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Design of restoration information system

Diplomová práce

Studijní program: N2301 – Mechanical Engineering
Studijní obor: 2301T049 – Manufacturing Systems and Processes

Autor práce: **Nagarajan Murugan**
Vedoucí práce: Ing. František Koblasa, Ph.D.

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Master thesis

Study programme: N2301 – Mechanical Engineering
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Author: **Nagarajan Murugan**
Supervisor: Ing. František Koblasa, Ph.D.

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DIPLOMA THESIS ASSIGNMENT

(PROJECT, ART WORK, ART PERFORMANCE)

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Rules for elaboration:

The goal of this thesis is to design information system which will be suitable for typical processes in restoration and renovation projects in Technical Museum of Liberec. This information system has two main purposes, to manage and describe restoration project in the field of mechanical engineering and to make young student who cooperate on projects understand typical functionality of ERP systems.

1. Introduction in to information system design, process analyses, VOC, management methodologies concerning with information system design, ULM etc.
2. Analysis and definition of typical processes of restoration projects in Technical museum of Liberec.
3. Design of information system processes and information system architecture.
4. Design of possible development and budget schedule.
5. Conclusion and evaluation.

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[1] LANGER, A. M. Analysis and design of information systems. 3rd ed. London: Springer, c2008. ISBN 978-1-84628-654-4.
[2] HEIJDEN, Johannes Govardus Maria van der. Designing management information systems. New York: Oxford University Press, 2009. ISBN 978-0199546329.
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[6] AVISON, D. E. a Gholamreza. TORKZADEH. Information systems project management. Los Angeles: SAGE, c2009. ISBN 978-1412957021.

Tutor for dissertation: **Ing. František Koblasa, Ph.D.**
Department of Manufacturing Systems and Automation

Dissertation Counsellor: **Ing. Miroslav Vavroušek**
Department of Manufacturing Systems and Automation

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prof. Dr. Ing. Petr Lenfeld
Dean

L.S.

Ing. Petr Zelený, Ph.D.
Head of Department

Liberec, dated: 15 November 2017

Declaration

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Abstract

The work presented in this thesis is the modeling of an information system supporting all activities of the exhibit restoration for the Technical Museum of Liberec. The main goal of this thesis is then to suggest system architecture of before mentioned Information system. In order to gather knowledge and analyze the current state of the Technical Museum on this topic, a literature review is established for the available research works which are mentioned using suitable criteria. Based on the requirements of the technical museum of Liberec, work consists of developing an information system (IS) design for Restoration. The proposed modeling is based on an object-oriented analysis approach using UML class diagrams and use case diagrams. The results announced at the design step includes the class diagrams which modeling the dynamic aspect of the system with the actors interacting with the processes and a class diagram that models the key concepts of information managed in the system. This modeling is generic for a company which takes into account good practices in Restoration.

Keywords

ERP, UML class diagrams, Information flow, Planning, Production.

Abstrakt

Závěrečná práce se zaměřuje na modelováním informačního systému podporujícího veškeré činnosti spojené s restaurováním exponátů pro Technické muzeum v Liberci. Hlavním cílem této práce je navrhnout systémovou architekturu dříve zmíněného informačního systému. S cílem shromáždit poznatky a analyzovat současný stav technického muzea v této oblasti je vypracován přehled literatury o dostupných výzkumných pracích, které jsou zmíněny pomocí vhodných klíčových slov. Na základě požadavků Technické muzea v Liberci se práce soustředí na vývoj informačního systému (IS) pro restaurování. Navrhovaná architektura je založena na objektově orientovaném přístupu s využitím diagramů tříd UML a použití schématických případů. Výsledky prezentované v kroku návrhu zahrnují diagram tříd, které modelují dynamický aspekt systému s uživateli, kteří se vzájemně propojují s procesy, a třídní diagram, který modeluje klíčové pojmy informací spravovaných v systému. Toto modelování je obecné pro společnost, která bere v úvahu osvědčené postupy v restaurování.

