The customer must tell the coordinator of the planned end date because it will be very important to put a date to the coordinator on project planning.
Specific data	Project Name Region Item list negociated between the company and the customer Coordinates project Planned start date Planned end date Operator Technology Technologist
Actors	Coordinator, Customer
Business restrictions	To manage the system the coordinator needs to have the following

	fields. Project Name Region Item list Planned start date Planned end date Operator Technology Technologist Other constraints: The planned start date must be before that planned finish date.
Post condition	The system must be updated. The coordinator may establish delivery notes. The coordinator will be able to create tasks. The coordinator may create repairs.

RI–03	Assign Tasks
Associated requirements	RI-01, RI-02
Precondición	There is availability The Project has been created. The task cannot be in a holiday period. The Project is not finished.
Description Requirement	The coordinator must assign the task to installers. When a taks is doing, it will be marked as pending start. When the coordinator mark a task as initiated the installer must be doing the task. When the task is completed the coordinator will mark it as finished.

Specific Data	Project Task state. (Pending start, initiated, finished) Start date Finish date Description Installers associated
Actors	Coordinator, Installer
Business restrictions	A task requires the following obligatory fields: State Start date Finish date The task must have one installer or more. The system cannot have in the same period holidays and tasks. The start date task must be before than the end date task.
Post condition	The system will update automatically all the forms

RI–04	**End Project**
Associated requirements	RI-01, RI-02, RI-03, RI-05
Precondition	All the tasks have been finished and there aren't repairs unsolved.
Description Requirement	The coordinator, once the tasks have been finished and there aren't repairs unsolved, must finish the Project as soon as possible. Once the project is finished, he will send to the customer an email. The customer will check if all the Requirements of the Project are completed. The coordinator must save the pictures that the

	installers have been taking in the repository Project. This repository will be in a folder for each project.
Specific Data	Project End date
Actors	Coordinator
Business restrictions	All the tasks have been finished and there aren't unsolved repairs.
Comments	
Post condition	The system must save the end date as now. The system will update automatically all the forms.

RI–05	**Receive Project Evaluation (Repair management)**
Associated requirements	RI-04
Precondition	--
Description Requirement	The coordinator receives the customer evaluation. This evaluation can have repairs. The customer will evaluate the defects with three levels. High: defects in the project are important: electrical fault, improper assembly, the chassis does not work... Medium: defects in the project are substantial: poor cable connection, bad cables protected... Low: defects in the project are minimal: poor labeling of cables, has not cleared the area... In case of having repairs the coordinator must mark the project as not finished. Furthermore he must add the repairs to the Project. If the Project doesn't have unsolved repairs the Project will be finished definitely.

Specific data	Solve date Description Repair level: High, Medium, Low
Actors	Coordinator, Customer
Business restrictions	To create repairs the Project cannot be finished.
Comments	
Post condition	The system will update automatically all the forms.

RI–06	**Manage holidays**
Associated requirements	RI-03
Precondition	We musn't have any assigned task in the period of the holidays. The employee must have a contract.
Description Requirement	The Human Resources responsible receives a holiday request by an active employee. The human resources responsible will create the holidays period. The system will create a task as holidays and the coordinator cannot delete or edit the task. The coordinator also cannot add a task in the same period of the holidays.
Specific data	Active Employee (Employee currently with contract) Holidays start date Holidays finish date
Actors	Human Resources Management
Business restrictions	Coordinators cannot create a task beetwen the holidays period. Human Resources cannot add holiday periods if the coordinator have planned the tasks. Human Resources cannot modify holidays tasks.

Post condition	The system must be updated.

RI–07	**Manage Map**
Associated requirements	RI-02
Precondition	
Description Requirement	The coordinator wants to see the satellite view of a Project location and the coordinator needs to know the route between the company and the Project.
Specific data	Project name Latitude Longitude
Actors	Coordinator
Business restrictions	-
Post condition	The system will be updated.

RI–09	**KPI installer**
Associated requirements	
Precondition	
Description Requirement	The coordinator and management want to know if an installer does the projects correctly. In case of the installer doesn't do the project correctly the company wants to know why. This requirement is related with improving the quality of the company.

Specific Data	Projects that have tasks in a period.
Actors	Coordinator, Management
Business restrictions	-

RI–08	**Weather Forecast**
Associated requirements	RI-02
Precondition	We need a Project location to know it.
Description Requirement	The coordinador will have the posiblity o have a weather forecast in the currently week.
Specific Data	Name of the project Latitude Longitude
Actors	Coordinator
Business restrictions	-

Conclusions

To make a better approximation of what we have done it will be the module diagram using BPMN among managers of the company and the manager of information systems. This will help us to get a clearer idea of what is needed in the module and how the company operates under the idea of management. Once we have done the BPMN diagram we have more clearly what the coordinators want. We want to describe with more detail the software Requirements, for this we have used the user case with the coordinators.

CHAPTER 8.-SYSTEM DESIGN

In the next chapter, we will describe the best practices for defining the design of the graphical user interface, the structure of the software data and the best practices for the production process.

Application structure

We will realize the aplication using the three layer model. The three layer model will have the following layers.

1.- Presentation Layer: In this layer we will have our Graphical User Interface,this layer will communicate the commands of the users and it will provide a information of the state system. This layer is communicated with business layer.

2.- Business layer: here we will do all the business rules and any restrictions that we will find all the preconditions are to come prepared in the use cases. We also recover the data from the presentation layer needed to display. This is where we store the objects that make up our application.

3.- Database layer: This is where the data reside and is the layer responsible for accessing them. We will use the database manager SQL Server 2005.

To communicate our layers we will use the facade design pattern, we will communicate the presentation layer with the layer of business; we will communicate the business layer with the data layer using ORM Nhibernate (database manager).

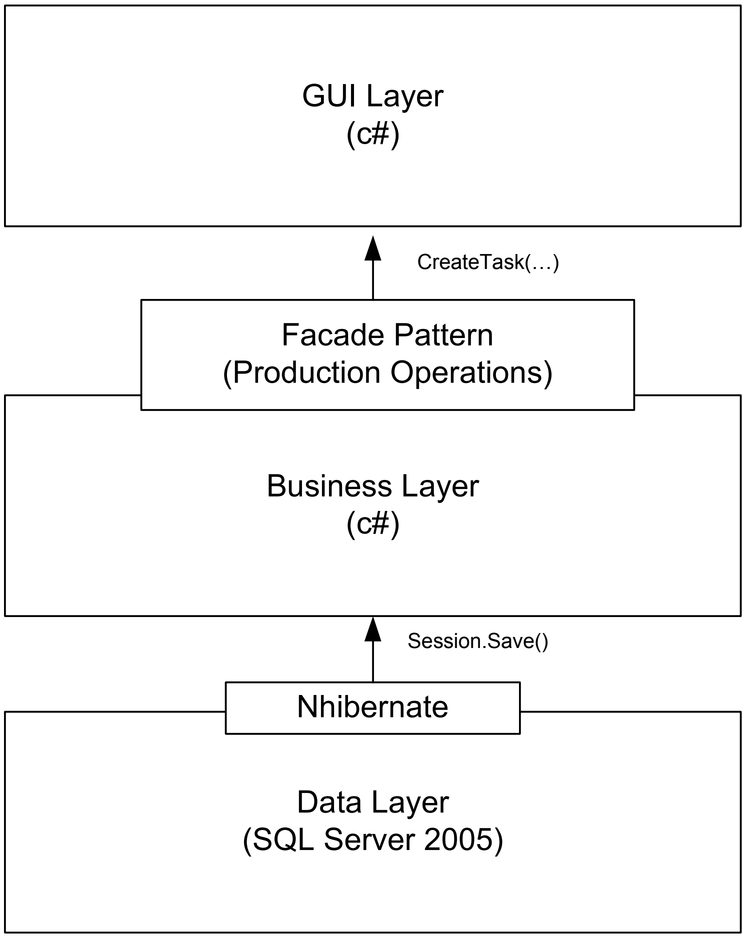


Figure 13 Layer scheme in Gestelecom

To use the facade pattern of the business layer we will use static classes. They have methods that will be able to perform operations. For each module we have a static class. This way of using the classes we will have restrictions in one place and gives us the possibility to develop different graphical interfaces for these methods.

Finally we can say that we have three projects for building our application.

1.-Components: We use the pattern adapter for each Devexpress component because we want to realize some specializations that we will consider in the following chapters. (See the next chapters)

2.-GUI: In this Project we will do the graphical user interface, we will have all the forms. These forms are organized by modules. Each module has a fold.

3.-Bunisses layer: In this Project we will save all of the classes that we will have in our software, furthermore we will save the functionality that we can use in our software. For this we will use the pattern façade to provide an unified and simple interface that it can communicate the business layer with graphical user interface layer For this we will have for each module of these classes.

GUI design

Why do we have to do a GUI study? (20)

The computerization work of the company has led to the need to develop applications for the particular requirements of the company and the workers require them to become familiar with their management. Traditionally it has emphasized the technology instead of the user when we are developing an application. However, the software design has evolved to ensure that user needs are achieved and systems are more intuitive and friendly. Two neologisms allow us to measure the suitability of the software to the capabilities and the limitations of the user: Usability and accessibility. It is intended to disseminate to achieve greater productivity and comfort to users.

The objective of designing the interface for our production module is that nobody is limited in the use of something because of these differences and it can be an application that helps to display information in a simple and intuitive way.

We briefly define what is usability and accessibility according to NIELSEN J (21). The usability of a system is a measure of its usefulness, ease of use, ease of learning and appreciation of the user for a task, a user and a given context. A usable application is that allows the user to concentrate on their task and he doesn't concentrate on its implementation.

A sentence that clearly defines the importance of interfaces is published by NORMAN, D. e n saying that << The interfaces are in the middle. I do not want to concentrate my energy on the interface; I want to concentrate on my work >> (22).

A problem that we encountered when we are designing graphical interfaces is that human beings are different from each other and all user interfaces should accommodate these differences so that anyone would be able to use it without problem.

How can we improve our graphical interfaces?

Improve the usability.

In the model of user-centered development, we believe that an interactive system must meet the demands of users who will use it. So if we want to achieve a good design we start with an analysis of the context where it is developed the job. For this we should analyze the characteristics of users, activities, and the stage where they perform those activities.

Guillermo M. Martinez de la Teja (23), responsible in science of ergonomics empathizes the importance of usability in systems developed specifically for certain users of a company, which it requires a certain level of training and instruction for their use. Usability ensures that the analysis have been included end users, their needs, experience, habits, capabilities and limitations. Furthermore, it allows more efficient use of the application and makes it easier to learn, reducing time and cost in training new users. This also encourages users to less advantage in terms of skills and experience. Also it reduces the mental load of the user[1]. Usability makes application tolerant to human error, allowing an easy retrieval. Besides it ensures that the application is subjectively pleasant. It is very important how the user is using the system, which is the aspect that often determines the degree of usability. The combination of the appearance of the interface with the speed and effectiveness of the response obtained by the user of the system, and support timely and appropriate information that is provided, as well as the language he is familiar, are of great importance for determine whether the system is pleasant and comfortable to wear by the user.

In summary and according to The Usability Professionals' Association.

The benefits of usability include:

- Increased productivity
  - The average software program has 40 design flaws that impair employees' ability to use it. The resulting cost of lost productivity can be up to 720%. (24)
  - Productivity within the service sector would rise 4% - 9% annually if every software program were designed for usability. (24)
  - Office workers "futz" with their machines an average of 5.1 hours each week, costing American businesses $100 billion annually in lost productivity.
  - In our case this point is very important because the company has many coordinators coordinating so many Projects.
- Decreased training and support costs
  - A study of MIS managers found that the training time for new users of a standard personal computer was 21 hours, whereas it was only 11 hours for users of a more usable computer. (25)
  - The training time or in our case is not so important but it can be if we would contract coordinators.
- Reduced development time and costs
  - The implementation of usability engineering techniques has demonstrated a reduction in the product development cycle by 33% - 50%. (26)
- Reduced maintenance costs
  - Every $1 invested in user-centered design returns between $2 and $100. (27)
  - 80% of software lifecycle costs occur during the maintenance phase. (27)
- Increased customer satisfaction
  - 63% of software projects exceeded their estimates, with the top four reasons all related to product usability:

[1] We highlight this point as very important and we want to treat this due to the coordinators have the current problem. (See chapter 5)

- Frequent requests for changes by users
- Overlooked tasks
- Users' lack of understanding of their own requirements
- Insufficient user-analyst communication and understanding

Heuristic Evaluation.

