CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

FACULTY OF ECONOMICS AND MANAGEMENT

DEPARTMENT OF MANAGEMENT

DIPLOMA THESIS

PROPOSAL OF PLANNING CHANGE OF INFORMATION SYSTEM IN A COMPANY USING CRITICAL CHAIN METHOD

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Department of Management

Faculty of Economics and Management

DIPLOMA THESIS ASSIGNMENT

Jan Stoklasa

Informatics

Thesis title

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Objectives of thesis

First objective of the theoretical part is to explain what Project management is, what are common tools and methodologies in today's best practice.
Second objective of theoretical part is to explain with Theory of Constraints and its solutions.
Objective of practical part is to design a schedule of change of Informational system in a company.
Partial goals are:
To identify all important project tasks and include them in schedule
Assign resources to each task
To eliminate resource multitasking on tasks
To find Critical Chain in tasks sequence

Methodology

Theoretical part will be covered by multiple resources.

Theory of Project management and methodologies will be compile by books and articles study.

Theory of CCM and TOC will be mostly covered by workshop by Goldratt CZ, s.r.o., "Critical Chain: Management of Individual Projects & Multi-project Management" lectured by Ing. Miroslav Šmíra [18]. Knowledge gained during this workshop will be applied also in practical part of this thesis.

Technological background will be also covered mostly by books and articles study and also author's knowledge gained at university and his real life practice, work at ECOM spol. s r.o. and current internship at Deloitte Advisory s.r.o.

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First, necessary tasks to finalize project and resources which can be assigned to each task will be found. Then tasks will be set up in their logical and durational. After that, where possible, multitasking of resources will be eliminated. Then Critical Chain of this project will be identified.

Critical tasks and whole project will receive time reserves – "buffers". Duration of whole project will be calculated by tasks' and buffers' lengths.

The proposed extent of the thesis

60 – 80 pages

Keywords

Project management, change of information system, critical chain, PRINCE2, PERT, critical path, theory of constraints, network analysis

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Recommended information sources

A Guide to the Project Management Body of Knowledge, copyright page, edition 5 2013 ISBN 978-1-935589-67-9

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Expected date of thesis defence

2015/06 (June)

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Prague on 30. 03. 2015

Declaration

I declare that I have worked on my diploma thesis titled „PROPOSAL OF PLANNING CHANGE OF INFORMATION SYSTEM IN A COMPANY USING CRITICAL CHAIN METHOD“ by myself and I have used only the sources mentioned at the end of the thesis. As the author of the diploma thesis, I declare that the thesis does not break copyrights of any third person.

In Prague on:

.....

Jan Stoklasa

Acknowledgement

I would like to thank Selby Richard, Ph.D., Ing. Roman Krtička, Ing. Jaroslav Formánek, Ing. Jan Bartoška, Ph.D., Ing. Miroslav Šmíra, Ing. Lukáš Kodera and all other persons, for their advice, experience and support during my work on this thesis.

PROPOSAL OF PLANNING CHANGE OF INFORMATION SYSTEM IN A COMPANY USING CRITICAL CHAIN METHOD

NÁVRH PLÁNU NA ZMĚNU INFORMAČNÍHO SYSTÉMU VE FIRMĚ POMOCÍ METODY KRITICKÉHO ŘETĚZU

SUMMARY

This thesis deals with solution of schedule of Information System change in ECOM spol. s r.o. using Critical Chain Methodology.

In theoretical part there will be explained issue of project management (PM), known PM methodologies and PM processes and more complex Critical Chain method and Theory of Constraints (TOC). Because of technical focus of the project there will be explained also essential terms related to Information systems and their change.

Practical part will deal with schedule and management of IS change using Critical Chain Method (CCM).

Result of this thesis will be detailed schedule of IS change solving all important tasks of this process.

KEYWORDS

Project management, change of information system, critical chain, PRINCE2, PERT, critical path, theory of constraints, network analysis

SOUHRN

Tato diplomová práce se zabývá řešením plánu změny informačního systému ve firmě ECOM spol. s r.o.

V teoretické části bude vysvětlena problematika projektového řízení (PM), známých metodologií PM a jejích procesů a podrobněji metoda Kritického řetězu a Teorie Omezení (TOC). Kvůli technickému zaměření projektu, budou vysvětleny také nezbytné termíny týkající se informačních systémů a jeho změny.

Praktická část se bude zabývat samotným plánem a řízením změny IS pomocí metody Kritického řetězu (CCM).

Výsledkem práce bude detailní plán změny informačního systému, řešící všechny důležité kroky tohoto procesu.

KLÍČOVÁ SLOVA

Projektové řízení, změna informačního systému, kritický řetěz, PRINCE2, PERT, kritická cesta, teorie omezení, síťová analýza

Contents

1 Introduction

Project is a set of activities which achieves a specific objective (quality) through a process of planning and executing tasks (schedule) and the effective use of resources (budget).

A project has distinctive attributes which distinguish it from ongoing work or business process workflow.

- While ongoing work is cyclic and repetitive, a project has discreet objectives and is funded only for the project life cycle.
- Projects have a finite life span with a clear beginning and specified scope of work, including the desired end-result deliverables, end date and budget/ resource constraints.
- Projects can be analysed into a set of tasks laid out on a timeline. A complex project may have several strands of these timelines with different teams of people coordinating their activity to achieve the required deliverables at the date due.
- Projects can be visualized as having milestones which define the required major steps of achievement (or deliverables) along the path toward final project completion. Milestones are important markers of progress that indicate if a project is on time or falling behind schedule.
- Project management seeks to gain control over six main variables: time, cost, quality, scope, risk, and people.

The three basic dimensions of project success are quality (end-results), time (schedule) and cost (budget). These are the issues that project managers are held accountable for:

- Quality – fitness of end deliverables for purpose or specification level
- Time – target completion date and schedule of tasks
- Costs – budget and resource allocation

Picture 1 - Triangle of Objectives

Source - [30]

Before organizations begun to apply project management tools in practice during second half of twentieth century, project were usually managed by engineers, architects and builders themselves. [1]

Robbins-Gioia, LLC, a provider of management consulting services, made a study over the perception by enterprises of their implementation of an Enterprise Resource Planning package. Their survey had 232 respondents spanning multiple industries including government, Information Technology, communications, financial and healthcare. A total of 36% of the companies surveyed had, or were in the process of implementing an ERP system. Robbing-Gioia have found that:

- 51% viewed their ERP implementation as unsuccessful
- 46% of the participants noted that while their organisation had an ERP system in place, or was implementing a system, they did not feel their organization understood how to use the system to improve the way they conduct business.
- 56% of survey respondents noted their organisation has a program management office (PMO) in place and of these respondents, only 36% felt their ERP implementation was unsuccessful.

Project failure is not defined by objective criteria but the perception of the respondents. [31]

According to another survey for French computer manufacturer and system integrator, BULL, by Spikes Cavell, 75% of IT project missed deadlines and 55% of them exceeded budged. [32]

It seems that ordinary project management methodologies cannot provide results due to their limited capabilities of considering constraints. And constraints and their overcoming is what this thesis is about.

2 Objectives and Methodology

2.1 Objectives

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3 Project Management and its Methodologies

First project management tool was Gantt chart, by Henry Gantt, who was called „the father of planning and control techniques". [2] This type of bar chart was independently developed by Karol Adamiecki as „Harmonogram" in 1896. [3] Gantt chart illustrates the start and finish dates of the tasks in a project. It can also project dependency relationships between tasks. It can also show progress of whole project.

Two mathematical project-scheduling models were developed during the 1950s. During Polaris missile submarine program, „Program Evaluation and Review Technique" (PERT) was developed by the United States Navy in conjunction with the Lockheed Corp. and Booz Allen Hamilton. It is a method to analyse involved time ordered tasks in completing project – the time needed to complete each task and minimum time needed to complete whole project.

DuPont Corp.'s and Remington Rand Corp.'s developed „Critical Path Method" (CPM) that calculates the longest path of planned activities in a project and earliest and latest that each task can start and finish without prolonging a project. Activities that would make project longer are critical – are on the longest path. [4]

CPM and PERT are commonly used in conjunction.

Since the beginning of project management as a discipline on its own, several associations were founded. Each published some best practice recommendation – methodology how to manage projects. E.g. The International Project Management Association (IPMA) was founded in Europe in 1967 [5] and Project Management Institute (PMI) was founded in 1969 in USA which in 1996 published „A Guide to the Project Management Body of Knowledge" (PMBOK). PMI also offers certifications.

There are multiple systematic, theoretical analysis of methods that can be applied to a project management. Most of them (like PRINCE2 and PMBOK) comes out of „best practice" recommendations. Others (like agile SCRUM) are commonly used for their original aim and environment they were created for.

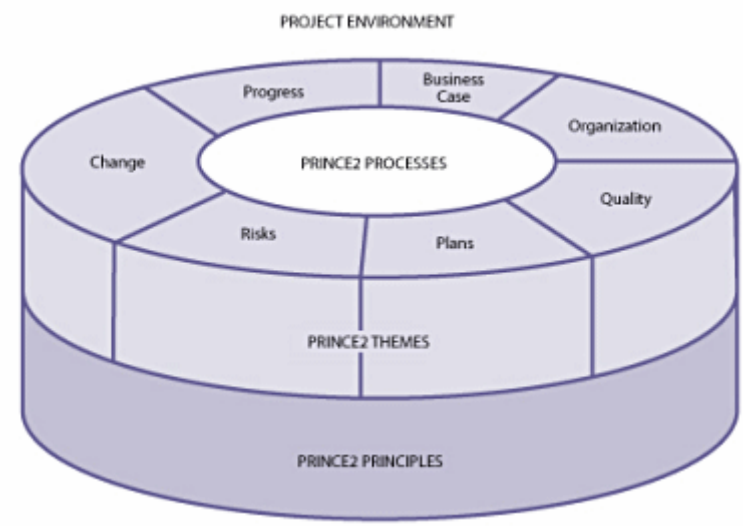
3.1 PRINCE 2

PRINCE (Projects IN a Controlled Environment) is British methodology based on older PROMPT II (which was used almost exclusively in IT environment) founded in 1989. Since then, PRINCE evolved to PRINCE2 in 1996 and its last large revision was in 2009. [6]

It was originally owned by UK Office of Government Commerce, now AXELOS Limited has registered copyright. PRINCE2 is applicable to all types of project, it manages the business focus of the project on a continuous basis and prevents managers from reinventing „the wheel" for PM. [7]

The PRINCE2 method addresses project management through integrated elements of principles, themes, processes and the project environment.

Picture 2 - The Structure of PRINCE2



Source - [7]

PRINCE2 Principles determine whether project is being managed using PRINCE2. Unless all seven of them are applied, project is not PRINCE2. Principles guide project manager through the project by „good practice". [7] The PRINCE2 principles are:

I. Continued business justification – is there a justifiable reason for starting the project that will remain consistent throughout its duration?

II. Learn from experience – PRINCE2 project teams should continually seek and draw on lessons learned from previous work.

III. Defined roles and responsibilities – the PRINCE2 project team should have a clear organizational structure and involve the right people in the right tasks.

IV. Manage by stages – PRINCE2 projects should be planned, monitored and controlled on a stage-by-stage basis.

V. Manage by exception – PRINCE2 project have defined tolerances for each project objective to establish limits of delegated authority.

VI. Focus on products – PRINCE2 projects focus on the product definition, delivery and quality requirements.

VII. Tailor to suit the project environment - PRINCE2 is tailored to suit the project's environment, size, complexity, importance, capability and risk.