Klíčová slova

ERP, diagramy tříd UML, informační tok, plánování, výroba.

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LIST OF ABBREVIATIONS

AMC	Adaptive Manufacturing Control
BI	Business Intelligence
BOM	Bill of Materials
CAD	Computer Aided Drawing
CRM	Customer Relationship Management
CRP	Continuous Replenishment Program
DFD	Data Flow Diagrams
ER	Entity Relationship
ERP	Enterprise Resource Planning
IS	Information System
ISO	International organization of standards
JIT	Just In Time
MES	Manufacturing Execution Systems
MRP	Materials Requirements Planning
MRR	Materials Removal Rate
PDM	Product Data Management
PLM	Product Lifecycle Management
RUP	Rational Unified Process
SCM	Supply Chain Management
SOP	Standard Operating Procedures
SRM	Self-Regulating Mechanism
TOC	Theory Of Constraints
UML	Unified Modeling Language
WIP	Work In Progress
WMS	Warehouse Management System
XML	eXtensible Markup Language

1. INTRODUCTION

Information systems is a set of interrelated components working together to collect, retrieve, process, store, and distribute information for the purpose of facilitating planning, control, coordination, analysis, and decision making in business organizations. Simply there is two types of perspective (i) Input-process-output perspective, (ii) Customer-organization-technology perspective. These systems are an essential part of interconnection with warehouse information about available materials, semi-finished products and purchases manufacture of products. In addition, it is usually an attempt to connect with other important business areas such as finance, marketing, personnel, etc. Such a comprehensive information system is called the ERP system (Enterprise Resource Planning). The aim of this diploma thesis is to design an information system based on principles ERP at Technical Museum of Liberec.

The aim of this thesis work is therefore to:

- Analyze the current planning method at Technical Museum of Liberec including the flow of information through the organization.
- Structure of the information system modules in the organization.
- Design of information System architecture using UML class diagrams.
- Design of possible development with the efficient budget schedule.

2. CLASSIFICATION OF INFORMATION SYSTEMS

An introduction to this chapter is to mention the classification of information systems. From a general point of view, the Information System can be divided according to the organizational levels that exist in the enterprises. It is a strategic, management, knowledge and operational level. The distribution of the Information System according to organizational levels is due to the fact that each level of organization requires a different approach to management. Such an Information System distribution is not very appropriate because none of these levels represents an isolated entity that should have its own independent information system. This division rather serves to make it clear what value automated data processing for individual levels in the enterprise. Appropriate allocation of corporate Information System is more likely to be in practice, which is also reflected by offers of enterprise Information system on the market and in line with expectations from Information System for business process management.

2.1. Bill of Materials Processing

BOMP's Bill of Materials Processing method began in the 1950s. The input data are interrelated the individual items of the parent/descendant and the technical data of the elements, purchase / purchased an item, suppliers, prices, technological process, construction documentation, means of production. The output data of this method is either single level, multilevel structural or an aggregate BOM. The Bill of Materials is the basis for time planning and production control, and it is also necessary for calculations of the factors of production. The robust process of material, employees, tools, etc., calculation of economic production bills, etc. The Bill of Materials Table. 1 shows what the product and its parts are composed of, assemblies, subassemblies, parts, and materials. For the full determination of relations between individual parts, subassemblies, and assemblies, a structural bill is used. It expresses the intrinsic link between the product and the assembly of the product and indicates how successive product grades are produced. There are two types of structural BOMs

1. Structural BOM according to disposition steps
2. Structural BOM according to production steps

File Inventory Bill of Materials View Reports Import/Export Data Settings Statistics User Interface Purchase Help

Add Part to Inventory | Edit Inventory | Delete from Inventory | Add/Edit Bill of Materials | Setup Reports | Settings | Print List | Buy Software | Help | Statistics

Allocated Shortages | Orphaned Parts | Stock Below Min. Level | Accounts | Customers | Vendors

Inventory | Search Inventory | BOM - Multi Level | BOM - Top Level | BOM - Single Level | Find Where Part Used | Purchase Orders | Works Orders | Quotes and Customer Orders