It is the most common way of evaluating the usability of applications. It is based on guidelines, checklists and practical rules are derived from the experience of designers and previous studies of cognitive and psychological principles as well as lessons learned from problems encountered in previous cases. It was developed by NIELSEN y MOLICH (6) and it consists to analyze the conformity of the interface with recognized usability principles.

The following 10 rules proposed by Nielsen usability are:

- Visibility of system status
- Use the language of the users
- Control and freedom to the user
- Consistency and standards
- Error prevention
- Minimize the charge of user memory
- Flexibility and efficiency of use
- Minimalist Design
- To help users to recognize, diagnose and recover from errors
- Help and documentation

Procedures for developing the GUI.

The heuristic evaluation will be carried out by two evaluators to find usability problems. It will be made by a person who creates the interface and other person with knowledge in computer science who is working as a coordinator in the company.

The evaluation session was made over the Internet using a webcam application with the reviser and he will interact with the application. If the evaluator has a problem using some interface elements created for this interface, he will be helpful but he should never be helped until he asks for help, for not to interfere with the normal processes of evaluation.

It is recommended to take notes as you complete the check list. The result of evaluation is a report with a list of usability problems that have been transgressed in the design review of the evaluator in terms of the principle or heuristic proposed above.

Logically, we are looking for experts of usability evaluation and design of user interfaces, but due to company policy, it is impossible to find people skilled in this area. To remedy this shortcoming, I have developed a guide of recommendations for have a minimum idea of usability.

Usability Recomendations. (28)

This section contains recommendations for the ergonomic design of IGUS. It is recalled that the fact that these recommendations are followed does not guarantee the usability of the application.

This recommendations guide attempts to optimize the relation between Operator – Task - Machine in the workplace where It was analyzed ergonomically the IGUS applications.

Presentation of Information

The interface designer has to propose the organization of elements on the screen and between screens, the font, color, use of graphics and illustrations, animations and navigation system.

Organization and distribution

The composition is how to sort and organize the elements of the image in space which gives us the structural format. Speaking of membership implies a certain order with all components participating in it equally. The information in the upper left is the most important since it is the first to be seen, and information on the top right of the lower hierarchy. It is recommended that the immediate as dialogs or warnings appear in the middle of the screen.

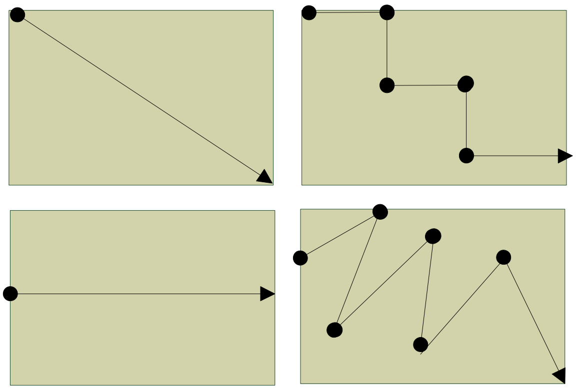


Figure 14 Visual routes in occident

Grouping of information related

Visual resources to gather information are varied, they can relate to the spatial proximity, or similarity, to group through the use of color is not a good agreement and can result in problems for readability, visual fatigue and it may even cause noise in communication process between man and machine.

Substractive Design

It means that you should remove anything that it does not help the visual communication. The display of information is a compromise between the need for the user to have all the information it requires to perform its task and the need to maximize the available space on the screen. It is advisable to select only the important information and not to waste space with irrelevant information. More important than that is information overload, which distracts and impedes the task the user must perform. This guide recommends that the number of sensitive areas is not greater than eight.

The first reason is to be taken which does not have to have a button for each possible task of the operator. These buttons abundance confuses the wasted space and increasing your chances of operator error. The current trend is the simplification of IGUS even for machine control as complex as aircraft have reduced the amount of information displayed to the operator. In our module we won't use more buttons. We only use the basics.

It is advised that there are only buttons for those functions whose result is visually obvious. If the operator does not see any results will continue pressing the button impatiently asking to what's happened.

It is not appropriate to use buttons for actions potentially destructive because it can be activated accidentally. In any real control panel buttons have this kind of physical barriers that prevent accidental activation. We will use a message box that it will have two possible answers and the default will be the least destructive.

Color characteristics

A common error in designing a screen is that it is trying to exploit the possibility of using the color you end up abusing it. This causes confusion to the person who will handle it, because the person is more concerned to adjust its view of the continuous change of color to the content of the information. It can produce optical effects or not harmonious deviations disproportionate attention. We will use only four colors in our module.

The following recommendations aim to improve the criteria for selecting color in an interface:

The color should be used operationally: The main usefulness of having the color in the graphical user interfaces is to highlight the most important information at the expense of the rest, so we can quickly identify the most relevant data. On the other hand a good color management can group the different elements of the screen in collections that they will be associated although they were got far spatially, they will be associated. We apply this point of view of associations and divisions both in physical components of screen and ideas or processes inherent in them. It is also very interesting when we have dynamic information over time as it changes the color when you change the status of information.

We need to use color as a cultural connotations and stereotypes: We must avoid combinations that may cause negative cultural connotations. Colors have psychological properties that act on our subconscious to be considered.

<The following table shows some of the meanings assigned to colors. (29)

Warm Colors	
Red	Danger, fright alarm
Yellow	Caution, Attention
Orange	Action, Caution

Cold Colors	
Blue	Calm, repose, quiet, tranquility
Green	Availability, freedom, protection
Violet	Mourning, spirituality, melancholy

Step wedge	
Black	Darkness, death
Grey	Neutrality, indifference
White	Neutrality, objectivity, purity

This function is reinforced with other communication resources: The color should never be used as a single communication resource. This is because not all humans have the ability to see color.

The contrast figure - background allows readability and to avoid visual fatigue.

It is generally recommended to have a figure with a dark color and a clear color figure that the opposite, because we will win readability. The next table shows that some combinations of colors can be seen as correct and incorrect. For example, the clear colors are well integrated if we use with dark colors, since there is a good contrast, but in other cases if they are not similar, we can combine clear colors among them. If we use dark tones like red and blue presented on the same screen we are forcing the user to an unnecessary effort of reading.

	Red	Yellow	Orange	Blue	Green	Violet	Black	Grey	White
Red	-	-	X	X	X	Ok	Ok	Ok	Ok
Yellow	-	-	-	Ok	-	-	OK	-	X
Orange	X	-	-	-	X	-	-	Ok	Ok
Blue	X	Ok	-	-	X	-	-	Ok	Ok
Green	X	-	X	X	-	-	Ok	-	Ok
Violet	Ok	-	-	-	-	-	-	-	X
Black	Ok	Ok	-	X	Ok	X	-	-	Ok
Grey	X	-	-	Ok	-	-	Ok	-	Ok
White	Ok	X	Ok	Ok	Ok	X	Ok	Ok	-

I have highlighted the colors that I will use. I want to use the red color to represent alert and alarm; I use the yellow to represent caution and the green to represent availability. I combine this clear colors (clear red, clear green, and clear yellow) with black due to I want that my coordinators don't have problems with readability.

The use of color should be consistent: The problem of misuse of the colors is not unique for each different screen. Each screen must be studied individually and examine how well the color is handled between the different screens of the application. In our case I have tried my interface in all of machines that I have and I have asked to each coordinator if they have any problem in the contrast of the colors that I have chosen.

The Fonts in the Graphical User Interface.

We must use the default font of the operating system.

We will use some resources to classify the information: In the communication relationships between the operator and the application, it is essential to a proper hierarchy of elements in the interface. Regarding the hierarchy of the text is recommended to use different font sizes and color before changing to italic or bold.

Icons in the GUI

Verify the need for a set of icons: We live in an age where the image is very important in our environment. However, not all images are necessary nor they have the desired aesthetic and functional quality.

The first thing is to ask whether it is necessary to have some non-alphabetic signs.

We need to select a metaphor and represent it adequately: Users must determine intuitively the use of an object to link it to another real world.

Use appropriate verbal redundancy.

We need to use icons used earlier: we must always contemplate and draw the user's prior knowledge.

In our case we don't have problems because we will use the common operations in our module and we will use the common icons.

Generals principles of usability

The operator must have a sense of control in the application.

In general, when a system is more complex, for one user without specific training will be more difficult to understand its structure and operation. The coordinator needs to feel he can control all aspects of the application from its interface. If we want to place a control interface to our users is recommended:

- Provide immediate, reversible and feedback actions:

The coordinator, as we see in the physical world, expects that every action that carries on the interface is accompanied by a response from the machine. If we push a button, immediately, there should be a signal that a process has begun. If this process takes more than 3 seconds, it is recommended to inform the operator. Such feedback can be done with the modification of the cursor, changing the shape of a clock, or some action to indicate the possible duration of the process and progress. We will use, as you can see in the following sheets, a dialog that shows that application is working for tasks that we need more time to load.

- The module must be redundant:

If our module is redundant provides us the flexibility to accommodate different user preferences, system settings, or abilities of the user. We must provide more than one way to enter data, to interact with the application, and display information. For example we will use two different ways to add tasks, one of this is in the calendar and the other way will be in the project.

- It should reduce the memory load of users.
- Simplify the tasks: An important component of the administrative work is data entry. This task can be optimized in terms of speed of loading and decrease the load on the memory if we follow these recommendations.
- Provide default options: We must assign a default entry for each field, for this we will use the most frequently charged and, if is necessary, should be easy to change for another different value.
- Prevent the development of the task depends on the memory of the operator: The operator does not have to remember complicated codes.
- We need to delegate work load: a necessary ergonomic principle is to avoid repetitive tasks performed by the operator if the machine can do it. Therefore, the cursor will automatically be placed in the right place to start or continue the load from one field to another automatically. Also if the input data includes such a unit, this should not be charged again and again by the operator, it also includes the unit in the field by default.
- Provide shortcuts: Shortcuts are keys and combination keys that allow to users to realize the most common actions, since they directly use the keyboard instead of mouse. In this way we gain efficiency and flexibility of use. These shortcuts are invoked by pressing CTRL + plus one or more characters.

It is recommended to respect the shortcuts of the operating system, because it helps in the ease of learning and the prevention of errors that will have to maintain consistency with the operating system.

We will use the shortcuts in the following combinations.

Combination	Description
CTRL+N	New element
CTRL+S	Save
CTRL+F	Find

CTRL+E	Edit Element
CTRL+C	Copy
CTRL+X	Cut
CTRL+P	Paste

Table 8 List of shortcuts that we will use in our module

After we've reviewed the most important features of the GUI and how we are going to make it, we will specify the design of our user interface depending on the features agreed in the previous paragraphs.

General feature of our GUI.

Our graphical interface is made up of a panel that will have all the functionality of the production module of our application. If a coordinator has dual monitor, we will have to offer them the chance to use it.

We will use the Tab Control component because we want to separate tabs with different panels because we cannot put in a window all functionality, this is not usable due to information overload.

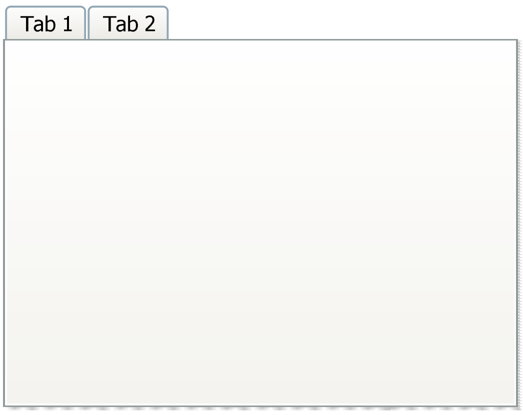


Figure 15 Tab Control Example

How can we ensure that the user can use dual screen or a screen?