PRINCE2 themes are aspects that must be addressed in parallel throughout the project. They explain the specific treatment required by PRINCE2 for various PM disciplines and why they are necessary. [7] The PRINCE2 themes are:

I. Business case – What value would delivering the project bring to the organization?

II. Organization – How will the project team's individual roles and responsibilities be defined in order for them to effectively manage the project?

III. Quality – What the quality requirements and measures are and how the project will deliver them.

IV. Plans – The steps required to develop the plans and PRINCE2 techniques that should be used.

V. Risk – How the project management will address the uncertainties in its plans and the project environment.

VI. Change – How the project management will assess and act on unforeseen issues or requests for change.

VII. Progress – The ongoing viability and performance of the plans and how and whether the project should proceed.

Processes of PRICE2 describes all steps of the project lifecycle – star to end. [7] Each process has checklists of recommended activities, products and related responsibilities:

I. Starting up a project

II. Directing a project

III. Initiating a project

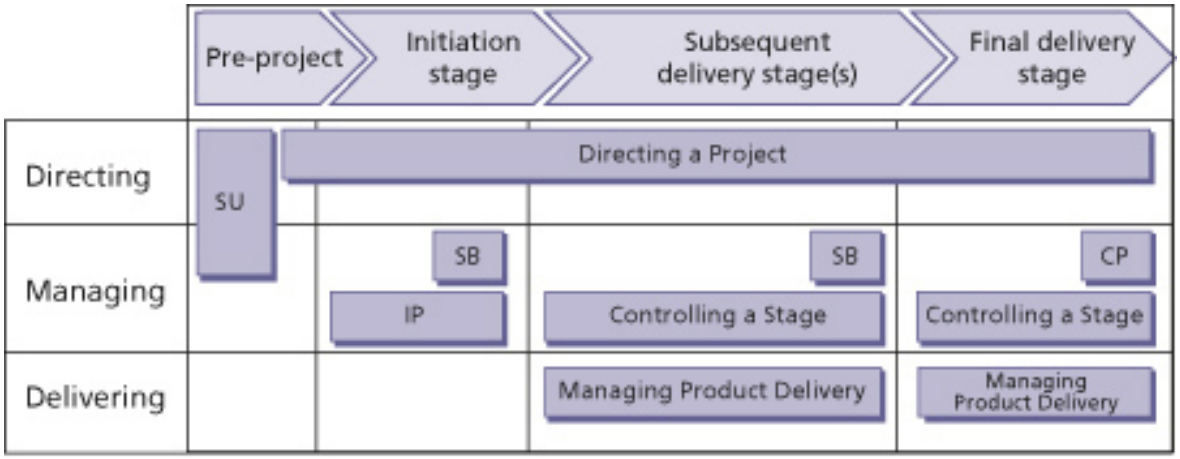
IV. Controlling a stage

V. Managing product delivery

VI. Managing stage boundaries

VII. Closing a project

Picture 3 - PRINCE2 Processes through the project lifecycle



Source - [7]

PRINCE2 Project Environment addresses the need to adapt this methodology to the specific context of the project. PRINCE2 in not „one size fits all" solution, but flexible framework that can be tailored to any type or size of project. [7]

3.2 PMBOK

Behind this methodology stands more than one authors and companies. It is administered by PMI which also provides certifications. [8]

First version of PMBOK was created in United States during 1996. Last version is from 20013. [8]

This standard is based on five process groups and ten knowledge areas [8].

Process groups are [8]:

I. Initiating – Those processes performed to define a new project or a new phase of an existing project by obtaining authorization to start the project or phase.

II. Planning – Those processes required to establish the scope of the project, refine the objectives, and define the course of action required to attain the objectives that the project was undertaken to achieve.

III. Executing – Those processes performed to complete the work defined in the project management plan to satisfy the project specifications

IV. Monitoring and Controlling – Those processes required to track, review, and regulate the progress and performance of the project; identify any areas in which changes to the plan are required; and initiate the corresponding changes.

V. Closing – Those processes performed to finalize all activities across all Process Groups to formally close the project or phase.

PMBOK knowledge areas are [6]:

I. Project Integration Management – this knowledge area is the only one that is included in each process group. Integration Management area connects and integrates all other areas

II. Project Scope Management – defines steps that leads to creation of scope of project and its reservation. It includes also managing of changes. First step is collection of requirements.

III. Project Time Management – deals with schedule creation based on project tasks. PMBOK puts emphasize to CPM.

IV. Project Cost Management – deals with budget creation and also with Earned Value Management (EVM) which calculates progress and outcome estimation.

V. Project Quality Management – includes processes and activities of the performing organization that determine quality policies, objectives and responsibilities so that the project will satisfy the needs for which it was undertaken [8].

VI. Project Human Resources Management – includes the processes that organize, manage, and lead the project team [8].

VII. Project Communications Management – includes the processes that are required to ensure timely and appropriate planning, collection, creation, distribution, storage, retrieval, management, control, monitoring, and the ultimate disposition of project information [8]. Focuses mainly on communication between all interested parties of the project (stakeholder management) [6].

VIII. Project Risk Management – includes the processes of conducting risk management planning, identification, analysis, response planning, and controlling risk on a project [8].

IX. Project Procurement Management – processes necessary to purchase or acquire products, services, or results needed from outside the project team [8].

X. Project Stakeholders Management – processes required to identify all people or organizations impacted by the project, analysing stakeholder expectations and impact on the project, and developing appropriate management strategies for effectively engaging stakeholders in project decisions and execution [8].

3.3 Agile Project Management

Agile Project Management, also called „Extreme Project Management" is a variant of iterative life cycle [10]. Agile methods complete small portions of the deliverables in each delivery cycle (iteration), but classic Iterative methods evolve the entire set of deliverables over time and completing them at the end of the project [9].

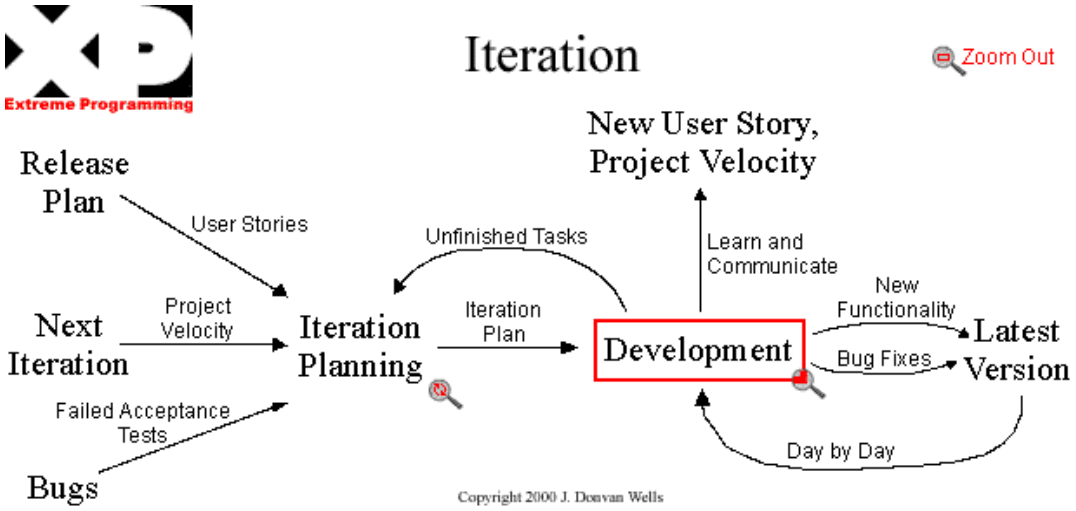
Agile Methods are mentioned in the PMBOK Guide under Project Lifecycle definition as adaptive project life cycle – „also known as change-driven or agile methods, that is intended to facilitate change and require a high degree of ongoing stakeholder involvement. Adaptive life cycles are also iterative and incremental, but differ in that iterations are very rapid (usually 2-4 weeks in length) and are fixed in time and resources." [8]

Agile Methodologies for example are [11]:

- Scrum – the „Product Owner" works closely with the team to identify and prioritize system functionality in form of a „Product Backlog". The Product Backlog consists of features, bug fixes, non-functional requirements, etc. - whatever needs to be done in order to successfully deliver a working software system. With priorities driven by the Product Owner, cross-functional teams estimate and sign-up to deliver „potentially shippable increments" of software during successive Sprints, typically lasting 30 days. Once a Sprint's Product Backlog is committed, no additional functionality can be added to the Sprint except by the team. Once a Sprint has been delivered, the Product Backlog is analysed and reprioritized, if necessary, and the next set of functionality is selected for the next Sprint.

- Extreme Programming (XP) – In XP, the „Customer" works very closely with the development team to define and prioritize granular units of functionality referred to as „User Stories". The development team estimates, plans, and delivers the highest priority user stories in the form of working, tested software on an iteration-by-iteration basis. In order to maximize productivity, the practices provide a supportive, lightweight framework to guide a team and ensure high-quality software.

Picture 4 - Diagram of XP



Source - [11]

- Dynamic Systems Development Method (DSDM) – DSDM, dating back to 1994, grew out of the need to provide an industry standard project delivery framework for what was referred to as Rapid Application Development (RAD) at the time. While RAD was extremely popular in the early 1990s, the RAD approach to software delivery evolved in a fairly unstructured manner. As a result, the DSDM Consortium was created and convened in 1994 with the goal of devising and promoting a common industry framework for rapid software delivery. Since 1994, the DSDM methodology has evolved and matured to provide a comprehensive foundation for planning, managing, executing, and scaling agile process and iterative software development projects. DSDM is based on nine key principles that primarily revolve around business needs/value, active user involvement, empowered teams, frequent delivery, integrated testing, and stakeholder collaboration. DSDM specifically calls out “fitness for business purpose” as the primary criteria for delivery and acceptance of a system, focusing on the useful 80% of the system that can be deployed in 20% of the time. Requirements are base-lined at a high level early in the project. Rework is built into the process, and all development changes must be reversible. Requirements are planned and delivered in short, fixed-length time-boxes, also referred to as iterations, and requirements for DSDM projects are prioritized using MoSCoW Rules:

- M – Must have requirements
- S – Should have if at all possible
- C – Could have but not critical
- W - Won 't have this time, but potentially later

All critical work must be completed in a DSDM project. It is also important that not every requirement in a project or time-box is considered critical. Within each time-box, less critical items are included so that if necessary, they can be removed to keep from impacting higher priority requirements on the schedule.

The DSDM project framework is independent of, and can be implemented in conjunction with, other iterative methodologies such as Extreme Programming and the Rational Unified Process.

- Feature-Driven Development (FDD) – FDD is a model-driven, short-iteration process. It begins with establishing an overall model shape. Then it continues with a series of two-week "design by feature, build by feature" iterations. The features are small, "useful in the eyes of the client" results. FDD designs the rest of the development process around feature delivery using the following eight practices:
  - Domain Object Modelling
  - Developing by Feature
  - Component/Class Ownership
  - Feature Teams
  - Inspections
  - Configuration Management
  - Regular Builds
  - Visibility of progress and results

FDD recommends specific programmer practices such as “Regular Builds” and “Component/Class Ownership”. FDD's proponents claim that it scales more straightforwardly than other approaches, and is better suited to larger teams. Unlike other agile methods, FDD describes specific, very short phases of work, which are to be accomplished separately per feature. These include Domain Walkthrough, Design, Design Inspection, Code, Code Inspection, and Promote to Build.