Bill of Materials - Multi Level

Bill of materials part No: 120-001 QTY: 1 Find Print List... **Total cost 1:** $246.97 **Total cost 2:** $297.59 **Total cost 3:** $343.91 **Total weight:** 0.00Kg

Level	Part No.	Description	QTY	Unit	Unit Cost 1	Wastage %	Ext. QTY	Ext. Cost 1	Ext. Cost 2	Ext. Cost 3	Category
1	120-001	Trolley, 3 wheeled	1.0000	EA							ASY
2	110-001	Wheel Housing	3.0000	EA							ASY
3	100-001	MS Bolt, M10x70, Galv	1.0000	EA	5.30	0.000	3.0000	15.90	19.20	22.50	FS
3	100-002	M10, washer, Galv	2.0000	EA	2.20	0.000	6.0000	13.20	19.20	25.20	FS
3	100-003	M10, Nut, Galv	3.0000	EA	1.50	0.000	9.0000	13.50	16.20	17.55	FS
3	100-004	MS Bolt, M10x30, Galv	1.0000	EA	4.00	0.000	3.0000	12.00	13.50	15.00	FS
3	100-005	M10 Square Nut	1.0000	EA	1.90	0.000	3.0000	5.70	6.30	6.90	FS
3	102-108	Wheel, with tyre, 100mm	1.0000	EA	15.00	0.000	3.0000	45.00	51.00	54.00	ASY
3	110-002	Top Piece	1.0000	EA							ASY
4	105-001	MS Flat 80x8	0.0500	LG	10.00	0.000	0.1500	1.50	1.80	2.10	RM
4	111-001	Galvanising	0.0010	KG	60.00	0.000	0.0030	0.18	0.20	0.21	PR
4	130-001	Labor	0.5000	HR	45.00	0.000	1.5000	67.50	82.50	97.50	PR
3	110-003	Side Piece	2.0000	EA							ASY
4	105-001	MS Flat 80x8	0.1000	LG	10.00	0.000	0.6000	6.00	7.20	8.40	RM
4	111-001	Galvanising	0.0010	KG	60.00	0.000	0.0060	0.36	0.39	0.42	PR
4	130-001	Labor	0.1000	HR	45.00	0.000	0.6000	27.00	33.00	39.00	PR
2	112-001	Plywood Platform	1.0000	EA							ASY
3	106-001	Plywood,12mm,2400x1200	0.1250	SH	75.00	0.000	0.1250	9.38	10.75	12.13	RM
3	111-006	Varnish, Semi Gloss	0.0500	l	10.00	0.000	0.0500	0.50	0.60	0.75	RM
3	130-001	Labor	0.6500	HR	45.00	0.000	0.6500	29.25	35.75	42.25	PR

Table. 1 Bill of materials [1]

It is a structural batch, sorted by production steps, and its method of the letter is indented. Key information is the unambiguous identification and item name, number of units, and unit of measure. It is possible to click on the "technological procedure" button for each item to start the process.

It is also necessary to realize that BOMs can be constructed from two views. First, from the designer's point of view, when the designer, for example, the parts put together a subassembly, which then does not actually exist, is only shown in the model or in the drawing for better clarity or understanding. In this case, it is a BOM. In the latter case, this is a production bin. It exactly respects the process of the product. In addition, there may be items subject to overhead production.

2.2. Materials Requirements Planning-I

The Material Requirements Planning System began to be used in the mid-1960s.In the necessity of materials for planning to avoid over-ordering on under-ordering of materials, to reduce unwanted expenses due to last minute ordering and to reduce capital locked up in excess. There are two kinds of demands, one is Independent demand which is for final products and another one is dependent demand for items that are sub-assemblies or component parts to be used in the production of finished goods.

Materials Requirements Planning (MRP) is a set of techniques that take the master production schedule and other information from inventory records and product structure records as inputs to determine the requirements and schedule of timing for each item.