The coordinators and I meet us to treat this problem and we thought that it would be interesting to give in an intuitive and easy way to change from one to two monitors. We wanted that the coordinator could choose the tabs that he wants to put in the second monitor in a freedom way.

How do we choose the tabs to join them to the other screen?

If we press the right button on the tab that we want to separate, it will appear a context menu that will offer the possibility of separating the tab in the tab control. Once it is separated, the coordinator will may add it to the monitor and maximize it, from that moment, we will have two monitors in the application. If the coordinator wishes to close the tab automatically independent, it will join to the Tab control.

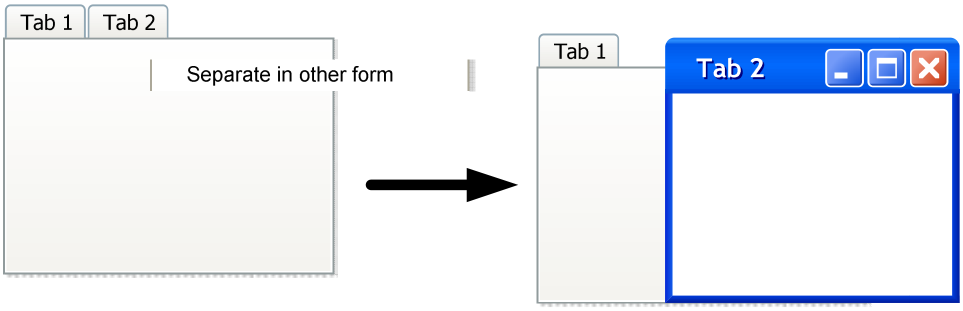


Figure 16 Diagram of what we build

Once we have determined the structure of the external application, we have to consider a possible internal structure within each form panel. To do this we will use based on widgets[2]. We will build on the widgets and we want to show as many details as possible to the coordinator. We must remember that in the previous guide we recommend that the number of sensitive areas is not greater than eight; therefore we will not use more than 8 widgets per form.

[2] A **widget** (or **control**) is an element of a graphical user interface that displays an information arrangement changeable by the user, such as a window or a text box. The defining characteristic of a widget is to provide a single interaction point for the direct manipulation of a given kind of data. Widgets are basic visual building blocks which, combined in an application, hold all the data processed by the application and the available interactions on this data.

Figure 17 Widget structure

As the coordinators will have several areas that can analyze the information we need to provide a mechanism to update each of the widgets automatically to keep the information updated at all times. The next chapter will describe how we have implemented the upgrade.

Figure 18 Widget Structure Update

As I said earlier in the guide we are going to incorporate a horizontal status bar to know the current state system. We want to avoid continually show message boxes we will use the horizontal status bar to report when making a transaction which is informative, for example: we have created a project correctly. In case of error, we will show a message box and a message in the status bar.

Figure 19 Widget structure with status bar

Other features to consider in the Graphical Interface

We will use to develop our GUI components DevExpress.Net that the company had already acquired. But we will make some changes to these components because among other things we want:

- We need to highlight where the focus element is in the component. We want to make it easier to see the component with focus. We want to highlight the component with a yellow background as shown in the figure below.

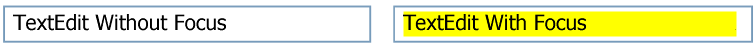


Figure 20 Text edit with focus, Text edit without focus

- In case of we use a text edit we want to use capital letters when the text is written because we want to normalize the format.
- When we press ENTER (if is not a multiline TextEdit), the module focus must go to the next component. This gives us ease and productivity.

Features of the application to develop the graphical interface

Once we have described the general aspects of our graphical interface and BPMN diagram. The coordinators and I met together to discuss what features they wanted and we saw the list below.

- Tasks that are pending completion that contains the coordinator.
- All details of a project.
- Schedule tasks to display the works holidays.
- Works completed receivable.

- Works at risk to end later than planned
- Weekly% availability
- We want to display a map that shows the route from the company to its location.
- Weather prevision.

After the meeting, we are going to do UML diagram to see what data the coordinators need to manage. We have made the UML diagram in the same meeting and we had a brainstorming session on what features the coordinators need to know to make a correct management of their production

The following figure details the UML Diagram.

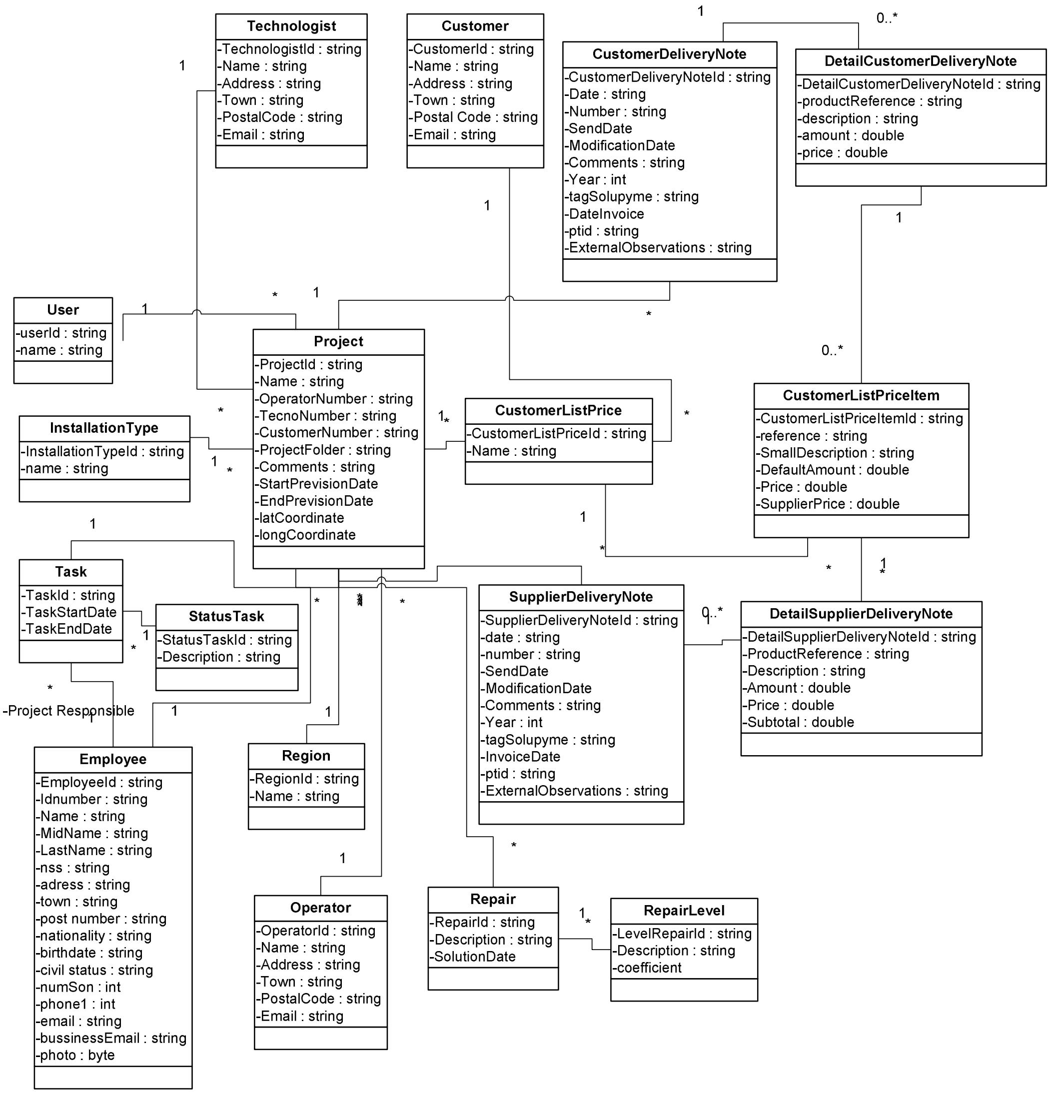


Figure 21 UML Diagram of the module

As we can see in the picture above the class of our most important module is the class project. We want to know from Project class the repair management (class repair and repairLevel), delivery customer management (in this module we will not see) and production tasks management (class employee).

The following table list has the main classes that I have captured of the coordinators in each class I will explain the most important attributes that have to help us better to understand how the new system will be.

In our Projects we want to know:

- The name of the project.
- The technologist.
- The technology.
- The Project type.
- The number that the technologist will use in our Project.
- The number that the customer will use in our project to find easily if the customer asks for the project.
- The customer coordinator
- The responsible of our project (coordinator)
- The customer Item list
- The prevision start date and prevision end date: we need to know these fields because if we don't finish a project in time we will have a penalization.
- The region where the Project would be built. We use this field to extract statistics per region.

In our Tasks we want to know:

- A description of these.
- The date that the task will start.
- The date that the task will finish.
- The task state (pending start, start, finish).
- The employees that will work in this task.
- The project that contains this task.

In our repairs we want to know:

- A description of these.
- The solution date.
- The repair level to calculate the KPIs.

GUI Prototypes

Once we have made use cases, an estimate of the design of UML class diagram and make a report with the general characteristics that will contain the new GUI, we have had a meeting to try to make a design using prototypes of the new graphical interface.

To make the prototype we will use the prototype life cycle. To do this we will be presenting our prototypes on paper until the coordinators are in agreement. We do the prototypes on paper because we can correct easily that the coordinators said at the moment. Finally, once the coordinators are totally agree we will build the final design using Visual Studio. Net.

In the next figures you can see how the prototypes were made. We built prototypes with Uml diagram and use cases. In this way the coordinator said any comments could see when we were developing them. The prototypes have been built always thinking about the productivity of the coordinator for this reason we have changed the order of some fields in the form. Furthermore we have been built thinking if we use small monitors because the coordinator can use the laptop screen. For this we have thought to use Split panels and Hidden panels because if we have panels that is difficult to view in our small screen we can see expanding the panels associated.

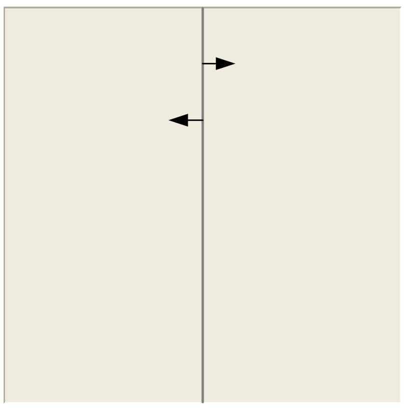


Figure 22 Split panel example

We have also proposed that panels will be able to expand if the resolution is greater (since .Net Forms has a property called dock > Fill). They are marked with arrows that span.

In the following figures you can see the four prototypes that I have made.