3.4 Process-based Management

Process-based management is a management approach that views a business as a collection of processes. The Processes are managed and improved by organization in purpose of achieving their Vision, Mission and Core Value. There is a clear correlation between processes and the Vision supports the company to plan strategies, build a business structure and use resources that are required to achieve success in the long run sufficiently. [12]

Vision, mission and core value are three crucial factors to manage an organization from a process perspective. Considering the vision, mission and value as a direction of their business, an organization can build their corporate strategy and determine the processes they will take into account. [15]

- Vision – an aspirational purpose what the organization would like to achieve in the long run. The vision leads the company to challenge various tasks and develop its own business strategy. In other words, the organization considers vision as a motivation to build a business structure, determine strategic plans and manage human resources. Therefore, the company carries out the "vision-achieving operations" as their primary goals.

- Mission – a fundamental purpose of a company that remains unchanged over time. The mission provides a guidance for decision making and gives a path to successful results. For instance, mission is different from a vision in that mission is a something to be achieved whereas a vision is something to be aimed for achievement. [16]

- Core Value – a principle that helps companies to determine whether the actions and decisions are right or wrong. The value is essential to take decision-making and sustain the company's long-term success. [14]

There are three stages in process-based management:

- Documenting the process – To manage its business from a process based perspective, an organization requires to understand what defines the process and which activities they consist of.

A business consists of different departments in charge of specific jobs or functions. Therefore, the processes support these managerial sectors and transform successful outputs. Then a process team performs a set of sequential tasks to analyse whether the organization delivers useful outputs to the customers.

Basically, processes are built by information that indicates the current state of company and research data such as customer satisfaction. The information includes customer-based agreement, management documentation, purchasing manuals and flow charts. For instance, the flow chart is a useful information in order to control the flow of processes and list several steps and activities in detail. [16]

- Analysing process performance – Analysed and clarified processes are allowed to implement on the actual business. Then, an organization monitors its business and improves the overall stage of process.

  To evaluate the sequence of process, measurement is an essential element that shows results of process performance with numerical and comparative data. In other words, organizations obtain a relevant analysis using the measurements that can be shown as graphical representations such as pie charts, bar charts, cause-and-effect analysis, and gap analysis.

  Many organizations highly depend on data and visual analysis processed by information system. For this reason, organization must obtain accurate analysis based on exact data and must be cautious for mistaken output that impacts whole process of their business.

  As a result, the measurements help the company to analyse current state of performance and give guidance for the firm's sustainable improvements. [16]

- Implementing the improvements – Having designed the processes of management system and analysed the performances using useful measurements, the final step is how to improve the system and maintain its effectiveness. Therefore, implementing the improvements is a key activity to examine the processes and improve the flow of the management system.

An organization determines which part of processes must be improved and modified. It analyses how each process influences a set of activities and applies the improvements to some parts of system. The purpose of implementation is to operate its business strategically and to deliver sufficient resources. In effect, the process based management results in outputs that satisfy their customers and develop the business itself. [17]

3.5 Critical Chain Project Management

Critical Chain Project Management (CCPM) is a method of planning and managing project developed by Eliyahu M. Goldratt.

In contrast to CPM and PERT it takes into consideration that our resources are limited by multiple reasons. These limitations are described by Theory of Constraints. [18]

3.5.1 Theory of Constraints

Theory of Constraints (TOC) sees any process as sequence of events (tasks, activities) that are all subject to probability. [21]

Thanks to evolutionary development, every rational man tends to behave the way that he:

- Avoids activities that is harming him
- Do activities that are good for him
- Doesn't care about other activities

This assumption makes estimation of task's duration hard for employee. Project Manager usually wants employee to make short estimates. That leads to short total time of project. Employees are often disturbed during their regular and project work which leads to exceeding originally estimated task duration which is causing delay of project. [18]

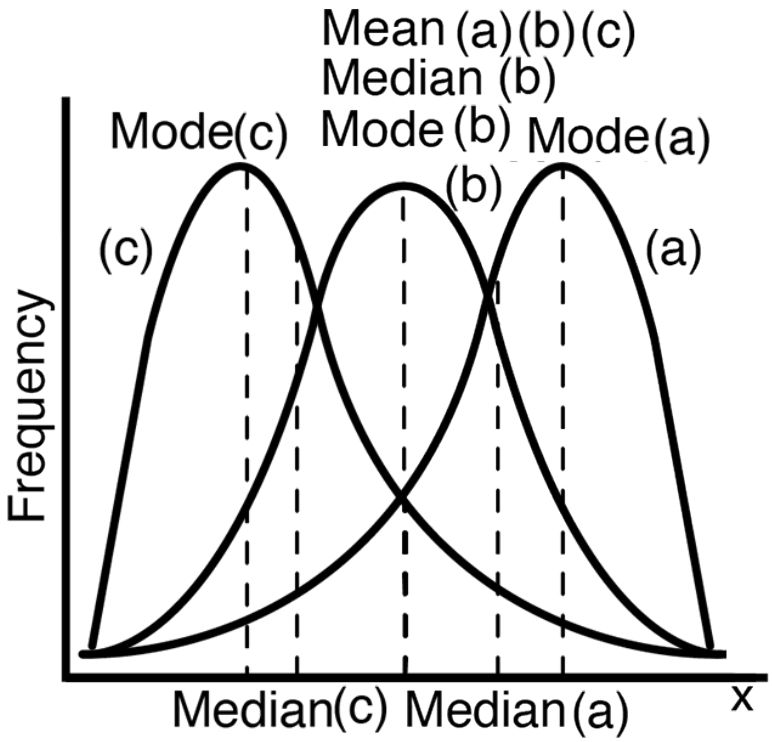
For that reason employees are in two conflicts:

- To OR Not to exaggerate task duration estimates
- To OR Not to hand in task when it is done if it is done before he originally estimated

Project manager is in similar situation. He can exaggerate durations of task and protect project from delay or don't protect project and try to finish it as soon as possible. [18]

According to TOC, task duration is described by Positively Skewed distribution (see Picture 4).

Picture 5 - Distributions



(a) Negatively Skewed

(b) Normal (no skew)

(c) Positively Skewed

Source - Own creation

In case that similar task was ever done in time, we can say that each task has its own time reserve. As seen in practice – customers are usually fain with 80-90% certainty of finishing task in time. [18]

Internal task time reserve consist of:

- Multitasking – worker usually has to do more than one task at once.
- Parkinson's Law – work expands so as to fill the time available for its completion. If worker finishes task earlier than expected he uses rest of the time to improve the product. CCPM is fain with product "good enough" so necessary improvements doesn't have any other effect than delaying project.
- Probability – Each task in a sequence has some probability of finishing in time. Probability of finishing whole project on time is calculated by multiplying each task probability → the more task in a sequence the higher probability of failure of finishing project in time.

- Student syndrome – most of one's afford is the highest with approaching deadline.

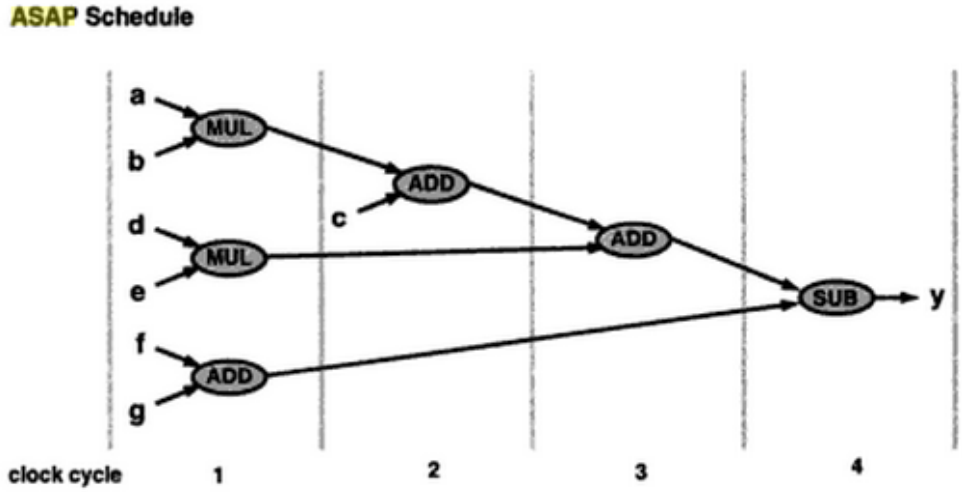
Tasks in sequence have logical relationship – dependency. Standard types of dependencies are [8]:

- Start to Start (SS) – Activity B can start only after Activity A has started
- Finish to Finish (FF) – Activity A must be complete before Activity B can finish
- Start to Finish (SF) – Activity B can't finish before Activity A starts
- Finish to Start (FS) – Activity A must be complete before Activity B can begin. This is considered "natural dependency".

Scheduling starts in timeline can be done by these methods [19]:

- ASAP – "As Soon As Possible", tasks are scheduled in the earliest possible start.

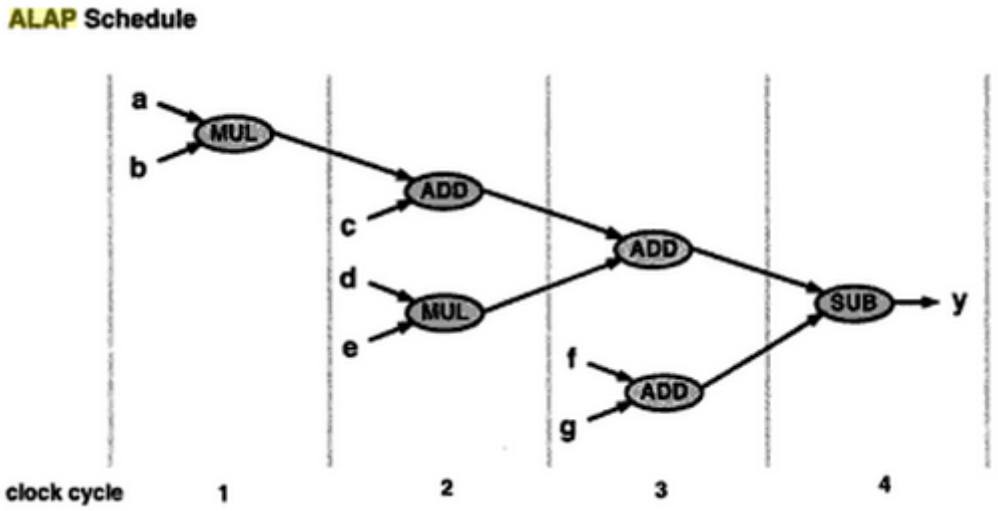
Picture 6 – ASAP Schedule



Source - [19]

- ALAP – "As Late As Possible", tasks are scheduled to latest possible start. According to CCPM this prevents from unnecessary occupation of resources and allows duration assumptions to be more precise.

Picture 7 - ALAP Schedule



Source - [19]

- ATAP – "As Timely As Possible", this approach is based on analysing each task on case-by-case basis to decide when the most opportune time is to begin. [20]

3.5.2 Drum Buffer Rope

Drum Buffer Rope (DBR) is one way how to deal with TOC.

Production is usually managed by two primary approaches [21]:

- Push approach – materials are released to production based on production schedule. There is model of production process that can estimate how material will go through manufacture process, when it will be on each production step and when product will be ready for shipment. These systems are called MRP II (Manufacturing Resource Planning).

- Pull approach – production is not planned, impulse to start to produce is sent by the end of manufacture process. It is produced only what is needed by that time. (JIT Systems) Responsibility for decisions during production process is on machine operators who don't see production requirements of whole company.