It can be applied to the inventory management system is appropriate for items that have a dependent demand and cornering to choose among many different options and the environment is complex and uncertain. The purpose of MRP includes control inventory levels, Assign operating priorities and plan capacity to load the production system. Master production schedule, Bills of materials, Inventory status file and lead time are the key inputs to the MRP Figure **1** Flow system of MRP-I[1]Figure 1 Shows that the flow system of MRP.

In the MRP outputs' that the Primary reports which have work orders/planned orders that schedule indicating the amount and timing of future orders, Order release which authorization for the execution of planned orders and lastly action notices/rescheduling notices which orders to be released, revised and canceled during the current time period. Additionally, in the secondary reports that describe performance control reports that evaluate system operations. They aid in measuring deviations from plans and also provide information to assess cost performance, planning reports which are useful to forecast future inventory requirements and in the exception reports which this help to find the major discrepancies such as late and overdue orders, excessive scrap rates, reporting errors.

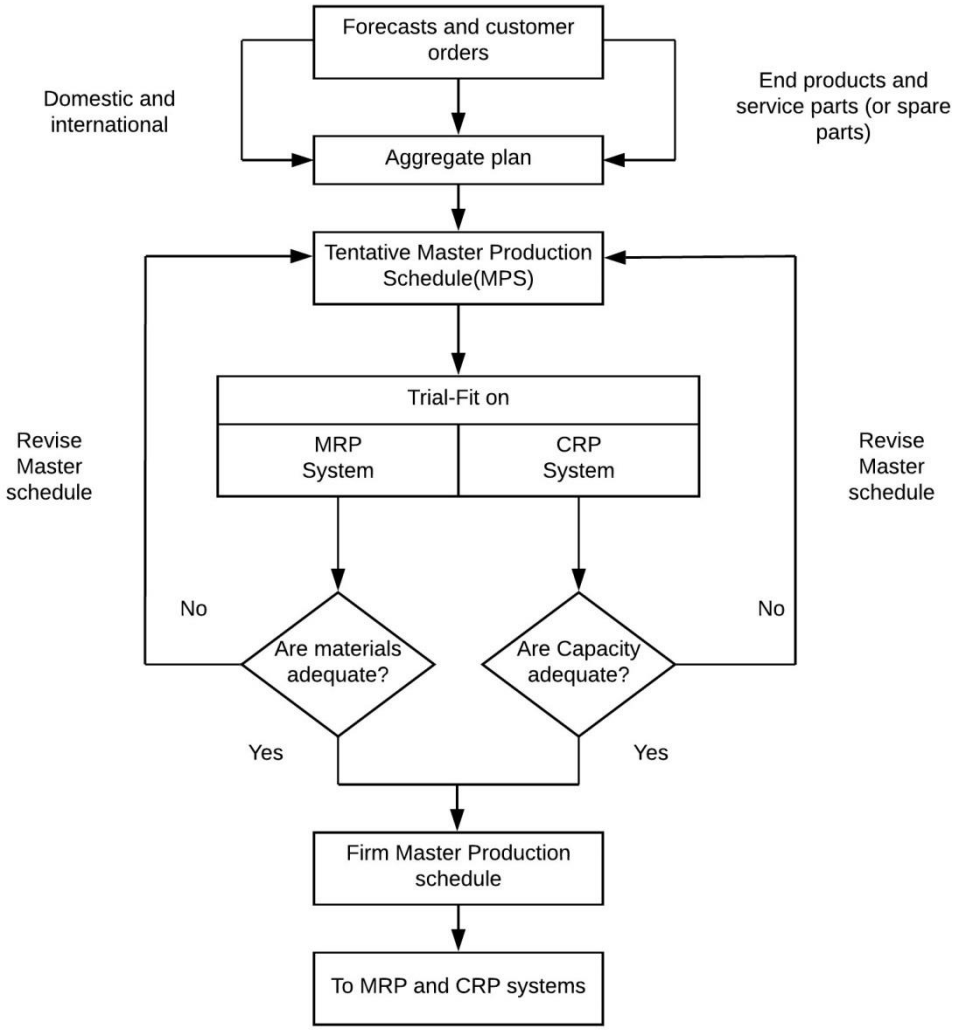


Figure 1 Flow system of MRP-I[1]