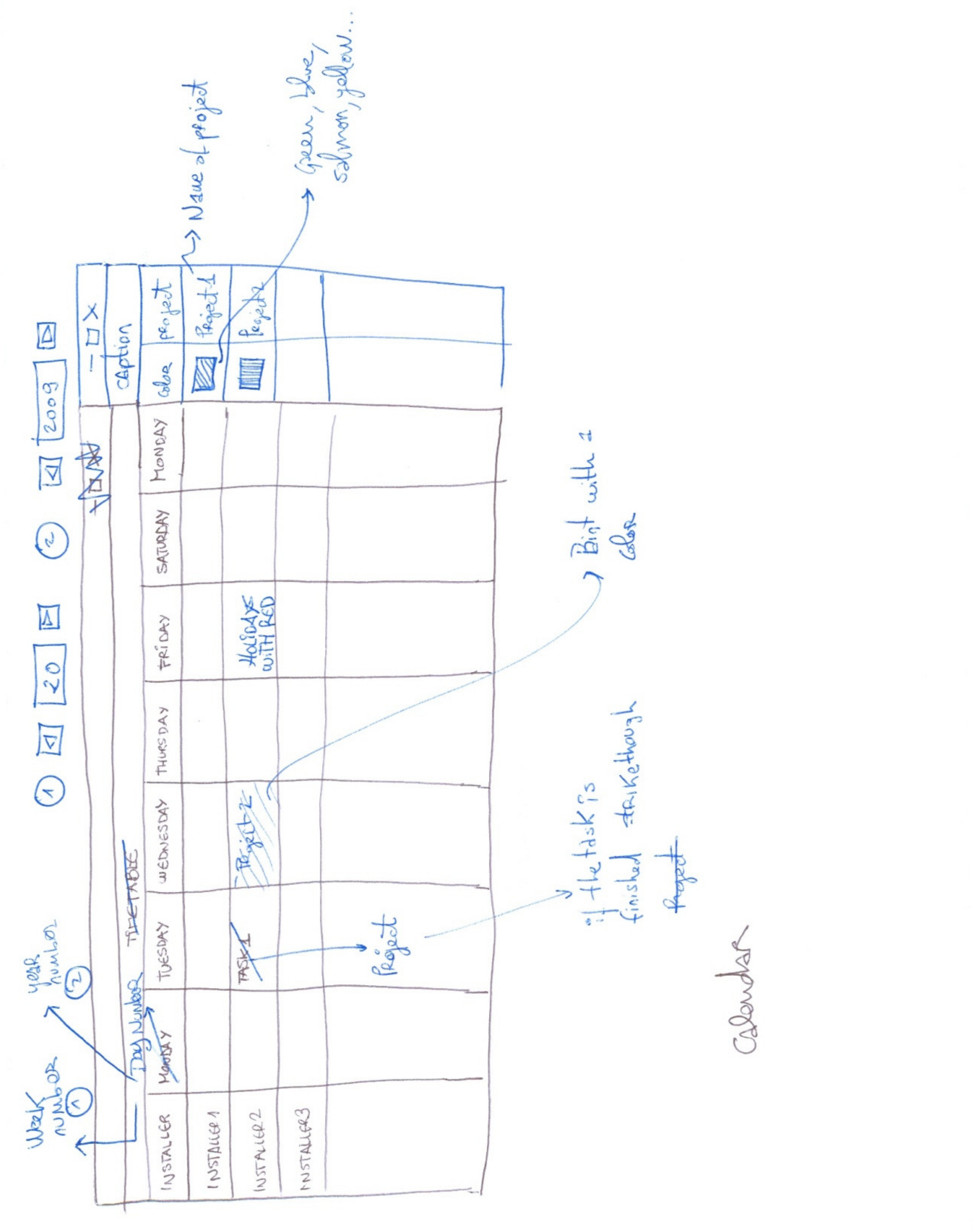


Figure 23 Prototype design of the calendar

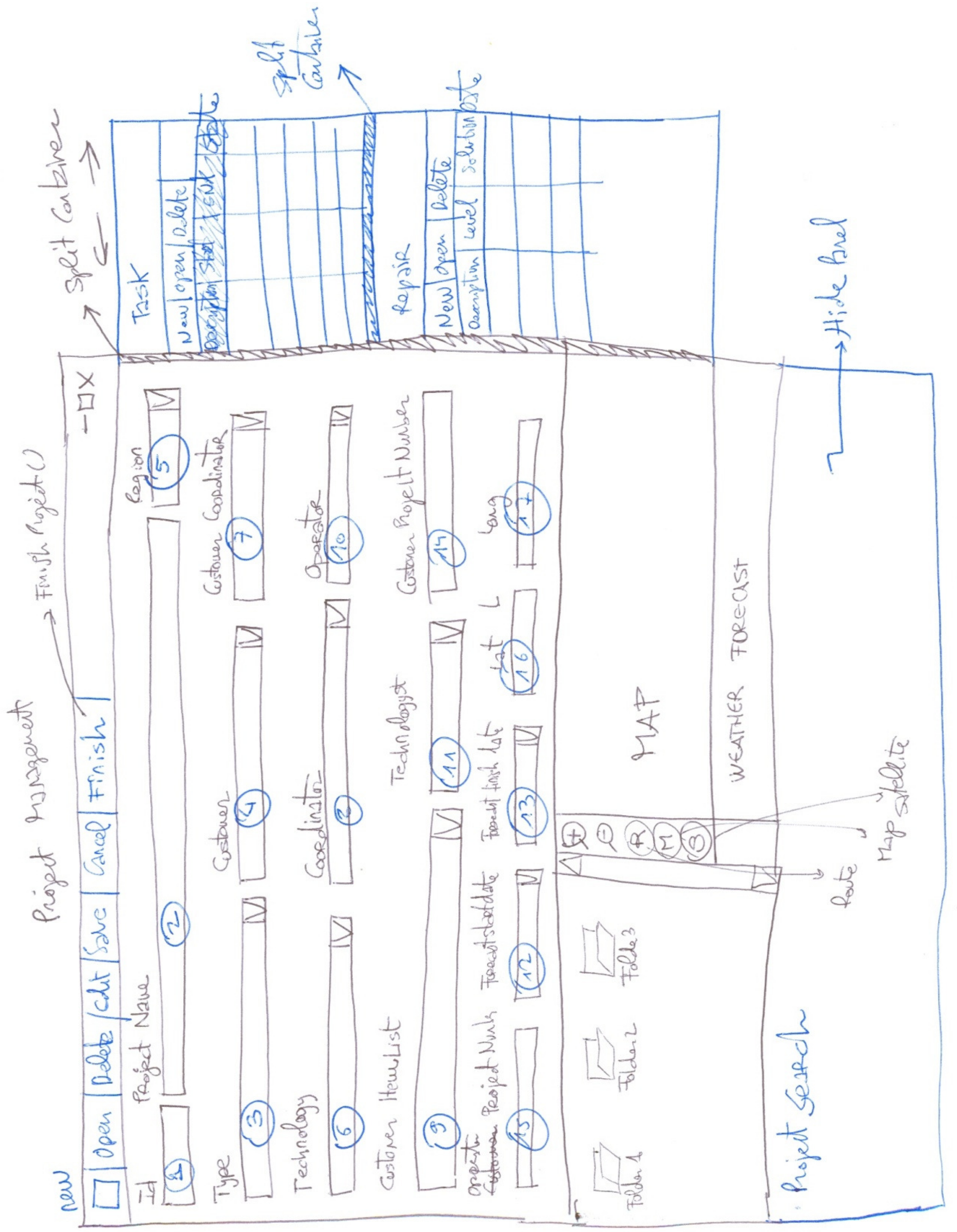


Figure 24 Prototype design of project management

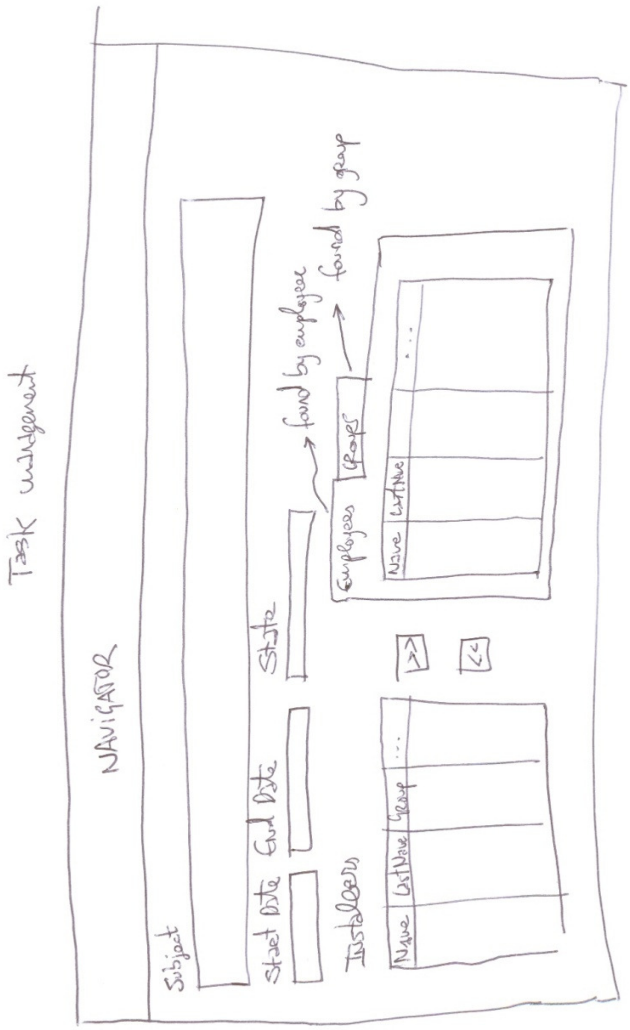


Figure 25 Prototype design of task management

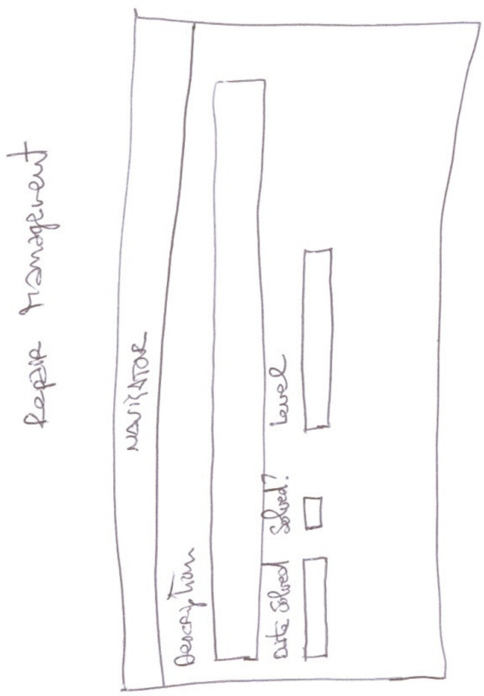


Figure 26 Prototype design of repair management

Map Management

One of the requirements we have been allocated in the previous chapter is to manage a map showing the route to us from the company location to the project location. Furthermore the coordinators want o have a satellite view to help them to discuss the ground in which the installer will do the project.

For this and after I have searched alternatives, I presented a summary of the different alternatives to carry out that requirement and I met the boss. Then we needed to try to agree with the best solution.

Here we will show a summarized table about each alternative. We will describe de advantages or disadvantages of each alternative. Then I will describe the selected option and why.

Alternative	Advantages	Disavantages
Google maps website. (30)	For free	Application not integrated. You need internet connection.
Owner component	Customizable	It requires much time and there are other solutions better.
Carnacgis (31) : Tool elaborated by Microsoft that offer a lot of ways to see the maps.	You can use without internet connection.	Price
GMap.Net (32) : Open source component.	You can access to the source code. Open source tool. If the map has loaded once time you don't need internet connection (cache).	It requires internet connection if the map is not loaded.

After we talk with the boss, we decided that the best tool for mapping was to GMap.Net because it is a free tool. To do this I decided to try to learn how to use the component. I made a test project and when I knew how to use each function (using the component documentation) and we could use the component.

GMap features.

We will describe the features that have GMap and we will show a picture of the component.