As stated in previous chapter about TOC, whole production process is affected by probability – production process is in this case stochastic. MRP II doesn't consider probability at all, JIT (because its nature) is resistant to probability effects. [21]

DBR sees any process as chain of events (affected by probability) and duration of each operation can be estimated (with some probability). Any chain is only as strong as it's the weakest link. Every product in production process has to go through this weak link – Narrow Point (DRUM) – e.g. production machine with the lowest capacity (the longest production time etc.). If at least one of the product's pieces has to go through this Narrow Point, we cannot produce more product than it is dictated by Narrow Point. It doesn't make any sense to release more materials into production than how many goes through Narrow Point. [21]

To produce maximum that system is able to, DRUM has to be exploited – it has to work on 100% of its capacity. To protect DRUM from "starvation" there has to be appropriate BUFFER to feed DRUM. [21]

Operations in production process after DRUM has higher capacity than DRUM and products flow through them easily even though they reach some obstacles. Time that takes products in the production flow reach DRUM is called ROPE. This duration has to be adjusted so that BUFFER isn't too full or too empty. [21]

DBR process is composed of these steps [18]:

- Identify DRUM – find Narrow Point in a process, if it is outside of this process, it cannot be solved by this method
- Exploit DRUM – us Narrow Point on its maximum capacity to maximize production
- Subordinate – every other production related activity is to be subordinate to DRUM. Do not produce more than DRUM can process and use BUFFER so DRUM doesn't "starve"
- Elevate – analysis of DRUM and increment of its capacity
- Repetition – analysis of whole process and finding new Narrow Point

3.5.3 Planning

CCPM plans tasks in project according to TOC. Thanks to Positively Skewed distribution of task duration, each task has its own time reserve. During process of project planning, CCPM considers only half of task duration estimated by its worker and eventually adds other half of original estimated duration as a Feeding Buffer.

Dependency between tasks is always Finish to Start.

CCPM utilizes ALAP scheduling so resources are not preoccupied and whole project can be easier time specified.

CCPM equip each task with list of activities that are necessary to complete before task can start. Task can be identified by its Unique ID (UID).

Task Manager (TM) is in charge of activity execution and its update.

CCPM doesn't assign resources as labour, humans or machines but assigns skills. This can help to solve unwanted multitasking of resources and is also according to "good enough" philosophy of CCPM. It is important that worker does his tasks, tasks doesn't have to be as perfect as possible. [18]

CCPM utilized PERT chart to see tasks sequence in logical order. PERT shows relations between tasks and their duration, not when tasks will be done. Tasks with duration shorter than 3-5% of whole project should not be included in a project schedule. Project that contains more than 300 tasks should be divided into logical blocks (development, testing, production, etc.) and each block should be managed as individual project. [18]

Critical Chain of a project is tasks sequence that prevents finishing project with given final resources sooner. Critical Chain is Narrow Point and DBR can be applied on project schedule. [18]

Project schedule and total duration is calculated by these steps [18]:

I. To assemble tasks sequence in logical and ALAP order without any time buffers in

II. To solve resource conflict and to supress their multitasking

III. To find Critical Chain

IV. To use Resource Buffers (RB) on tasks that are on Critical Chain to protect them from delayed availability of resources. RB is half of task duration.

V. To calculate duration of Critical Chain and to use its half as Project Buffer (PB) at the end of whole project. PB protects Completion Date from changeability of tasks on Critical Chain.

VI. To use Feeding Buffers (FB) on non-critical tasks that are linked to Critical Chain to protect them from delay. FB is half of duration of non-critical chain.

VII. Duration from start of firs task to the end of Project Buffer is the Total Project Duration.

VIII. To repeat whole process and to try to find ways to make Critical Chain shorter (use more resources etc.) and add new Buffers.

Project Milestones:

- Project End (PE) – date of project completion including Project Buffer. Only one in a project – output.
- Contractual Milestone (CMS) – behaves like project output. It has to be protected by Milestone Buffer. CMS can be for example Release Date of product or link between two related parallel projects (e.g. structural and purchase projects).
- Start No Early Than (SNET) – waiting for approval, budget release, surviving stock-inventory or accounting period
- Internal Milestone (IMS) – symptom. “When it should to be done and how does it look like now?” (e.g. when testing should have started and what is the time difference, one month before meeting)
- Purchasing Task (PT) – traces purchasing tasks, has duration and delivery date, expected date/need date. Monitors the need to process buffers.
- Full kit (FK) – mechanism which blocks execution of some activity until there are ready all necessary things to complete that activity.

3.5.4 Management using Buffers

Real duration of each task in project usually differs from what was estimated in the beginning of a project. This is due to stochastic nature of all involved activities.

Completion Date of a project is then "shooting on moving target". CCPM doesn't force tasks to complete on time. Some tasks are finished earlier than expected (if PM is able to convince workers to hand in done work in advance without improving what was done) and some are delayed. On average, delayed and earlier task should cancel each other out so Completion Date should not be compromised. [18] In case that duration differences are too diverse, CCPM gradually consumes Project Buffer.

3.5.5 Monitoring

Monitoring of project contains of monitoring and managing all project Buffers and their progressive consumption. [18]

Inside Project Buffer there can be designed Trigged Points which executes some alternative solutions of Project Schedule (Rescue Plan) or inform PM about amount of consumed Project Buffer. [18]

First Trigger Point can be located for example in the middle of Project Buffer to inform PM that there were some obstacles during Project execution. Second Trigger Point can be in 1/3 of the second half of Project Buffer so PM knows that some alternative plans should be prepared. Last Trigger Point can be in 2/3 of the second half of Project Buffer and this one actually executes Rescue Plan. [18]

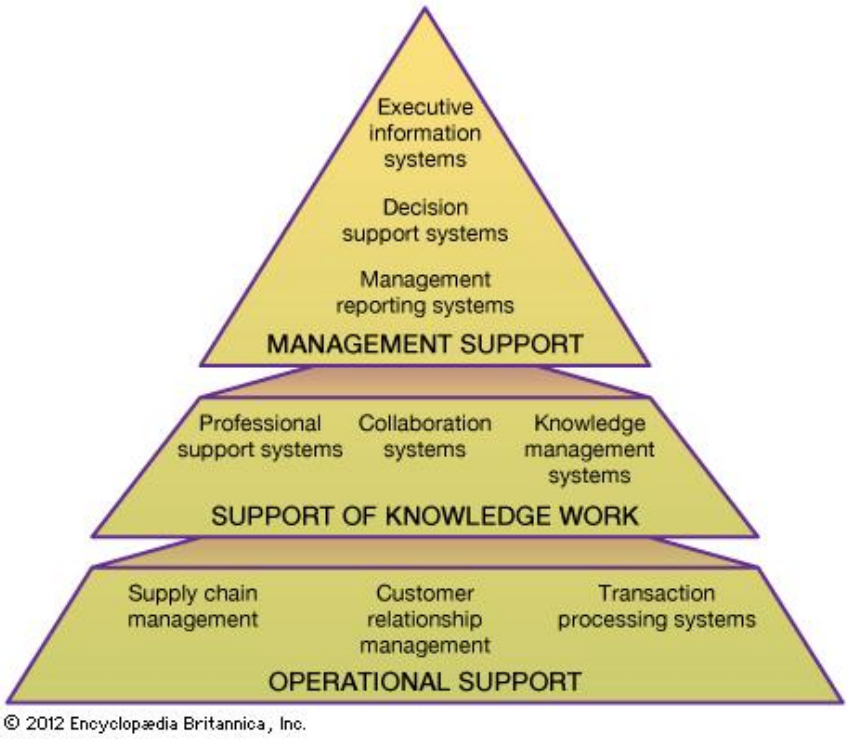
Locations of Trigger Point depends on remaining project duration of the project and remaining amount of Project Buffer which should be always half of that time. [18]

4 Technological Background of the Project

4.1 Information System

Information system is an integrated set of components for collecting, storing, and processing data and for delivering information, knowledge, and digital products. Business firms and other organizations rely on information systems to carry out and manage their operations, interact with their customers and suppliers, and compete in the marketplace. For instance, corporations use information systems to reach their potential customers with targeted messages over the Web, to process financial accounts, and to manage their human resources. [22]

Picture 8- Knowledge work: Information System structure



Source - [22]

4.2 Change of System

When a new system needs to be implemented in an organization, there are three different ways to adopt this new system [26]:

- Big Band Adoption (Instant Changeover) – when everybody associated with the new system moves to the fully functioning new system on a given date. The Big Bang adoption type is riskier than other adoption types because there are fewer learning opportunities incorporated in the approach, so quite some preparation is needed to get to the Big Bang. Once the management has decided to use the big bang method and supports the changes which are needed for this, the real changing process can start. This process exists of several steps: converting the system, releasing parts of the system and training the future users.

- Parallel adoption – In order to reduce risk, the old and new system run simultaneously for some period of time after which, if the criteria for the new system are met, the old system is disabled. The process requires careful planning and control and a significant investment in labour hours. There are several instances when parallel conversion cannot be considered a viable conversion strategy. First consider if the new system contains significant schema changes. Data elements required by one system that are not being populated by the other can lead to at best data inaccuracies and at worst data corruption. Another concern is if the system relies on consumer off the shelf technology (COTS). If a COTS vendor's documentation states that more than one application cannot share the same database, then parallel conversion is not an option.

- Phased adoption – different parts of the organization are implemented in different subsequent time slots. The phased approach takes the conversion one step at a time. The implementation requires a thoroughly thought out scenario for starting to use the new system. And at every milestone one has to instruct the employees and other users. The old system is taken over by the new system in predefined steps until it is totally abounded. The actual installation of the new system will be done in several ways, per module or per product and several instances can be carried out. This may be done by introducing some of the functionalities of the system before the rest or

by introducing some functionalities to certain users before introducing them to all the users. This gives the users the time to cope with the changes caused by the system. It is common to organize an implementation team that moves from department to department. By moving, the team learns and so gains expertise and knowledge, so that each subsequent implementation will be a lot faster than the first one.

4.2.1 Hardware audit

This process consist of thorough inspection of current IT hardware – mail servers, databases, system server and workstations.

Concern is whether current hardware is still reliable and can run newly planned software "smoothly" and securely according to software specifications and current security standards.

Anything that is a potential threat to a new system must be replaced.

4.2.2 Data Migration

Data migration is the process of transporting data between computers, storage devices or formats. It is a key consideration for any system implementation, upgrade or consolidation. During data migration, software programs or scripts are used to map system data for automated migration. [23]

Source Data has to be transformed into format which future system will understand. Source to source transformation provides developers with the ability to remove much of the dull and/or tedious work of recognizing simple and potentially complex patterns in code and updating them accordingly. By using a transformational programming language a developer is able to write a set of rules that can be applied to source code. These rules (provided they are valid/correct), when run on the original source code, will produce syntactically valid transformed code. Essentially it allows the unique to write code that will itself write (transform) code. [24]

There are many different types of source to source transformations. Generally these different types of transformations fall into one of two categories [25]:

- Translation – a transformation from a language X into another language Y, where X is not the same as Y. That is to say, the source language and the target language are two different languages. There are several different types of Translation. These include, but are not limited to, Synthesis, Compilation, Migration, Reverse Engineering, and Analysis.
- Rephrasing – involves a transformation within the same language but merely stated a different way. The different types of Rephrasing are Normalization, Optimization, Refactoring, and Renovation.