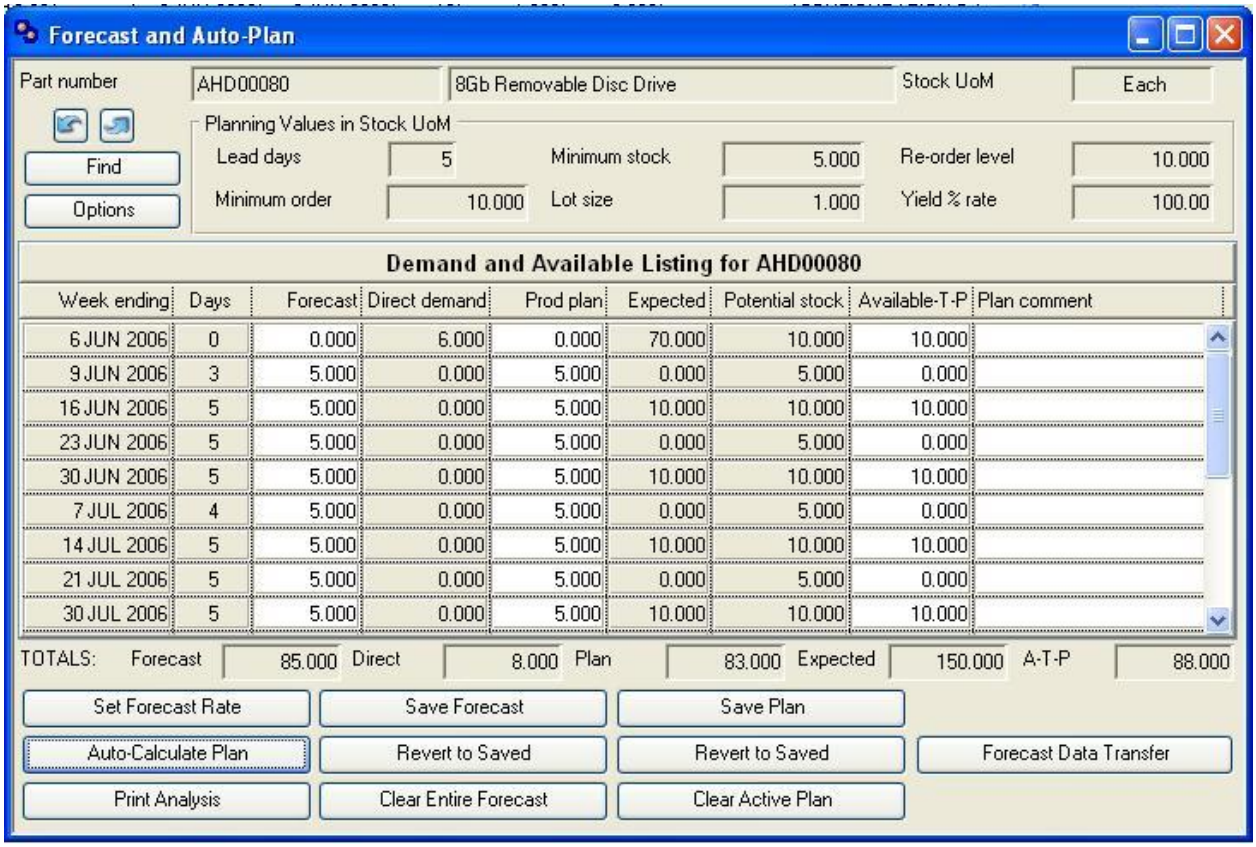


Figure 2 MRP-I forecast period selection window[2]

Figure 2 shows that variety of time buckets with the function of process, and material planning. MRP will take any resulting Production Plan as a specific requirement to dispatch goods on the plan dates. Therefore, if you forecast and plan by weekly or monthly buckets you should take care that you forecast demand in advance of expected dispatch so that production will be suitably ahead of the expected need to dispatch. The Forecast and Auto-Plan can be set to a variety of time buckets. When you operate this function from Process, Material Planning, Forecast, and Auto-Plan, you are first presented with a forecast period selection window. You can also reset the options by clicking on the Options button.