- Free
- Open source .NET control
- Cross platform
- Enable use routing, geocoding and maps from Google, Yahoo!, Virtual Earth, OpenStreet in Windows Forms and Presentation.
- Supports caching
- Cached Map DB list
- Many hands make light work
- Maps Icons configuration

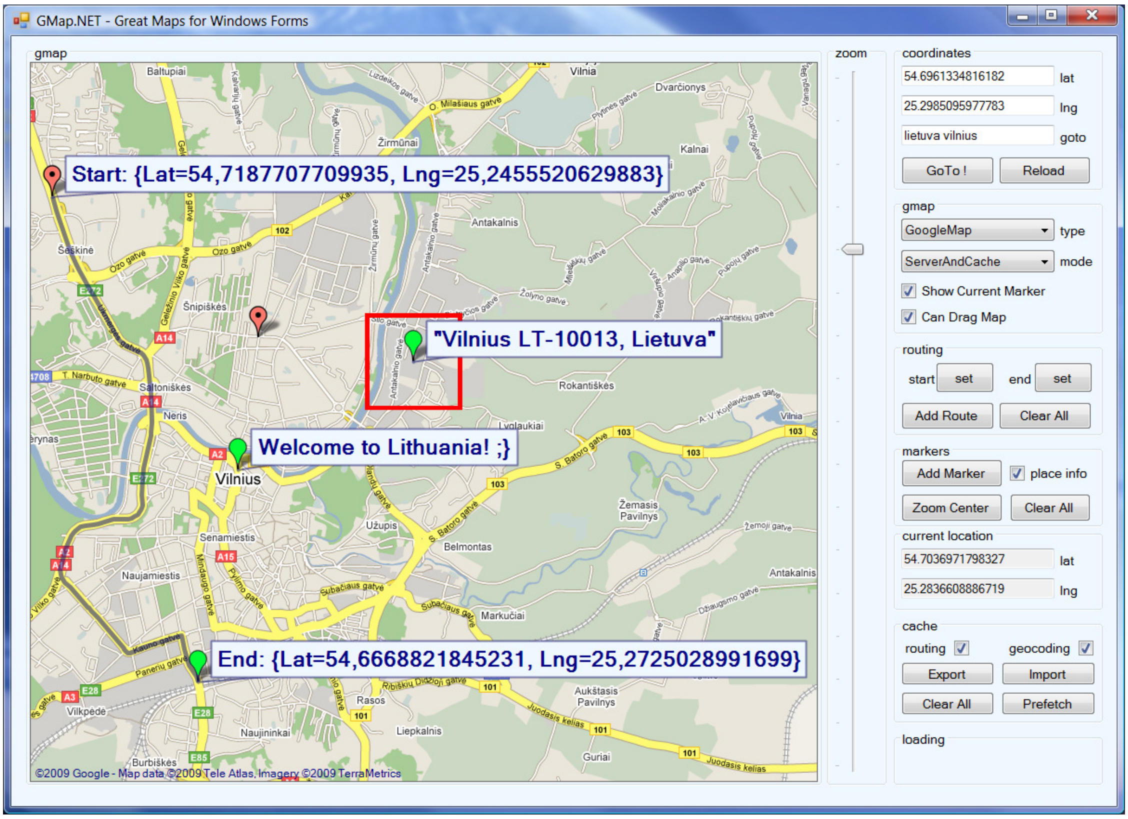


Figure 27 Example of GMap.Net

Searching for a web service, weather forecast

To make the prediction of time we need to find a web service by entering latitude and longitude coordinates answering this weather.

For this I made a summary table on each of the alternatives and the potential advantages and disadvantages it has (the same procedure that map component search). At the end of Table I describe the choice.

Option	Advantages	Disavantages
Website (33)	Free	Unable to integrate with the application (website)
Yahoo web service (34)	Free	Only valid in United States
Ibm web service (35)	The web service is in spain	Cost

Finally, we discussed (the manager and I) and decided that the coordinators have to find in the website, because we cannot use the Yahoo option and the boss does not want to spend money for a web service.

KPI Design

KPI, also known as Key Performance Indicators or Key Success Indicators (KSI), help an organization define and measure progress toward organizational goals. (36)

Once an organization has analyzed its mission, identified all its stakeholders, and defined its goals, it needs a way to measure progress toward those goals. Key Performance Indicators are those measurements. In our case we has defined the company goal: improving the installers quality, for do this we need to evaluate each installer, to evaluate this we need to know what mistakes has the installer and the level of this mistakes in each Project.

Advantages of using KPIs

The KPIs are often tied to the organization's strategy (as exemplified by techniques such as the Balanced Scorecard).

The KPIs are indicators that allow senior executives to communicate the mission and vision of the company to lower hierarchical levels, directly involving all partners in achieving the strategic objectives of the company.

For an organization it is necessary to identify their KPI's. The key to do this are:

- Have a pre-defined business process.
- Have clear objectives / performance required in the business process.
- Having a quantitative / qualitative results and possible comparison with the target.
- Investigate variations and adjust processes and resources to achieve short-term goals.
- Key Performance Indicators Must Be Quantified

KPIs are often tied to the organization's strategy (as exemplified by techniques such as the Balanced Scorecard).

To define the KPI we have relied on the premises that F. John Reh has defined. (36)

- **Title of KPI:** Repairs per Installer
- **Defined:** The total coefficient number of the repairs that the installer has done in his projects. For each repair we can see 3 types of coefficient.
    - **High:** defects in the project are important: electrical fault, improper assembly, the chassis does not work ...(1 point)
    - **Medium:** defects in the project are substantial: poor cable connection, bad cables protected ... (0.5 point)
    - **Low:** defects in the project are minimal: poor labeling of cables, has not cleared the area ... (0.25 point)
- **Measured:** Every 3 months the management groups will have a meeting with each installer to see the results of the KPI and to argue what the reason is that the installer has so errors in his installations.
    - Some solutions can be:
      Need for training.
      Solve installer problems.
      Solve coordinator problems.
- **Target:** Increase the quality of projects,

Conclusion

Throughout the chapter we have seen everything on a good design. We have specified some artifacts such as polls, prototype design, result tables, user cases, which have helped us to define in a formal manner our application, therefore the implementation is easy.

CHAPTER 9.-IMPLEMENTATION

In the next section we will specify a summary of the implementation based on the design seen in the previous chapter; we describe only those aspects of implementation that we see more interesting. If you want to deep into the code I have attached the source code.

User case implementation.

To implement the use cases, as we said in the previous chapter, we will deploy our application in three layers, we have implemented using the GUI designer in Visual Studio.Net and each use case we have built operations related. These operations are located in the facade class OperacionesProduccion. Each transaction is a static method of the class and within each operation, we have restrictions on business. Business restrictions are sentences in which if the condition is satisfied the software throws an error.

For example the use case analysis RI-04:

RI–04	End Project
Associated requirements	RI-01, RI-02, RI-03, RI-05
Precondition	All the tasks have been finished and there aren't repairs unsolved.
Description Requirement	The coordinator, once the tasks have been finished and there aren't repairs unsolved, must finish the Project as soon as possible. Once the project is finished, he will send to the customer an email. The customer will check if all the Requirements of the Project are completed. The coordinator must save the pictures that the installers have been taking in the repository Project. This repository will be in a folder for each project.
Specific Data	Project End date
Actors	Coordinator
Business restrictions	All the tasks have been finished and there aren't unsolved repairs.
Comments	

Post condition	The system must save the end date as now. The system will update automatically all the forms.

And the source code in the Business Layer

```
public class OperacionesProduccion
{
       public static void finishProject(string projectId)
         {
              //GET selected the project
              Project ob=getProject(projectId);
              ISession sesion = SesionGestelecom.GetInstance().sesion;
              ITransaction transaction = sesion.BeginTransaction();
              try
              {
                  //RESTRICTIONS*******************************
                 foreach(Produccion.Repair r in
              FachadaInterfaz.ProductionOperations.getRepair(projectId))
                  {

                      if (r.SolveDate == null)
                      {
                          throw new
Excepciones.ExcepcionGestelecomElementoNoEncontrado("The project can
not end because there is a repair that is not resolved");
                      }
                  }
                  foreach (Produccion.Task oT in
FachadaInterfaz.ProductionOperations.getTaks(idObra))
                  {
                      if (oT.state.idStateTask!= Production.
Task.StateFinished)
                      {
                          throw new
Excepciones.ExcepcionGestelecomElementoNoEncontrado("The project can
not end because there is a task not finished");
                      }
                  }

                  ob.projectFinished= true;
                  sesion.Update(ob);
                  transaction.Commit();
              }
              catch (Exception e)
              {
                  transaction.Rollback();
                  throw e;
              }
```

```
        }
```

This is very intuitive and easy to detect errors because we do not mix the layer interface with the layer of business logic. The exceptions are at the top of the function and the software throws the exceptions if any restriction of the user cases is true. Finally at the end of the function we update the data.

```
The source code on GUILayer

private void gestelecomButtonFinish_Click(object sender, EventArgs e)
        {
            try
            {
            //The function
      GestelecomAplicacion.FachadaInterfaz.OperacionesObra.finishProjec
      t (_project.projectId);
            //Observer Pattern
                this.formPrincipal.updateallforms();
            }
            catch (Exception err)
            {
                MessageBox.Show(err.Message, "Error",
MessageBoxButtons.OK, MessageBoxIcon.Error);
            }
        }
```

In the GUI layer you can see only the name of the function and a sentence try catch to capture the exception if is produced.

Calendar Building

For the implementation of the timetable we have relied on the use of a grid which we have made a query in which we look for tasks that are within a week, we have created the following class `TaskCalendar` that we will use to save in the grid as Dataset.

In the following picture you can see the UML diagram.

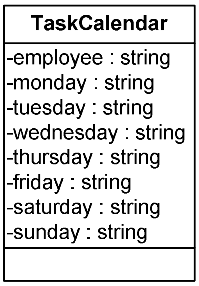


Figure 28 UML of calendar building

CHAPTER 10.-Results

Once implemented and delivered the application we have carried out another survey in which we observed the results of our coordinators (now 3) and we have obtained satisfactory results in the following aspects:

- Ease of use of the software because we've done a good study of usability and application to guide users. The coordinators have been satisfied with the ease of use that the application has.
- Improved productivity due to shotcut and usability guidelines.
- Improvement in the production process of the company. Now, we have greater control over the projects, tasks and more information.
- By improving the productivity in these times of crisis we have improved competition with other companies.

However, some weaknesses that we have in the new module are:

- At first when you implant a new module or a new application the users always have problems of adaptability, but over a week the coordinators have been adapted successfully to the module.
- The coordinators want to know what projects are delayed.
- The coordinators would also like to see the weather forecast inside the module because they waste so much time searching the weather forecast in the website.

CHAPTER 11.-Evaluation and discussion

The evaluation of the new module has been successfully because the company productivity has been improved.

About the Requirements capture:

Building the BPMN diagram helped Talens Plisman to standardize the production process. That even helped me to be able to do requirements estimation. To know the requirements helped us to define clearly how the software will be.

About the usability study:

The usability guide study and the action of doing the prototypes helped the company to improve the user´s productivity and satisfaction. If the users don´t feel good with the software, they will reject it.

About the implementation:

The way to do the software with three layers complicate the logic application but at the same time it helps to be easier to modify it. We can find where is each component, function...

About the KPIS report:

The installers are evaluated and the information help us to decide. For example, We can be able to know if one installer isn´t doing his work correctly because of the reason that there is not enough formation about his work.

The project helped me to try to build software for different users and also it helped me to try to do simple actions.

Many projects fail due to his use difficulty and because the projects do unnecessary operations. For this reason I think that it is very important the last note, and I think that the computers science have to focus on that.

Improvements:

The company wants to improve the production so the software has to have some characteristics:

A partir de ahora la empresa desea mejorar aún más la producción y quiere que realice las siguientes características.

The installers have to enter in a website to be able to download the pictures. With these pictures, they know well the project that they will do. Even they have installation manuals of the projects that are doing.

The coordinators, following the technologist and the type of work, will have to introduce the documentation in the application.

To do more performance reports.

CHAPTER 12.-Conclusion and further work.

The accomplishment of an investigation for construction of a module for a company is not a simple task. We must carry out many tasks and many artifacts so that the implementation is carried out correctly. As I were in the company, it has helpful served to be able to carry out the project to me since I have not had an exigency since the work required investigation. The realized investigations have been basically the study of because the company needs the module (since there have been many incidences and it was required to increase the control).

We needed to choose always the best option according to the company in which we are (if the best option is a great company perhaps would be the acquisition of a software ERP since it will help to standardize processes and a user license will be able as well to be paid).

Discovering and applying diagrams BPMN will help the company to standardize the processes and to improve the efficiency of them. It will help to understand of a general form the problem us to the managers of the application so that the company helps to that the requirements are explained in detail.

The study of the usability has helped as far as improving the accessibility, ease of use, efficiency of use of our application and the use of the best practices and patterns to realize an implementation that can be modified more easily.

Therefore I can say that very I am satisfied with the work carried out since the masters thesis has been in charge to investigate a real problem appeared in a company and that, because concretely the production differs considerably from the general processes of production of the companies. A great acquired experience is able to apply in later modules or applications that I ‘m going to build.