Data migration is categorized as storage migration, database migration, application migration and business process migration. These scenarios are routine IT activities, and most organizations migrate data on a quarterly basis. [23]

Data migration occurs for a variety of reasons, including [23]:

- Server or storage equipment replacements or upgrades
- Website consolidation
- Server maintenance
- Data centre relocation

Original System Data will be "Rephrased" during this project using prepared Migration Protocols.

4.2.3 End-Users Training

Thorough training of End-Users of new Information System is very important element of change management.

Strategy of Training – analysis of employee structure can tell, what strategy is the most suitable for given organisation. It mostly depends on organisation size (number of people),

its complexity and its structure. At complex large organisation, end-users can be for example trained by “Key Users” selected from organisation’s staff, which receive their training from contractor’s Lecturers.

Subject of Training – training of whole system can be divided into logical segments and these segments (classes) can be taught separately. Thoughts should be also given to structure and content of study materials.

Training Feedback – after each class feedback from students should be collect so classes can be evaluated for their content, execution, speed etc. With negative feedback it is crucial to adjust coming classes. There should be also some kind of knowledge test of what students learned during these classes.

4.2.4 Testing

Testing can be divided into multiple areas, which covers the need of controlling a quality of set processes. Some areas are simple, other are more complex and track functionality across the system.

- Unit Tests – objective of these tests is to check settings of individual functions of a system. Monitor tools of these tests can be detailed report. Outputs are Report of testing process, List of modules ready to Function Tests, Status Report. When Status Report is closed for every implemented modules, testing can pass over to Function Tests

- Function (Modules) Tests – serves for confirmation of correct settings of individual system areas (modules of systems and their functions including programming, reports and interfaces) by testing scenarios over test data. Selected users use Testing Scenarios to perform activities in a system with test data and compare their achieved results with estimated results. All errors are registered into the scenarios to correspondent tasks. Outputs of Function Tests are Report of process and results of testing, Successfully Finished Scenarios. When Status Report is closed for all Function Tests, testing can pass over to Integration Tests.

- Integration Tests – objective is to confirm functionality of implemented system as integrated unit including continuity to each system modules and surrounding systems and processes outside implemented system (other systems…). For each Integration Scenario there is defined sequence of activities/checks of individual departments (responsible persons) which are in charge of Integration Testing. Sequences in scenarios have to be abide and after successful completion of department testing, responsible person notifies another department (which is next in line). Testing results are recorded into Integration Scenarios. Outputs are Report about testing process and Successfully Finished Scenarios.

- Stress Test – to check quality of implementation of system function during standard traffic and its peaks. Stress Test's most important component is tuning of system response during simulated traffic with high number of users who are executing complex transactions in a system according to prepared Scenarios. Stress responses of a systems are recorded and these records will be evaluated and implemented into another round of testing. Outputs are Report of testing process with recommendation of state solutions and Record of Stress responses.

- Recovery Test – to check system ability to recover from backup. Output is Report about test result.

- Security Test – to test secure access to system data. Users test individual system processes following test scenarios and verify that they cannot reach other data than they are authorised.

4.2.5 Go-Live

Go-live process turns new system on for the end-users and obtains feedback on the solution and monitors the solution.

5 Project of IS Change

5.1 ECOM spol. s r.o.

ECOM is a company, which deals by a supplier of detectors for flash, preparative and analytical purposes, as for complete system for analytical and preparative HPLC. HPLC is acronyms for High Pressure Liquid Chromatography.

Company was founded in October 1991. ECOM is Czech company with headquarters in Prague, capital of Czech Republic. The company is oriented on innovative solutions in areas of flash, preparative and analytic chromatography and control processes. Their goal is continue in high level of development, production and applications. ECOM believe that high quality of products and answerable service support innovative effort and effectiveness of their customers. ECOM has 33 employees these days, last year turnover was 62 million Czech Crowns.

5.1.1 Current IS – Altus Vario

Altus Vario is Czech economic ERP/CRM software.

Top management of ECOM issued a tender for new IS because current IS have insufficient possibility of following materials and stock during production process according to company's structure.

Used technologies [28]:

- Application of Microsoft Access with opportunity of own extensions
- Shared Library of Vario objects that allows to react on legislation changes
- Transactional processing
- Data sharing through Windows File server

5.1.2 New IS – Vision32

ERP/CRM system Vision32 is Czech software by company Vision Praha s.r.o. This solution was chosen by ECOM during tender for its customization possibilities which allowed ECOM to follow materials and stock in production more precisely.

General characteristics [29]:

- Database server is based on Sybase SQL Anywhere which is available for both Windows and Linux platforms.
- Vison32 utilizes client-server architecture (double layered architecture)
- Client Vision32 can be used outside OS Windows on terminals, smartphones and tablets
- Its Graphic User Interface, system behaviour can be customize
- Access Rights usage for sensitive data protection

5.1.3 Current Hardware and New Hardware

ECOM took this opportunity to completely redesign mail and system servers, their operational system, database server and all workstations.

Author cannot provide any further details because of confidential issues. Any HW specifications inside ECOM are considered sensitive data.

5.2 Schedule

Schedule will be done according to Critical Chain methodology.

5.2.1 Used Software

For creating Gantt Charts software GanttProject will be used. It is free project scheduling and management app for Windows, OSX and Linux.

First version was wrote in 2003 by Alexandre Thomas during his study at University of Marne-la-Vallée. On January 29th of the same year, GanttProject page is registered on SourceForge.[33]

For this project was used the latest version 2.7 – code name "Ostrava".

This software is available in multiple languages, e.g. Brasilian Portuguese, Croatian, Czech, Estonian, Finnish, French, Galician, German, Italian, Latvian, Norwegian, Polish, Russian, Serbian, Slovenian and Swedish.

5.2.2 List of tasks and their duration

Table 1 - Pre-Project Tasks

Task Name	duration [days]
Tender	1
Contract signature	1
Project Definition	10

Source - Own creation

Table 2 - Set of Tasks

Task Name	duration [days]
Project	
Organisation	5
HW Audit	2
HW Purchase	15
HW Installation	5
New IS Installation	21
IS Configuration	5
Preparation of the test environment	15
Testing Scenarios Creation	15

Source - Own creation

Table 3 - Migration Tasks

Task Name	duration [days]
Data Migration	
Preparation of Migration Protocols	5
Probationary Sample Migration	5
System Data Migration	15
Migrated Data Check and Correction	10

Source - Own creation

Table 4 - Testing Tasks

Task Name	duration [days]
Testing	
Unit Tests	7
Function Tests	15
Integration Tests	15
Stress Tests	5
Recovery Tests	2

Source - Own creation

Table 5 - User Training

Task Name	duration [days]
User Training	
Class Scheduling	5
Inviting Users to Classes	1

Source - Own creation

Table 6 - Classes and Feedbacks

Task Name	duration [days]
Classes	
Economics, HR	
E_Class01	1
E_Feedback01	1
E_Class02	1
E_Feedback02	1
E_Class03	1
E_Feedback03	1
Sale	
S_Class01	1
S_Feedback01	1
S_Class02	1
S_Feedback02	1
S_Class03	1
S_Feedback03	1
Stock and Purchasing	
SP_Class01	1
SP_Feedback01	1
SP_Class02	1
SP_Feedback02	1
SP_Class03	1
SP_Feedback03	1
Production	

P_Class01	1
P_Feedback01	1
P_Class02	1
P_Feedback02	1
P_Class03	1
P_Feedback03	1

Source - Own creation

Table 7 - End of Project

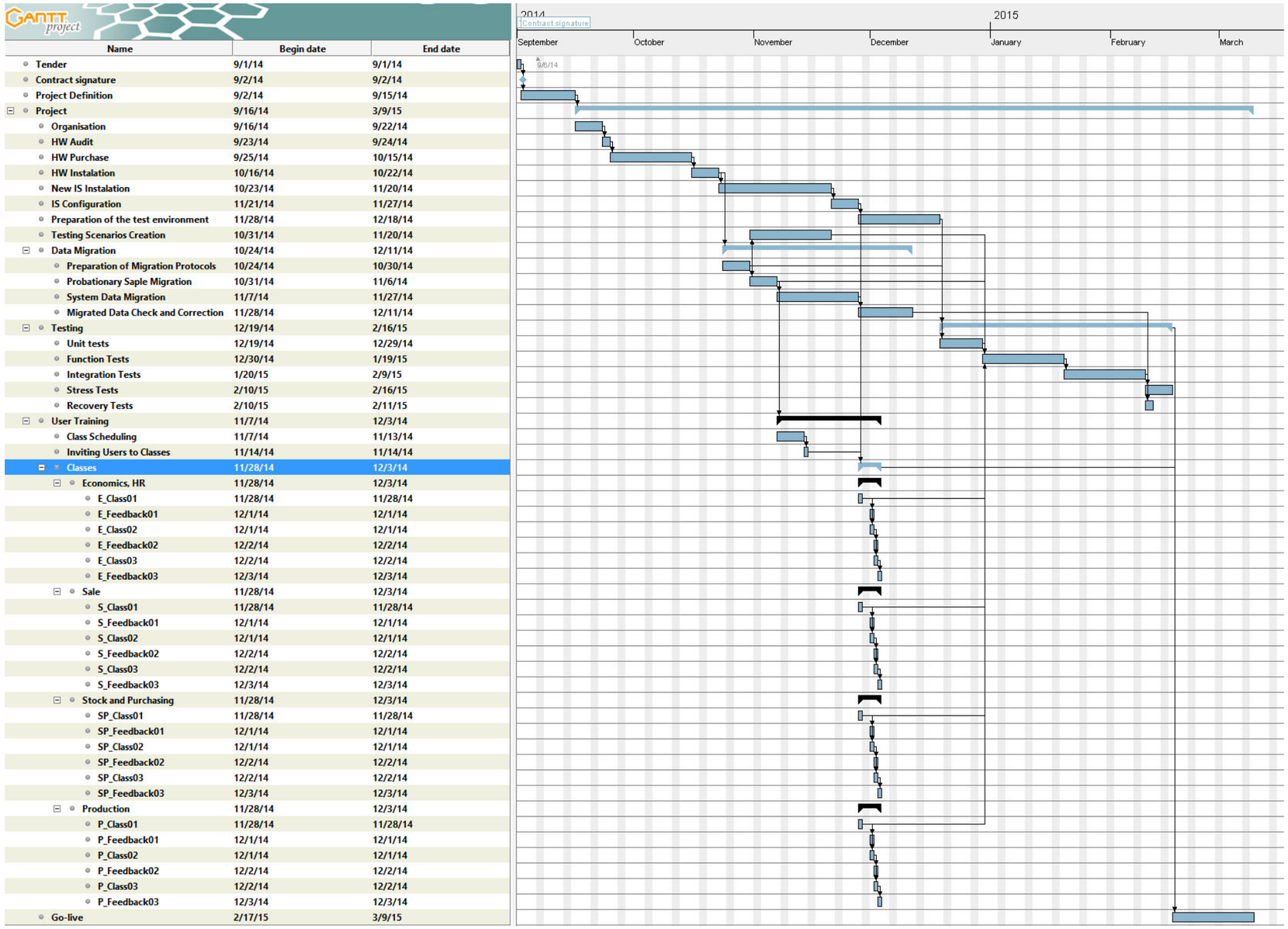
Task Name	duration [days]
Go-live	15

Source - Own creation

5.2.3 Gantt Charts

On Picture 8, there is Gantt Chart of all important tasks in logical order.