In the case of weekly buckets, the system takes the last active weekday of each week in the appropriate calendar as the forecast date. In the case of monthly buckets, the system takes the last active day of each month in the appropriate calendar as the forecast date. This means that weekly and monthly buckets are not necessarily of an equal number of days. If there is only one active calendar day in a particular week, a bucket for that week will be shown. The number of active days in each bucket is shown on the list that can choose the Use Sales rather

than a Stock option in cases where there is a complex conversion which would otherwise lead to odd numbers. [2]

Benefits of MRP

- Keep inventory levels to a cost-effective minimum.
- Keeps track of inventory that is used
- Tracks the amount of material that is required
- Set safety stock levels for emergencies
- Determine the best lot sizes to fulfill orders
- Set up production times among the separate manufacturing stages.
- Plan for future needs of raw

Drawbacks of MRP

- Inaccurate information can result in miss-planning,
- Overstock, under- stock or lack of appropriate resources.
- The inaccurate master schedule will provide wrong lengths of time for production. It can be costly and time-consuming to set up.

2.3. Material Requirements Planning-II

The Material Requirements Planning System began to be used in the mid-1970s. Manufacturing resource planning (MRP-II) is defined as a method for the effective planning of all resources of a manufacturing company. Ideally, it addresses operational planning in units and financial planning. This is not exclusively a software function, but a combination of people skills, dedication to database accuracy, and computer resources. It is a total company management concept for using human resources which are used more productively.

Business planning, purchasing, forecasting, Inventory control, order entry and management, shop floor control, faster production scheduling, distribution requirement scheduling, service requirement scheduling, service requirement planning, capacity requirement planning, capacity requirement planning and accounting are the modules in the MRP-II Figure 3 shows that the flow system of CRP.