APPENDIX

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B)List of figures

C)List of tables

D)List of Plots

E)Production Module User Manual of Gestelecom 2.0.

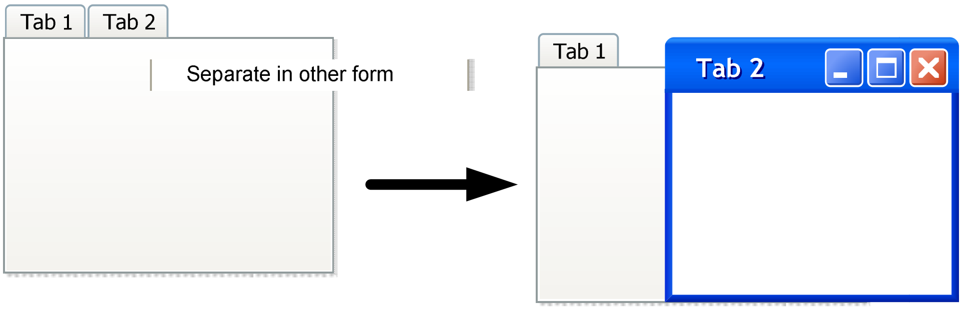
We will describe the features of the production module of Gestelecom 2.0.
The first step will be to login, we need to enter a username and password.

Once inside the application we will see two options in our production module: Management Production Panel and a KPI Report, KPI Installer.

Management Production Panel

Management Production Panel is the main option for the management of the production module. If you click in this option you will see a window with 2 tabs: calendar and general.

You can put in two screens each tab. If you want to extract the tab in other window you must do right click and click in separate in other form.



If you want to put your separated tab in the management production panel, you just close the separated window and the tab will put in the management production panel.

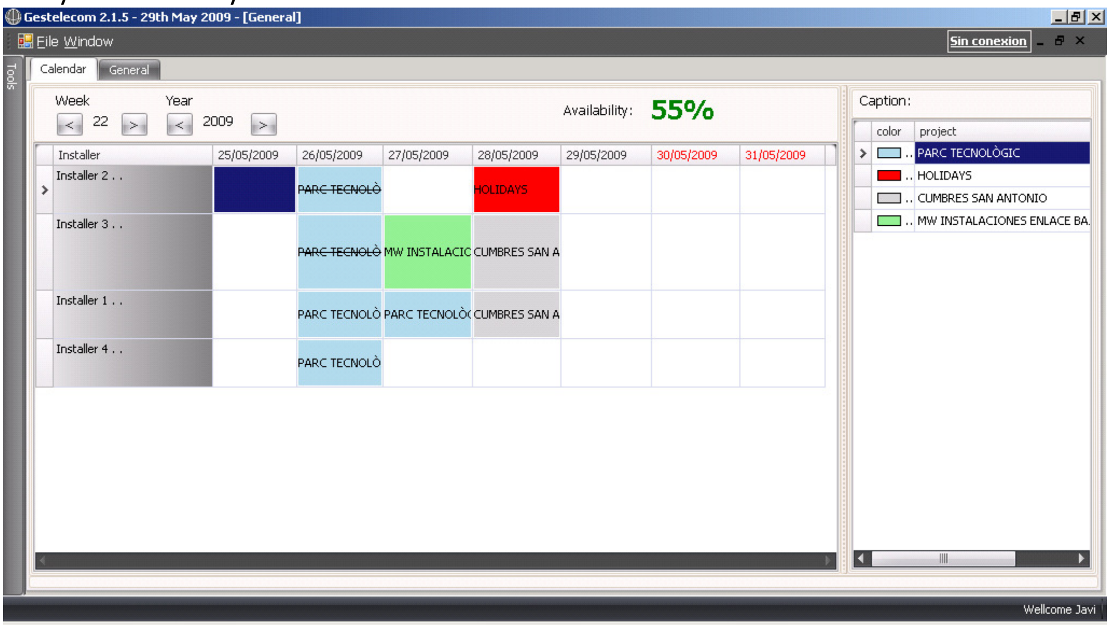
Calendar

In this part you will see the planning of all of the installers. At the top you can see the week and year. Week is represented by the number of weeks is in the year. You can also see the field availability that represents the availability that is in the company during the week. How to calculate availability is to look at which days are available for installers.

$$Availability = \frac{Worked\ hours}{Working\ hours}$$

Worked hours = Hours that doesn't have tasks.

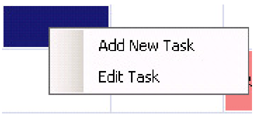
Total Days = Hours days.



In the central parte we can see the planning; in the left part (in gray color) we will see all of the installers that are currently in the company. In the right part we will see all of the tasks that we have in a week; they will be showed by colors. Now we are going to describe the different types of task that we have.

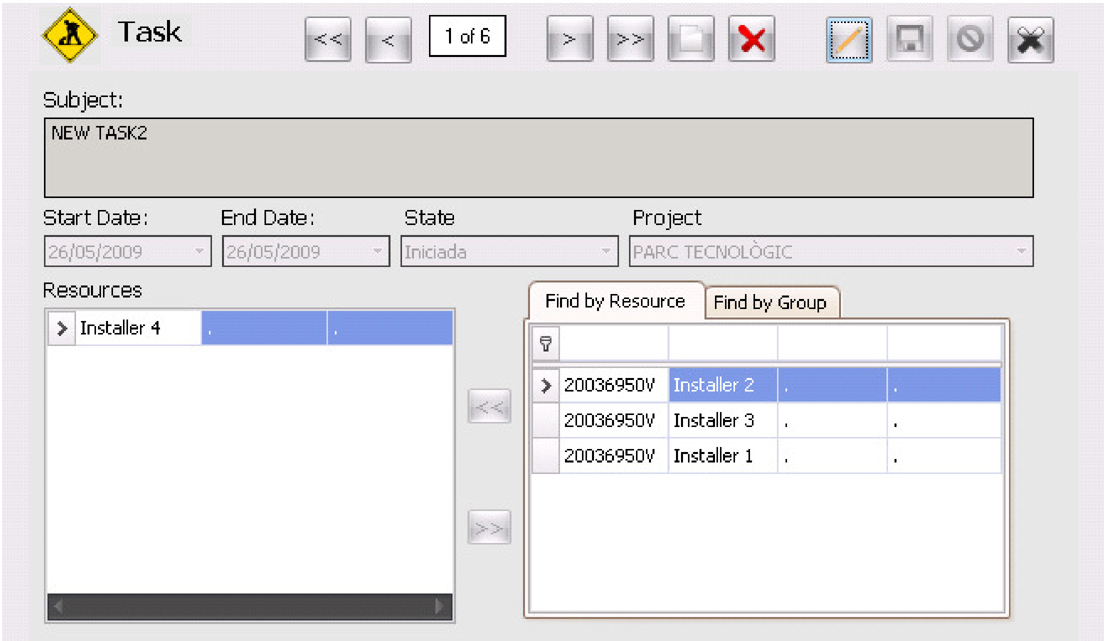
Caption	Description
HOLIDAYS	This task is a vacation day. Vacation days are created by staff from Human Resources Management. A coordinator cannot create tasks when there is a vacation day. He also cannot modify the holidays; he should consult with staff in Human Resources. Tasks are always represented by the red color.
MW INSTALACIC	This task is a not finished task. The coordinators can add, edit or delete this kind of tasks.
~~PARC TECNOLÒ~~	This task is a finished task. The coordinators can add, edit or delete this kind of tasks.

If we do right click in a cell we can edit or create new tasks. When we create or edit tasks the application shows us the task management form.

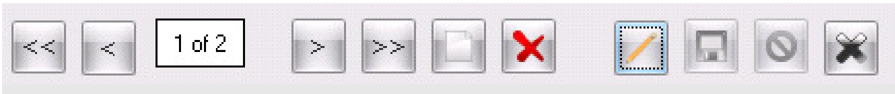


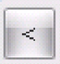
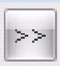
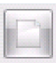
Task Management Form

Task Management Form is responsible for creating, editing and deletion of the tasks of our company.



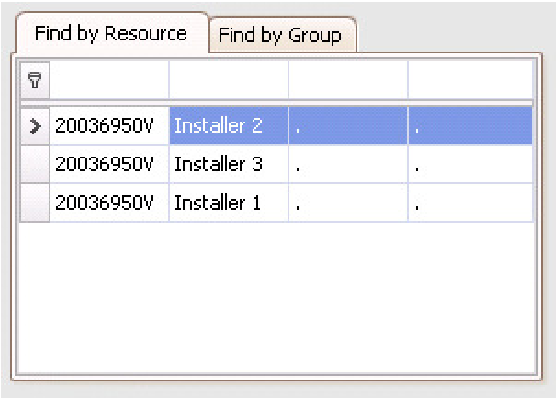
In the upper region we see a panel of tasks management that can browse the various registers, add records and delete records. We describe each item and we indicate the shortcut.



Button	Shortcut	Description
	CTRL+UP	First record
	CTRL+LE FT	Previous record
	CTRL+RI GHT	Next record
	CTRL+DO WN	Last record
	CTRL+N	New Record
	--	Delete Record

	CTRL+E	Edit Record
	CTRL+S	Save Record
	--	Cancel the current edition
	--	Close Form

In the section below you can add employees. The system only will show the employees that have contract currently in the company. You can add a group of employees if you do click in the tab Groups.



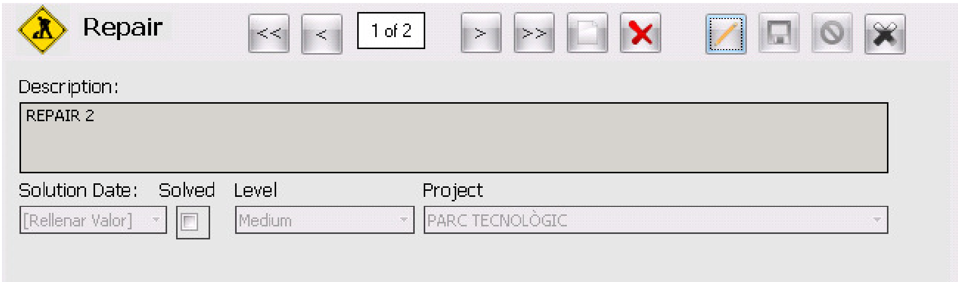
Restrictions when we want to create or edit tasks.

- We cannot create or edit the task if there are holiday's tasks.
- The start date must be before than the end date.
- If the project is finished we cannot create, edit or delete a task of this project.

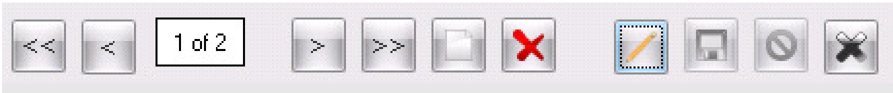
Repair Management Form

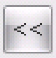
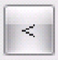
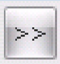
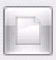
Repair management Form is responsible for creating, editing and deletion of the repair of our company.

I



In the upper region we see a panel of repair management that can browse the various registers, add repairs and delete repairs. We describe each item and we indicate the shortcut. These options are in the repair form.



Button	Shortcut	Description
	CTRL+UP	First record
	CTRL+LEFT	Previous record
	CTRL+RIGHT	Next record
	CTRL+DOWN	Last record
	CTRL+N	New Record
	--	Delete Record
	CTRL+E	Edit Record
	CTRL+S	Save Record
	--	Cancel the current edition
	--	Close Form

The levels of the repairs are the following:

Level	Description
High	Defects in the project are important: electrical fault, improper assembly, the chassis does not work...
Medium	Defects in the project are substantial: poor cable connection, bad cables protected...
Low	Defects in the project are minimal: poor labeling of cables, has not cleared the area...