Picture 9 - Starting Gantt Chart



Name	Begin date	End date
Tender	9/1/14	9/1/14
Contract signature	9/2/14	9/2/14
Project Definition	9/2/14	9/15/14
Project	9/16/14	3/9/15
Organisation	9/16/14	9/22/14
HW Audit	9/23/14	9/24/14
HW Purchase	9/25/14	10/15/14
HW Instalation	10/16/14	10/22/14
New IS Instalation	10/23/14	11/20/14
IS Configuration	11/21/14	11/27/14
Preparation of the test environment	11/28/14	12/18/14
Testing Scenarios Creation	10/31/14	11/20/14
Data Migration	10/24/14	12/11/14
Preparation of Migration Protocols	10/24/14	10/30/14
Probationary Saple Migration	10/31/14	11/6/14
System Data Migration	11/7/14	11/27/14
Migrated Data Check and Correction	11/28/14	12/11/14
Testing	12/19/14	2/16/15
Unit tests	12/19/14	12/29/14
Function Tests	12/30/14	1/19/15
Integration Tests	1/20/15	2/9/15
Stress Tests	2/10/15	2/16/15
Recovery Tests	2/10/15	2/11/15
User Training	11/7/14	12/3/14
Class Scheduling	11/7/14	11/13/14
Inviting Users to Classes	11/14/14	11/14/14
Classes	11/28/14	12/3/14
Economics, HR	11/28/14	12/3/14
E_Class01	11/28/14	11/28/14
E_Feedback01	12/1/14	12/1/14
E_Class02	12/1/14	12/1/14
E_Feedback02	12/2/14	12/2/14
E_Class03	12/2/14	12/2/14
E_Feedback03	12/3/14	12/3/14
Sale	11/28/14	12/3/14
S_Class01	11/28/14	11/28/14
S_Feedback01	12/1/14	12/1/14
S_Class02	12/1/14	12/1/14
S_Feedback02	12/2/14	12/2/14
S_Class03	12/2/14	12/2/14
S_Feedback03	12/3/14	12/3/14
Stock and Purchasing	11/28/14	12/3/14
SP_Class01	11/28/14	11/28/14
SP_Feedback01	12/1/14	12/1/14
SP_Class02	12/1/14	12/1/14
SP_Feedback02	12/2/14	12/2/14
SP_Class03	12/2/14	12/2/14
SP_Feedback03	12/3/14	12/3/14
Production	11/28/14	12/3/14
P_Class01	11/28/14	11/28/14
P_Feedback01	12/1/14	12/1/14
P_Class02	12/1/14	12/1/14
P_Feedback02	12/2/14	12/2/14
P_Class03	12/2/14	12/2/14
P_Feedback03	12/3/14	12/3/14
Go-live	2/17/15	3/9/15

Source - Own Creation

Total duration between starting point September the 1st 2014 and end point March 10 2015 is 191 days.

List of resources – “skills” and tasks that these resources are assigned to is in Table 8.

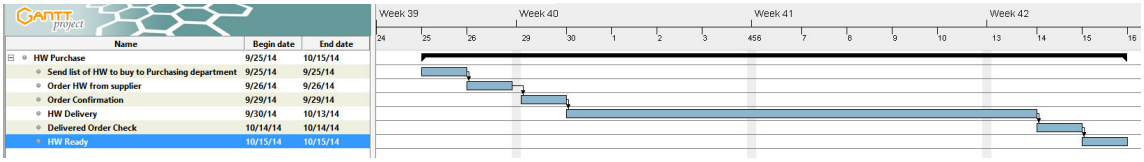
Table 8 - Resources' Tasks

Decision-making Management	Contractor	IT specialist	Lecturer	System Data Specialist
Tender	Contract signature	Project Definition	E_Class01	Preparation of Migration Protocols
Contract signature	Project Definition	HW Audit	E_Class02	Probationary Sample Migration
Project Definition	Organisation	HW Purchase	E_Class03	System Data Migration
Organisation	IS Configuration	HW Instalation	S_Class01	Migrated Data Check and Correction
Class Scheduling	Testing Scenarios Creation	New IS Instalation	S_Class02	
	Unit Tests	IS Configuration	S_Class03	
	Class Scheduling	Preparation of Migration Protocols	SP_Class01	
	Inviting Users to Classes	Probationary Sample Migration	SP_Class02	
	E_Feedback01	System Data Migration	SP_Class03	
	E_Feedback02	Migrated Data Check and Correction	P_Class01	
	E_Feedback03	Unit Tests	P_Class02	
	S_Feedback01	Integration Tests	P_Class03	
	S_Feedback02	Function Tests	E_Feedback01	
	S_Feedback03	Stress Tests	E_Feedback02	
	SP_Feedback01	Recovery Tests	E_Feedback03	
	SP_Feedback02	Go-Live	S_Feedback01	
	SP_Feedback03	Preparation of the test environment	S_Feedback02	
	P_Feedback01	Testin Scenarios Creation	S_Feedback03	
	P_Feedback02		SP_Feedback01	
	P_Feedback03		SP_Feedback02	
	Go-Live		SP_Feedback03	
			P_Feedback01	
			P_Feedback02	
			P_Feedback03	
Accounting	Sales	Purchasing	Expedition	Production
Function Tests	Function Tests	HW Purchase	Function Tests	Function Tests
Integration Tests	Integration Tests	Function Tests	Integration Tests	Integration Tests
E_Class01	E_Class01	Integration Tests	SP_Class01	P_Class01
E_Class02	E_Class02	SP_Class01	SP_Class02	P_Class02
E_Class03	E_Class03	SP_Class02	SP_Class03	P_Class03
	S_Class01	SP_Class03		
	S_Class02			
	S_Class03			

Source - Own creation

Most of these tasks can be broken down to more detail - “HW Purchase” is broken down as example on Picture 10.

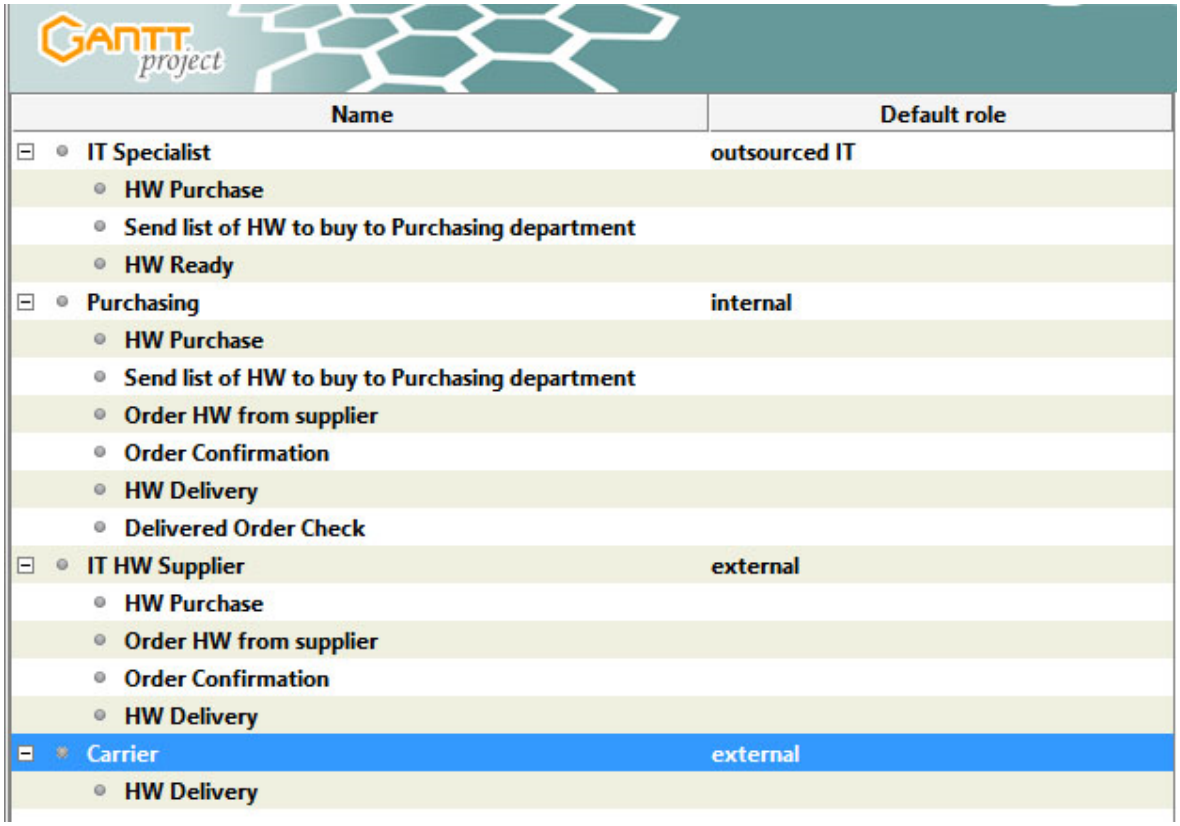
Picture 10 - HW Purchase in more detail



Source - Own creation

List of resources that are needed to complete this task is on Picture 11.

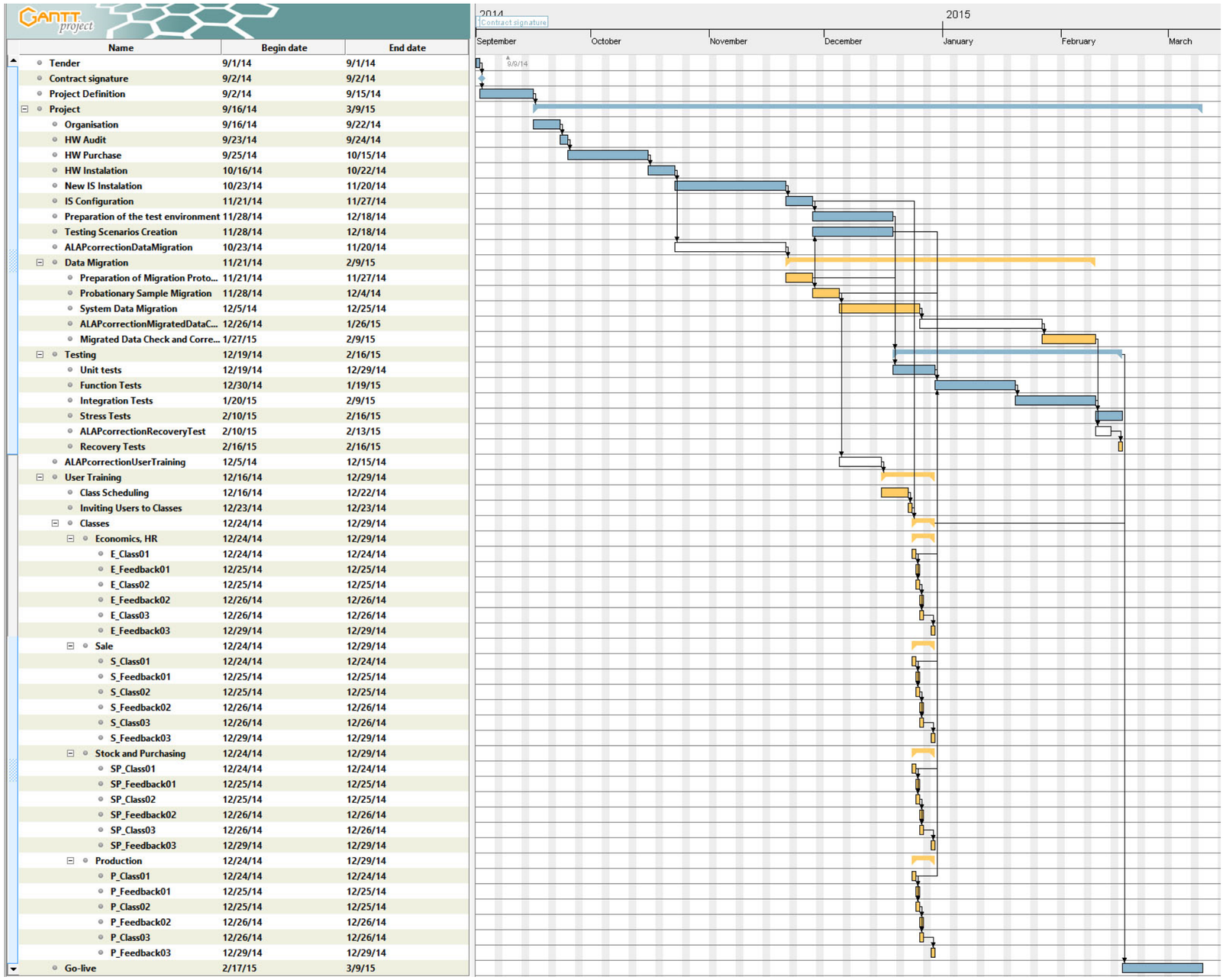
Picture 11- Resources of HW Purchase



Source - Own creation

All task have to be scheduled by ALAP method. Because of SW limitations this was done by adding “Correction Activities” before delayed task. This “shadow” activities are white on Picture 12. Delayed tasks are orange.