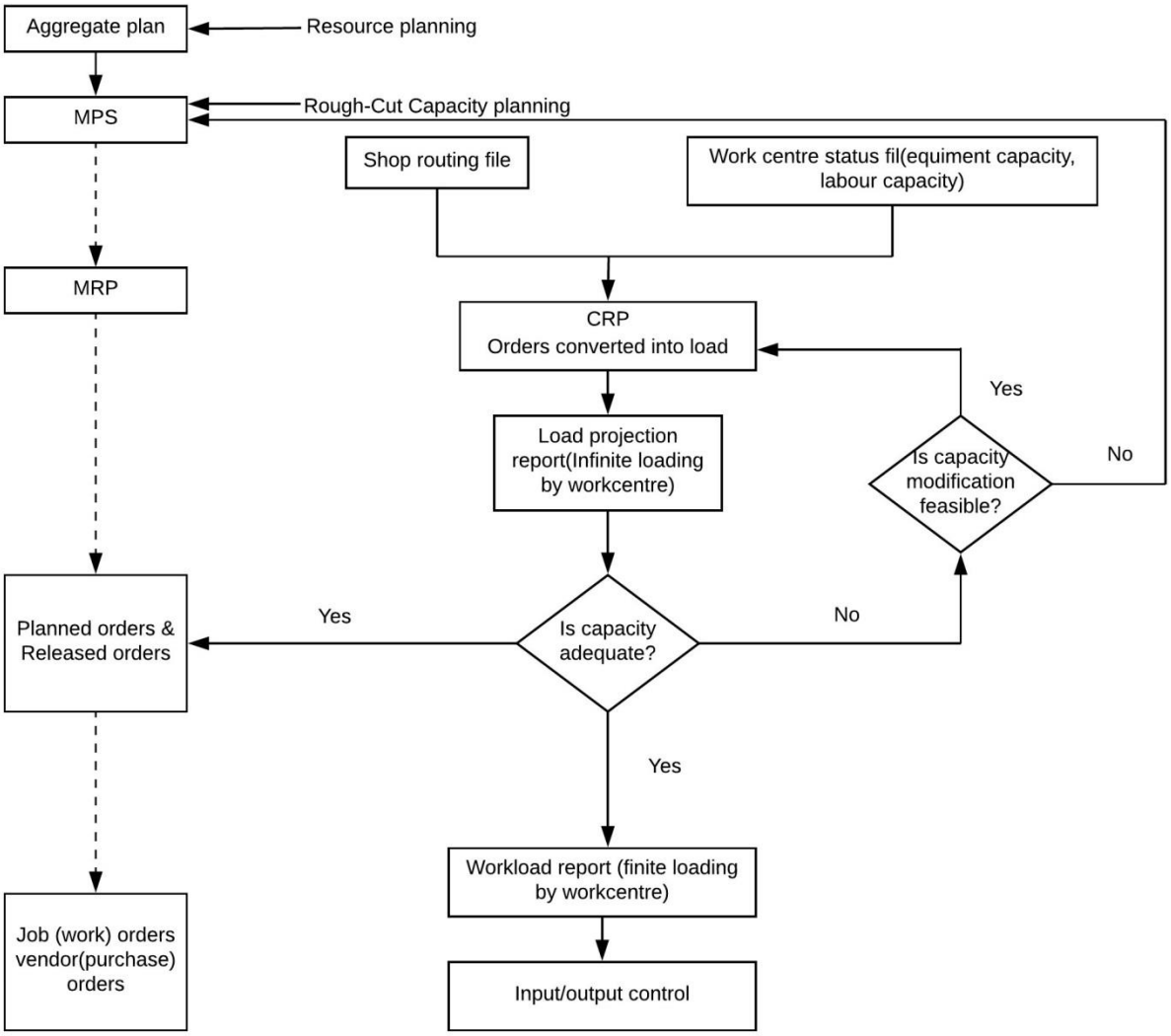


Figure 3 Flow system of Capacity Requirement Planning[1]

Capacity requirement planning is a technique for determining what labor and personnel equipment capacities are needed to meet the production objectives symbolized in the master production schedule and materials resource planning.

Benefits of MRP-II

- More efficient use of resources with reduced inventories
- less idle time
- Fewer bottlenecks
- Better priority planning with quicker production starts and schedule flexibility,
- Improved customer service along meet delivery dates
- Improved quality and lower price possibility
- Improved employee morality
- Better management information.

2.4. Enterprise Resource Planning

Enterprise resource planning and management, ERP (Enterprise Resource Planning), is a type of enterprise information system that allows you to cover and integrate internal business processes. Internal business processes are those that manage the company completely. It is mainly production, logistics, human resources and business economics. These processes should allow the system to cover at all levels, ranging from operational to strategic. ERP systems are therefore considered such applications that allow enterprise data management to help with the logistics chain in all processes through which the product travels through the whole enterprise, including production and related financial and cost accounting, as well as human resource planning. These processes usually try to automate the system as much as possible. At the same time, the system should allow shared data to be shared and allow for online availability.

The first generation of ERP systems originated in the 1980s and is based on its predecessor MRP II system. In the area of production planning and management, there has been no change in MRP II system, the vast majority of ERP systems use the MRP II method for production planning and management. There are some exceptions where systems use the TOC (Theory of Constraints) method. These systems include, for example, QAD Enterprise Applications or Infor ERP SyteLine. There are several ERP systems that use it for Planning and Manufacturing of the Just In Time (JIT) method, based on the principle of drawing, not pushing.

Appropriate deployment of ERP systems should primarily result in the realization of cost-cutting benefits that have been caused by less effective business management. These benefits should be measurable. In addition, business process benefits and quick access to information should also be achieved. These benefits are not measurable. The term ‘ERP’ itself is not self-explanatory and refers to the business software that has been designed to record and manage your enterprise data.