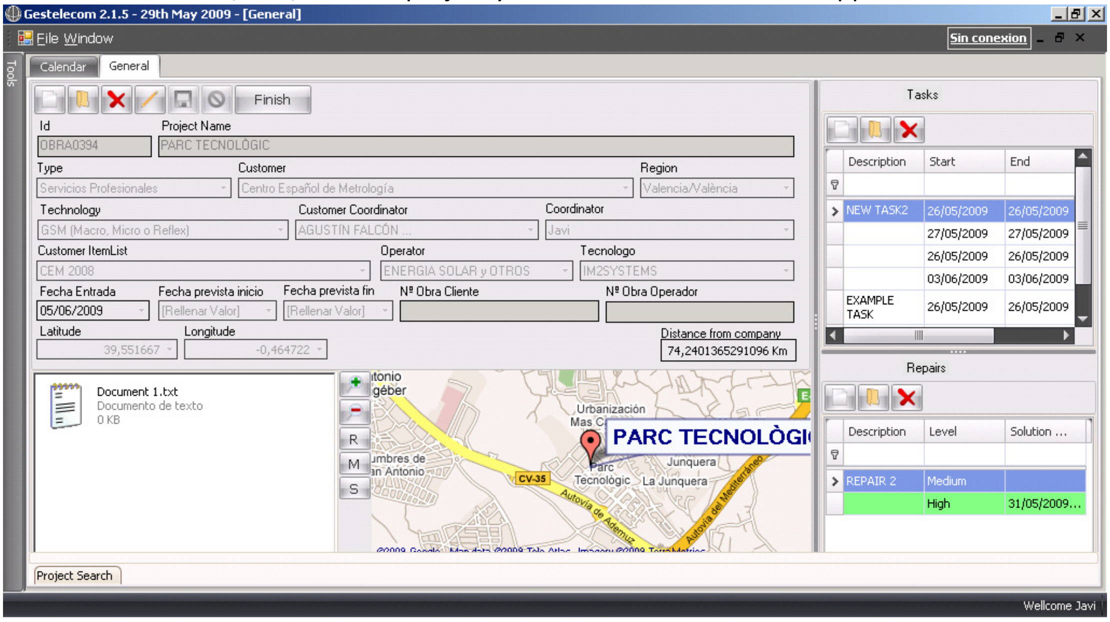
Restrictions when we want to create or edit tasks.

- We cannot create, edit or delete the repair if the project is finished.

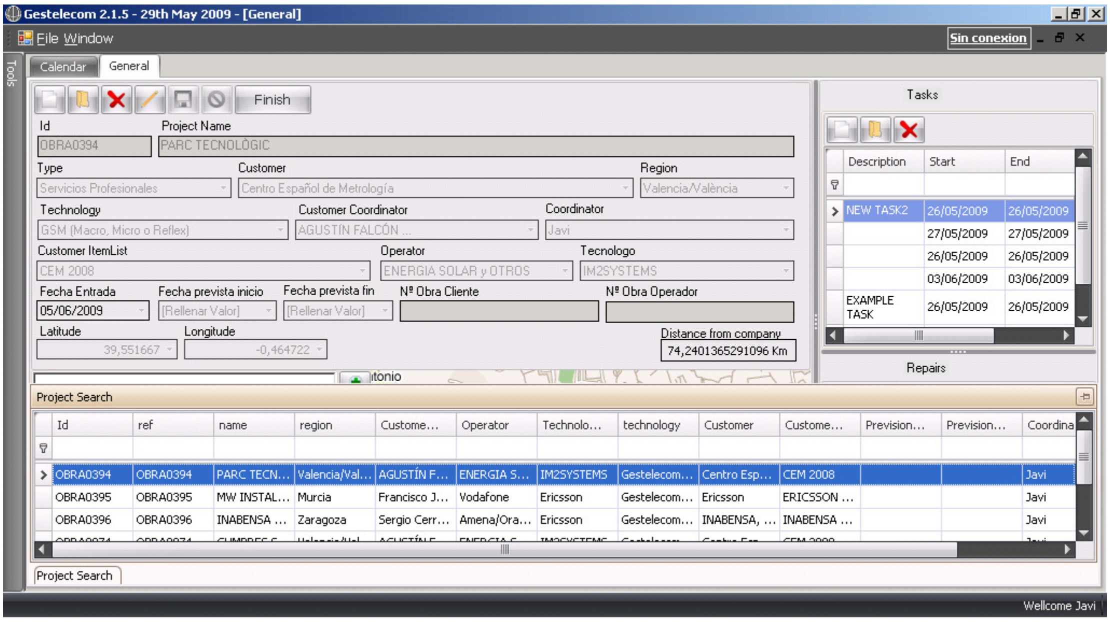
Project Management

In the general tab you have the management of the projects you can see in the center section that you have the project data, and in the right you can manage the tasks and the repairs of the projects.

If we want to create, edit, delete a project you can see a toolbar in the upper section.



If you want to Find or change the project you can do click in project search (or put the key CTRL+F). The project automatically will change.



You can finish a project, if you want to finish a project you only need to click in finish button. The project will finish if all the tasks are finished and the project doesn't have unsolved repairs.

E)Technical stuff

QUESTIONARIE 1.

Please check only one possible answer to these questions
1 .- If you had to make some improvement in the software that would improve?
a. - Improve the Production Department
b. - Improve Sales
c. - Improve Finances
d. - Other: ________________________

2 .- What are the many problems that appear in the company?
a. - No standardize business
b. - Lack of communication
c. - Lack of information
d. - Lack of coordination with the departments

3 .- What other weaknesses do you find in the company?
____
____

4.-List possible solutions to solve problems
____
____

5.- Assess the current situation of the company regarding the systems of information and specify why.
a. Very Good
b. Good
c. Normal
d. Poor
____
____

QUESTIONNAIRE 2

Please check only one possible answer to these questions in other case fill in the lines.

1 .- What improvements have you identified the new module?

____
____
____

2.-What is the evaluation of the new production module?
1=Good, 5=Poor.
1 2 3 4 5

3.-Is the module easy to use?

____
____
____

4.- What would you improve for the new production module?

____
____
____

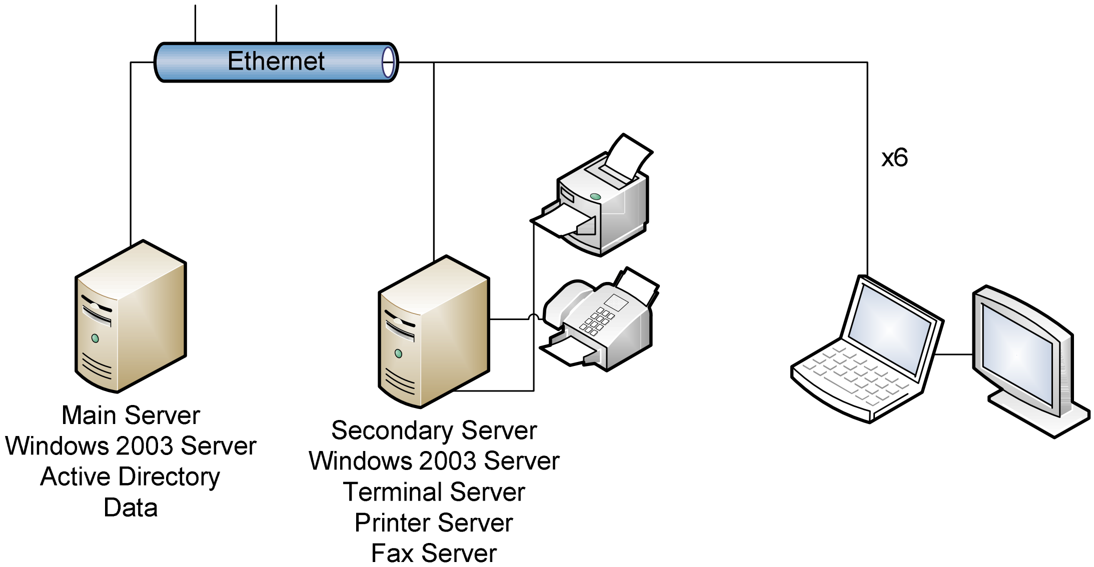
F)Physical structure of the company

As for information technology department, currently we have two servers.
The first server has the main feature and it has the following functions:

- Windows 2003 Server
- Database Server (SQL Server 2005)
- Active Directory Server
- 5 Raid Hard disks (2+1 for the operative System and 3+2 for data)

The second server has the secondary feature and it has:

- Terminal Server
- Printer Server
- ZetaFax Fax Server

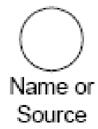
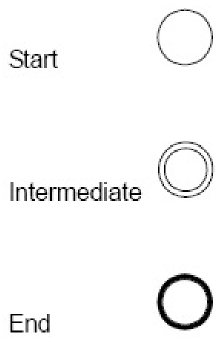


Draw 1 Company Structure

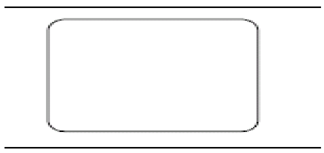
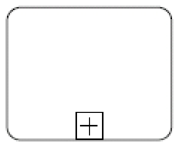
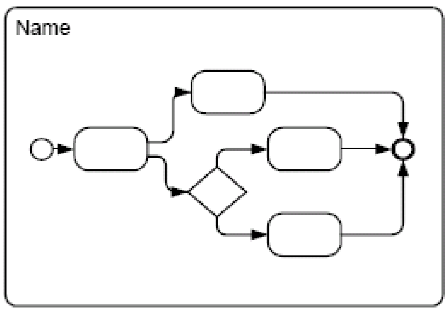
Each computer of each employee has two screens: one laptop screen and another screen.

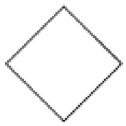
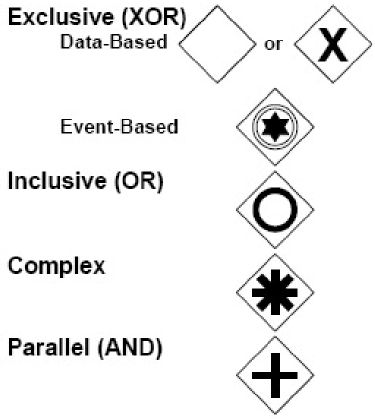
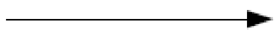
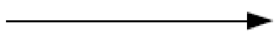
G)BPMN Notation (BPD) [3]

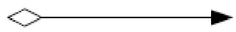
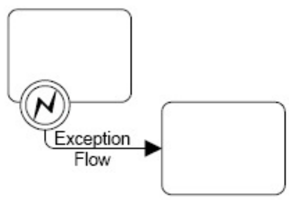
This table displays a list of the business process concepts that could be depicted through a business process modeling notation.

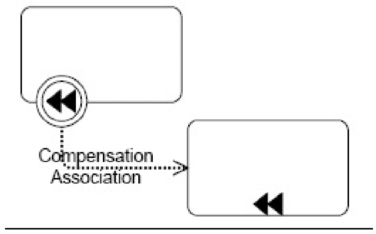
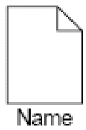
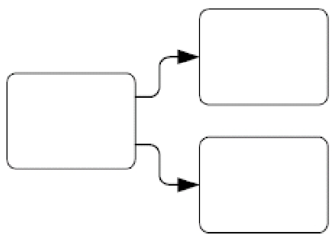
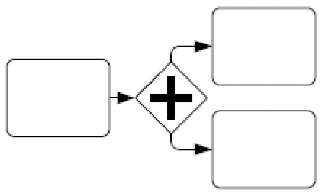
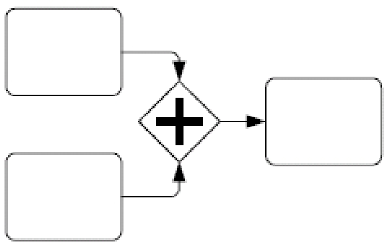
Element	Description	Notation
Event	An event is something that "happens" during the course of a business process. These events affect the flow of the process and usually have a cause (trigger) or an impact (result). There are three types of Events, based on when they affect the flow: Start, Intermediate, and End.	
Flow Dimension (e.g., Start, Intermediate, End) Start (None, Message, Timer, Rule, Link, Multiple) Intermediate (None, Message, Timer, Error, Cancel, Compensation, Rule, Link, Multiple) End (None, Message, Error, Cancel, Compensation, Link, Terminate, Multiple)	As the name implies, the Start Event indicates where a particular process will start. Intermediate Events occur between a Start Event and an End Event. It will affect the flow of the process, but will not start or (directly) terminate the process. As the name implies, the End Event indicates where a process will end.	