Picture 12 - ALAP Schedule



Name	Begin date	End date
Tender	9/1/14	9/1/14
Contract signature	9/2/14	9/2/14
Project Definition	9/2/14	9/15/14
Project	9/16/14	3/9/15
Organisation	9/16/14	9/22/14
HW Audit	9/23/14	9/24/14
HW Purchase	9/25/14	10/15/14
HW Instalation	10/16/14	10/22/14
New IS Instalation	10/23/14	11/20/14
IS Configuration	11/21/14	11/27/14
Preparation of the test environment	11/28/14	12/18/14
Testing Scenarios Creation	11/28/14	12/18/14
ALAPcorrectionDataMigration	10/23/14	11/20/14
Data Migration	11/21/14	2/9/15
Preparation of Migration Proto...	11/21/14	11/27/14
Probationary Sample Migration	11/28/14	12/4/14
System Data Migration	12/5/14	12/25/14
ALAPcorrectionMigratedDataC...	12/26/14	1/26/15
Migrated Data Check and Corre...	1/27/15	2/9/15
Testing	12/19/14	2/16/15
Unit tests	12/19/14	12/29/14
Function Tests	12/30/14	1/19/15
Integration Tests	1/20/15	2/9/15
Stress Tests	2/10/15	2/16/15
ALAPcorrectionRecoveryTest	2/10/15	2/13/15
Recovery Tests	2/16/15	2/16/15
ALAPcorrectionUserTraining	12/5/14	12/15/14
User Training	12/16/14	12/29/14
Class Scheduling	12/16/14	12/22/14
Inviting Users to Classes	12/23/14	12/23/14
Classes	12/24/14	12/29/14
Economics, HR	12/24/14	12/29/14
E_Class01	12/24/14	12/24/14
E_Feedback01	12/25/14	12/25/14
E_Class02	12/25/14	12/25/14
E_Feedback02	12/26/14	12/26/14
E_Class03	12/26/14	12/26/14
E_Feedback03	12/29/14	12/29/14
Sale	12/24/14	12/29/14
S_Class01	12/24/14	12/24/14
S_Feedback01	12/25/14	12/25/14
S_Class02	12/25/14	12/25/14
S_Feedback02	12/26/14	12/26/14
S_Class03	12/26/14	12/26/14
S_Feedback03	12/29/14	12/29/14
Stock and Purchasing	12/24/14	12/29/14
SP_Class01	12/24/14	12/24/14
SP_Feedback01	12/25/14	12/25/14
SP_Class02	12/25/14	12/25/14
SP_Feedback02	12/26/14	12/26/14
SP_Class03	12/26/14	12/26/14
SP_Feedback03	12/29/14	12/29/14
Production	12/24/14	12/29/14
P_Class01	12/24/14	12/24/14
P_Feedback01	12/25/14	12/25/14
P_Class02	12/25/14	12/25/14
P_Feedback02	12/26/14	12/26/14
P_Class03	12/26/14	12/26/14
P_Feedback03	12/29/14	12/29/14
Go-live	2/17/15	3/9/15

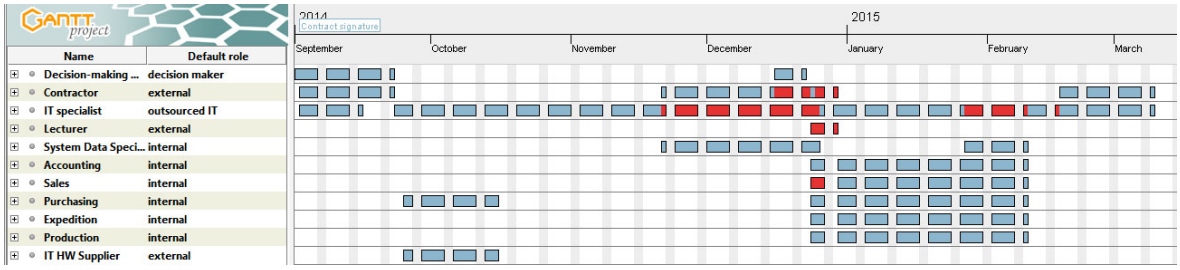
Source - Own creation

Transforming tasks sequence into ALAP scheduling did not make the whole project any longer.

Resources' multitasking can be eliminated either by adding another similar resource or shifting tasks in time and delaying the project.

Resources' multitasking is visible on Picture 13 as red cells.

Picture 13 - Multitasking of resources



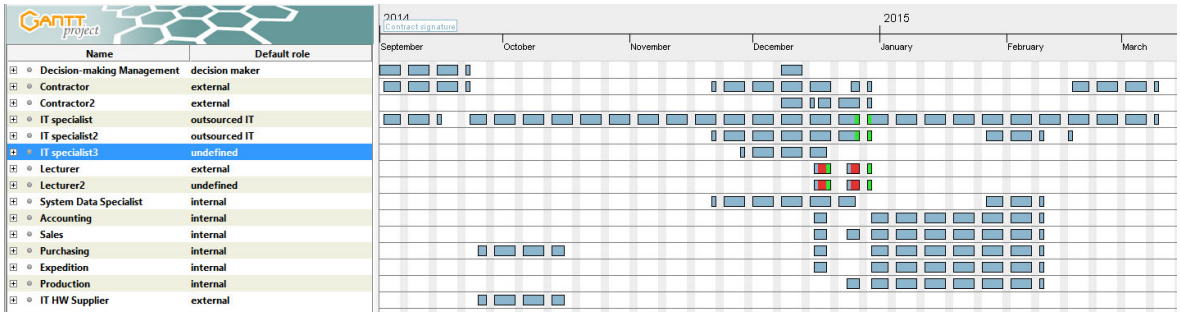
Source - Own creation

Most multitasking was at external or outsourced resources. In that case we are paying for service, adding another resource to help won't increase cost. To the project there were added resources: Contractor2, IT specialist 2 and 3, Lecturer2.

Only internal multitasking was in case of Sales in Training activities. Lecture Economics, HR was shifted to earlier start (ALAP correction activity was nearly consumed by this move) so Sales is free to visit lecture Sale.

Result of these steps is on Picture 14. Green cells are in case of partial resource occupation.

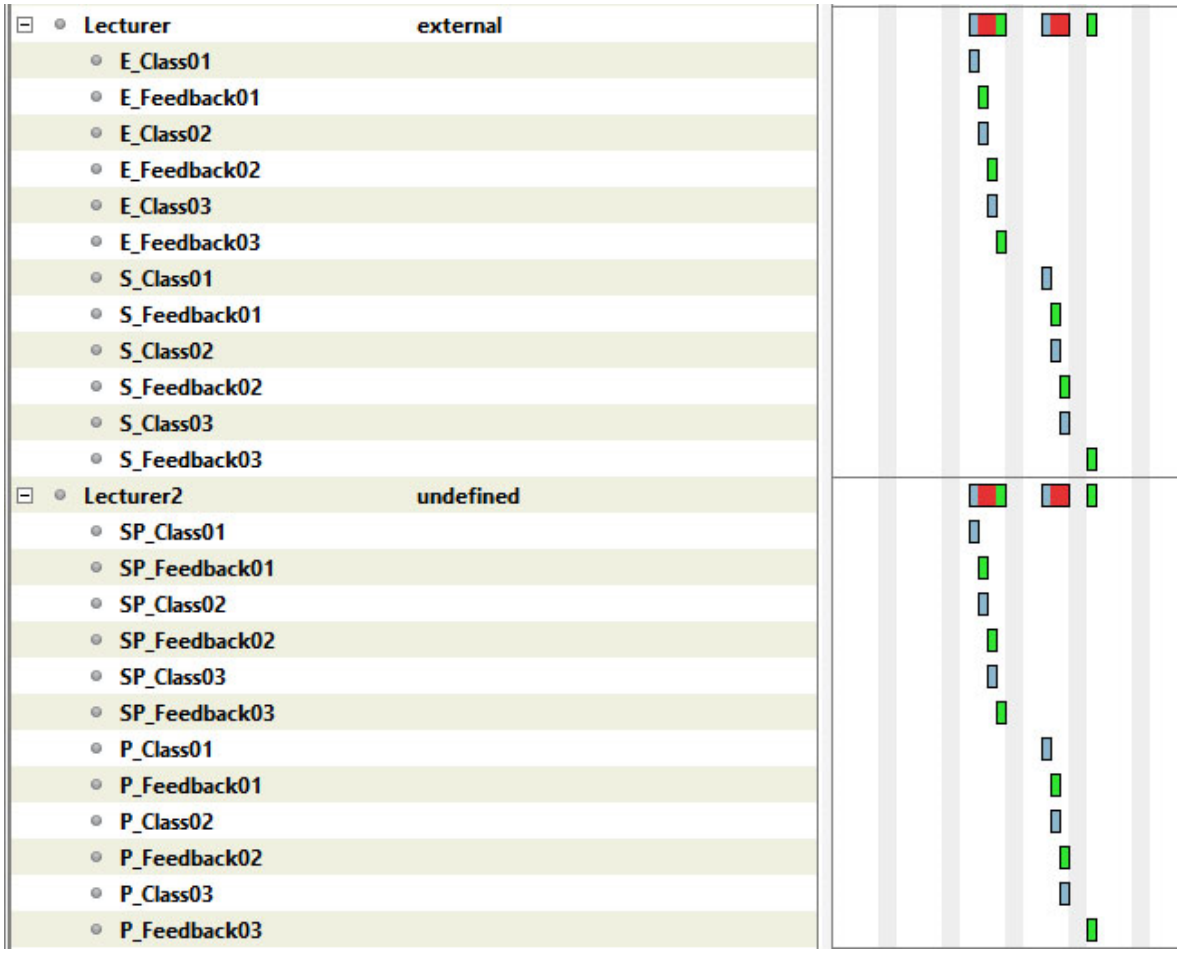
Picture 14 - Eliminated Resources' Multitasking



Source - Own creation

Only red cells remained at Lecturers. Detail of these activities is on Picture 15 below.

Picture 15 - Lecturers' multitasking

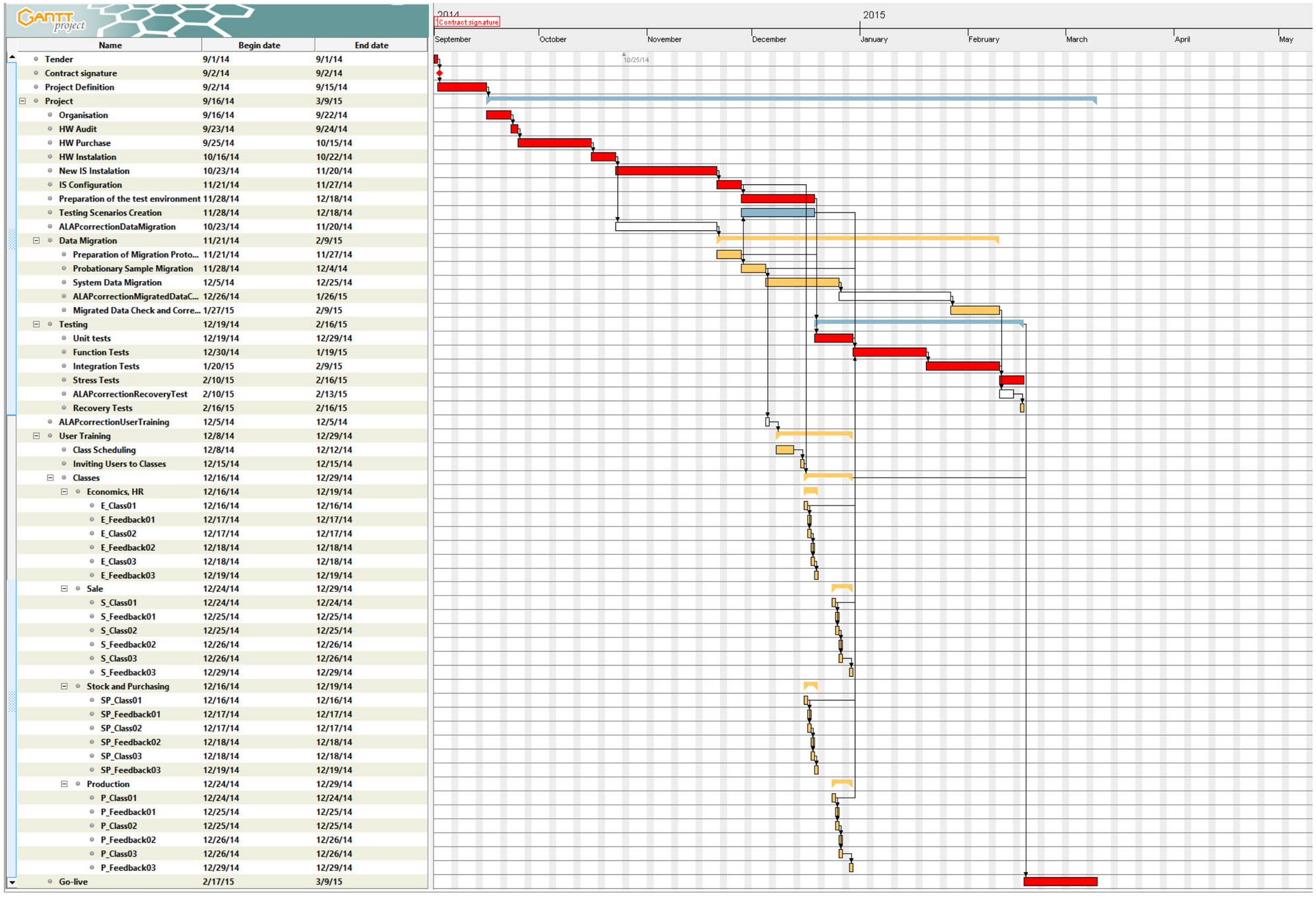


Source - Own creation

Multitasking of these resources is caused by activities X_Feedback0X. These tasks consist of conducting feedback about past lectures so they can be improved in the future. These tasks are shared between Lecturers (50% occupation) and Contractors (50% occupation). In author's opinion, Lecturers can handle conduct feedback after right after class and evaluate them together with Contractors – schedule and resources don't have to be adjusted any more.

As stated above in this thesis, Critical Chain is sequence of activities which prevents finishing project with given final resources sooner. On Picture 16, Critical Chain of this project is highlighted with red colour.

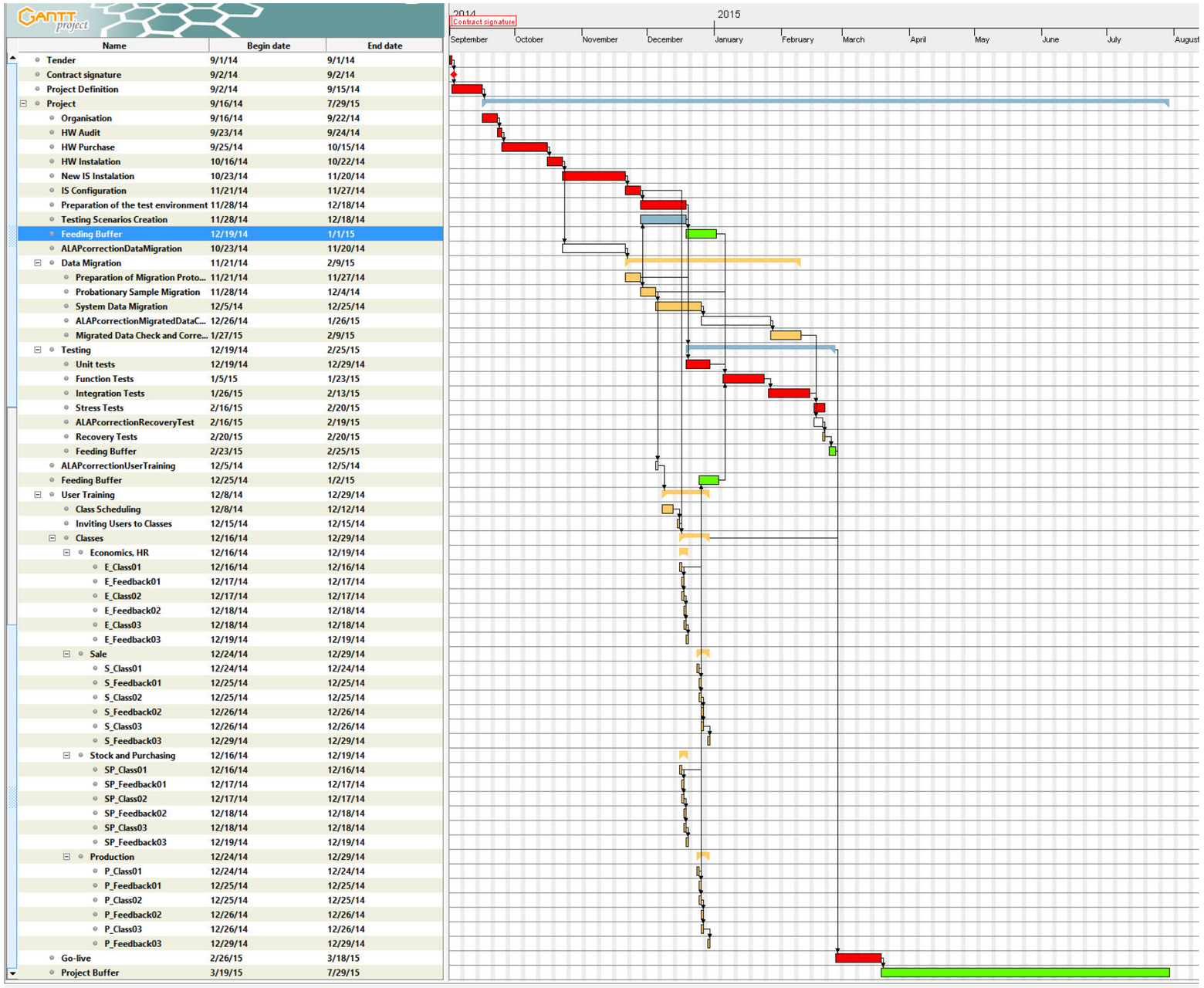
Picture 16 - Critical Chain



Source - Own creation

Next step in scheduling project by Critical Chain method is to add Project and Feeding Buffers in to the schedule. Buffers are green tasks on Picture 17.

Picture 17 - Critical Chain with Buffers



Source – Own creation

Project Buffer protects whole project from delaying. Its length is half of Critical Chain length. In this case 95 days.

Feeding buffers are where Non Critical branches of activities are linking to Critical Chain. Their length is half of the duration of the Non Critical branch (chain).

It is important to take into consideration gaps in project chains caused by deliberate task delaying or logical and date sequence of activities – chain with big gap doesn't have to be protected by buffers as well as chain with no time reserve.

As seen on Picture 16, some Class activities could be delayed in order to be ALAP. Considering that these activities are focused on teaching end users, it is not desirable to break them apart in time and delay only those Classes that can be delayed. End-users could forget what they learned in previous class. Also resources occupied by these activities are not required in later tasks so they are not unnecessarily preoccupied.

Project duration is now 332 days – September the 1st 2014 till July the 29th. Compared to the original duration of 191 days, project with protected Critical Chain is longer by 141 days. Original end point was March 10 2015.

5.3 Monitoring

Execution and monitoring of the project are not subject of this thesis. As explained in theoretical part, monitoring would be done by managing all project Buffers and their progressive consumption. Inside Project Buffer there would be designed Trigged Points which would executes some alternative solutions of Project Schedule (Rescue Plan) or inform PM about amount of consumed Project Buffer.

5.4 Budget

Budget is very important part of any project. Analysing of how much budget was exceeded is one of project's success attributes.

ECOM spol. s r.o. however considers budget information, contracts' details and other money related deals as sensitive data and author was not authorised to disclosed any of them.

6 Conclusion

Theoretical part of this thesis explained what Project management is and described common methodologies in today's best practice – starting with British PRINCE2, American PMBOK over to specially designated Agile and Process-Based Project management ending with Critical Chain Project Management and Theory of Constraints which CCPM is based on.

Theory of Constraints was described as method, which sees any situation as sequence of events (tasks, activities) that are all subject to probability. Drum Buffer Rope was explained as a possible way to deal with TOC. The main idea is to find something in a system or sequence of activities that is preventing the system to be more effective. When this limitation is located, it must be exploited and everything else has to be subordinated to the limitation – DRUM. When system is optimised, new DRUM should be located and whole process repeated.

Practical part dealt with a schedule of change of Informational system in a company ECOM spol. s r.o. First, all important tasks in this process were found. Resources were not described as tools or individuals but as skills so manpower was replaceable.

Then all tasks were set up into a logical order and expressed by Gantt Chart. After that, author dealt with the problem of resource multitasking and explained when it as necessary to add more resources, when to reschedule tasks and in which case multitasking wasn't a concern.

Critical Chain was then found and whole project was protected from delay by Project Buffer. Feeding Buffers were where Non Critical branches of activities were linking to Critical Chain of the project.

Project's duration increased from 191 days to 332. This longer project has, on the other hand, probability of finishing as planned over 80% [18].

If this project would be executed according this schedule, tasks and their delay or early finish would be monitored. Delayed task would consume some of added buffers and proportion of consumed buffers and elapsed time gives Project Manager signals about project's performance.

These partial goals of practical part were fulfilled:

- To identify all important project tasks and include them in schedule
- Assign resources to each task
- To eliminate resource multitasking on tasks
- To find Critical Chain in tasks sequence

7 List of Resources

7.1 List of Literature

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7.2 List of Pictures

7.3 List of Tables