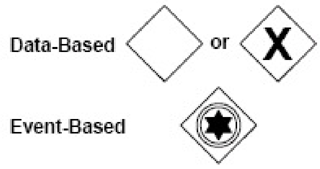
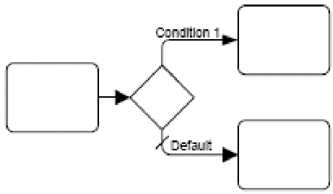
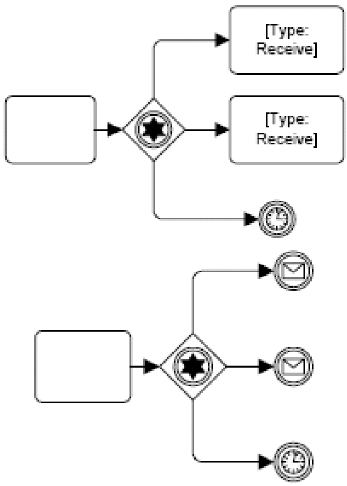
[3] Summary of BPMN guide. http://www.visual-paradigm.com/documentation/bpmnspec.jsp?format=pdf

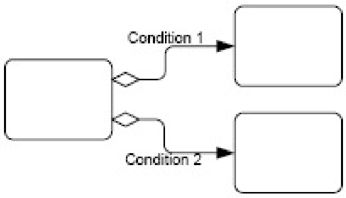
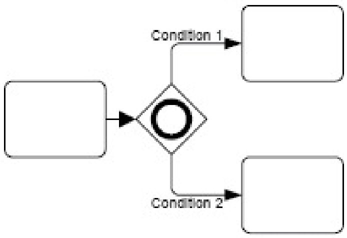
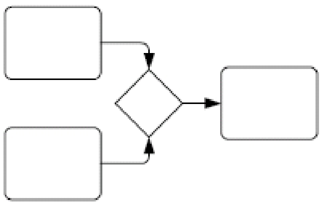
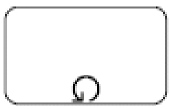
Type Dimension (e.g., Message, Timer, Error, Cancel, Compensation, Rule, Link, Multiple, Terminate)	Start and most Intermediate Events have "Triggers" that define the cause for the event. There are multiple ways that these events can be triggered. End Events may define a "Result" that is a consequence of a Sequence Flow ending.	
Task (Atomic)	A Task is an atomic activity that is included within a Process. A Task is used when the work in the Process is not broken down to a finer level of Process Model detail.	
Process/Sub-Process (nonatomic)	A Sub-Process is a compound activity that is included within a Process. It is compound in that it can be broken down into a finer level of detail (a Process) through a set of subactivities.	See next two figures
Collapsed Sub-Process	The details of the SubProcess are not visible in the Diagram. A "plus" sign in the lower-enter of the shape indicates that the activity is a SubProcess and has a lower-level of detail.	
Expanded Sub-Process	The boundary of the Sub-Process is expanded and the details (a Process) are visible within its boundary. Note that Sequence Flow cannot cross the boundary of a Sub-Process	

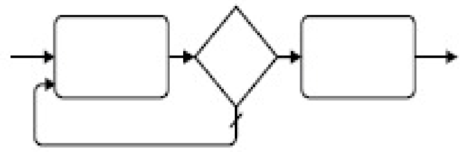
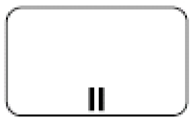
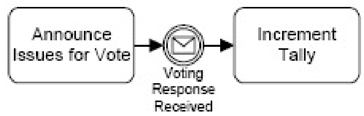
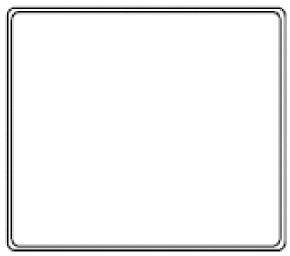
Gateway	A Gateway is used to control the divergence and convergence of multiple Sequence Flow. Thus, it will determine branching, forking, merging, and joining of paths.	
Gateway Control Types	Icons within the diamond shape will indicate the type of flow control behavior. The types of control include: • XOR -- exclusive decision and merging. Both Data-Based and Event-Based. Data-Based can be shown with or without the “X” marker. • OR -- inclusive decision and merging • Complex -- complex conditions and situations (e.g., 3 out of 5) • AND -- forking and joining Each type of control affects both the incoming and outgoing Flow.	
Sequence Flow	A Sequence Flow is used to show the order that activities will be performed in a Process.	See next seven figures
Normal Flow	Normal Sequence Flow refers to the flow that originates from a Start Event and continues through activities via alternative and parallel paths until it ends at an End Event.	
Uncontrolled flow	Uncontrolled flow refers to flow that is not affected by any conditions or does not pass through a Gateway. The simplest example of this is a single Sequence Flow connecting two activities. This can also apply to multiple Sequence Flow that converge	

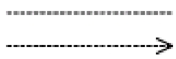
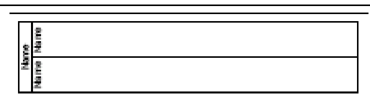
	on or diverge from an activity. For each uncontrolled Sequence Flow a "Token" will flow from the source object to the target object.	
Conditional flow	Sequence Flow can have condition expressions that are evaluated at runtime to determine whether or not the flow will be used. If the conditional flow is outgoing from an activity, then the Sequence Flow will have a minidiamond at the beginning of the line (see figure to the right). If the conditional flow is outgoing from a Gateway, then the line will not have a mini-diamond (see figure in the row above).	
Default flow	For Data-Based Exclusive Decisions or Inclusive Decisions, one type of flow is the Default condition flow. This flow will be used only if all the other outgoing conditional flow is not true at runtime. These Sequence Flow will have a diagonal slash will be added to the beginning of the line (see the figure to the right).	
Exception Flow	Exception Flow occurs outside the Normal Flow of the Process and is based upon an Intermediate Event that occurs during the performance of the Process.	
Message Flow	A Message Flow is used to show the flow of messages between two entities that are prepared to send and receive them. In BPMN, two separate Pools in the Diagram will represent the two entities.	

Compensation Association	Compensation Association occurs outside the Normal Flow of the Process and is based upon an event (a Cancel Intermediate Event) that is triggered through the failure of a Transaction or a Compensate Event. The target of the Association must be marked as a Compensation Activity.	
Data Object	Data Objects are considered Artifacts because they do not have any direct effect on the Sequence Flow or Message Flow of the Process, but they do provide information about what activities require to be performed and/or what they produce.	
Fork (AND-Split)	BPMN uses the term "fork" to refer to the dividing of a path into two or more parallel paths (also known as an ANDSplit). It is a place in the Process where activities can be performed concurrently, rather than sequentially. There are two options: Multiple Outgoing Sequence Flow can be used (see figure top-right). This represents "uncontrolled" flow is the preferred method for most situations. A Parallel (AND) Gateway can be used (see figure bottom-right). This will be used rarely, usually in combination with other Gateways.	 
Join (AND-Join)	BPMN uses the term "join" to refer to the combining of two or more parallel paths into one path (also known as an AND-Join or synchronization). A Parallel (AND) Gateway is used to show the joining of	

	multiple Flow.	
Decision, Branching Point; (OR-Split)	Decisions are Gateways within a business process where the flow of control can take one or more alternative paths.	See next five rows.
Exclusive	An Exclusive Gateway (XOR) restricts the flow such that only one of a set of alternatives may be chosen during runtime. There are two types of Exclusive Gateways: Data-based and Event-based.	
Data-Based	This Decision represents a branching point where Alternatives are based on conditional expressions contained within the outgoing Sequence Flow. Only one of the Alternatives will be chosen. Event-Based This Decision	
Event-Based	This Decision shows a branching point where Alternatives are based on an Event that occurs at that point in the Process. The specific Event, usually the receipt of a Message, determines which of the paths will be taken. Other types of Events can be used, such as Timer. Only one of the Alternatives will be chosen. There are two options for receiving Messages: Tasks of Type Receive can be used (see figure top-right). Intermediate Events of Type Message can be used (see figure bottom-right).	

Inclusive	This Decision represents a branching point where Alternatives are based on conditional expressions contained within the outgoing Sequence Flow. In some sense it is a grouping of related independent Binary (Yes/No) Decisions. Since each path is independent, all combinations of the paths may be taken, from zero to all. However, it should be designed so that at least one path is taken. A Default Condition could be used to ensure that at least one path is taken. There are two versions of this type of Decision: The first uses a collection of conditional Sequence Flow, marked with mini-diamonds (see top-right figure). The second uses an OR Gateway, usually in combination with other Gateways (see bottom-right picture).	 
Merging (OR-Join)	BPMN uses the term “merge” to refer to the exclusive combining of two or more paths into one path (also known as an a OR-Join). A Merging (XOR) Gateway is used to show the merging of multiple Flow. If all the incoming flow is alternative, then a Gateway is not needed. That is, uncontrolled flow provides the same behavior.	
Looping	BPMN provides 2 (two) mechanisms for looping within a Process.	See Next Two Figures
Activity Looping	The attributes of Tasks and Sub-Processes will determine if they are repeated or performed once. There are two types of loops: Standard and Multi-	

	Instance. A small looping indicator will be displayed at the bottom-center of the activity	
Sequence Flow Looping	Loops can be created by connecting a Sequence Flow to an “upstream” object. An object is considered to be upstream if that object has an outgoing Sequence Flow that leads to a series of other Sequence Flow, the last of which is an incoming Sequence Flow for the original object.	
Multiple Instances	The attributes of Tasks and Sub-Processes will determine if they are repeated or performed once. A small parallel indicator will be displayed at the bottom-center of the activity.	
Process Break (something out of the control of the process makes the process pause)	A Process Break is a location in the Process that shows where an expected delay will occur within a Process. An Intermediate Event is used to show the actual behavior (see top-right figure). In addition, a Process Break Artifact, as designed by a modeler or modeling tool, can be associated with the Event to highlight the location of the delay within the flow.	
Transaction	A transaction is a Sub-Process that is supported by special protocol that insures that all parties involved have complete agreement that the activity should be completed or cancelled. The attributes of the activity will determine if the activity is a transaction. A double-lined boundary indicates that the Sub-Process is a Transaction.	
Nested/Embedde	A nested (or embedded) Sub-	There is no special indicator for nested

d Sub-Process (Inline Block)	Process is an activity that shares the same set of data as its parent process. This is opposed to a Sub-Process that is independent, re-usable, and referenced from the parent process. Data needs to be passed to the referenced Sub-Process, but not to the nested Sub-Process.	Sub-Processes
Group (a box around a group of objects for documentation purposes)	A grouping of activities that does not affect the Sequence Flow. The grouping can be used for documentation or analysis purposes. Groups can also be used to identify the activities of a distributed transaction that is shown across Pools.	
Off-Page Connector	Generally used for printing, this object will show where the Sequence Flow leaves one page and then restarts on the next page. A Link Intermediate Event can be used as an Off-Page Connector.	
Association	An Association is used to associate information with Flow Objects. Text and graphical non-Flow Objects can be associated with the Flow Objects.	
Text Annotation (attached with an Association)	Text Annotations are a mechanism for a modeler to provide additional information for the reader of a BPMN Diagram.	
Pool	A Pool represents a Participant in a Process. It is also acts as a "swimlane" and a graphical container for partitioning a set of activities from other Pools, usually in the context of B2B situations.	
Lanes	A Lane is a sub-partition within a Pool and will extend the entire length of the Pool, either	

	vertically or horizontally. Lanes are used to organize and categorize activities within a Pool.	