Enterprise resource planning is comprehensive, end-to-end, integrated software that claims to "do it all." Unfortunately, traditional ERP systems are complex, inflexible, not scalable, expensive, and not easy to use.[3]

Figure 4 ERP Systems[4]

Figure 4 shows the function of ERP systems and its area. An ERP system automates and integrates core business processes such as taking customer orders, scheduling operations and keeping inventory records and financial data. This can drive huge improvements in the effectiveness of any organization by:

- Assisting you in defining your business processes and ensuring they are complied with throughout the supply chain
- Protecting your critical business data through well-defined roles and security access
- Enabling you to plan your workload based on existing orders and forecasts
- Providing you with the tools to give a high level of service to your customers
- Translating your data into decision making information.

Benefits of ERP:

- Find time to focus on growing your business
- Access the right information to make decisions
- Build and maintain close customer relationships
- Minimize duplicate data entries, errors, and delays
- Optimize cash flow for business needs

2.4.1. Classifications of Enterprise Resource Planning

At the beginning of the description of ERP systems, four cores internal enterprises were mentioned the processes covered by these systems. By the ability to cover these processes can also be divided into ERP systems:

- All-in-One
- Best of Breed
- Lite ERP

The All-in-One group covers the universal ERP systems it covers all four of these internal processes. However, universal ERP systems can also be included in this category, covering all of the internal processes mentioned above, except for human resources management. This is due to the introduction of these processes into the information system is a question of a subcontractor who is purely oriented towards this group. Integrate of this group into a single ERP is no longer particularly demanding and a supplier of these ERP systems are responsible for putting the system into operation, including the subcontracting. This putting the system into operation should therefore only be the project.

The advantage of these systems is a good integration that most people can do Businesses. The disadvantage of these systems is the smaller variety of functions in the individual industries and also very poorly tailored to the exact needs of every business, where it is hard to reach the software architecture.

Best of Breed is the best of its kind, representing such a group of ERP systems, which are more process-orientated from the previously mentioned internal processes or are in a particular field at the highest level with a variety of features and options. It does not have to cover all internal processes. These systems are typically implemented only to cover a particular enterprise information system or in combination with other information systems within a given ERP concept.

Benefits here include very detailed functionality in individual fields. As a disadvantage, unequal data can be attributed to the diversity of systems, the processes being poorly coordinated and the deployment of these systems necessary split the implementation into multiple projects.

The third category of ERP systems is Lite ERP. These systems are designed exclusively for small and medium-sized enterprises, where they are, compared to other ERP systems, the city cheaper. Their lower price is at the expense of functional limitations. The advantage of systems in this category is the lower price and the possibility of fast system deployment[3]. The disadvantage is the lower variety of functions and other constraints caused by the lower price. ERP systems of the most significant could be included in a separate category of world brands offering these systems. These are SAP Business Suite systems and Oracle E-Business Suite. These systems could be included in the All-in-One category, where they can cover all fields in the enterprise, but they are also at the highest level to cover individual internal processes in the enterprise.

2.4.2. Enterprise Resource Planning-II

This group of information systems is intentionally described in this thesis in the subchapter ERP systems, not as a separate category of information systems. It is because splitting systems from this perspective would not be too good. Most businesses use their existing systems to further develop and improve the functionality of the system in areas where it is needed. One of the key features of the information system is, therefore, its possible customization and openness for synergy with other applications.

Like ERP II or Extended ERP (Enhanced), ERP systems are generally considered ERP systems that, as mentioned earlier, cover internal business processes complemented by the interconnection of internal processes with external processes. These processes, as the definition suggests, are processes that take place outside the enterprise itself. These include Customer Relationship Management (CRM) and Supply Chain Management (SCM). Furthermore, ERP II systems also support Business Intelligence (BI).

2.5. Warehouse Management System

WMS stands for Warehouse management system and it means a warehouse management system can play an integral role in helping your supply chain run smoothly and it helps with tracking movement location and status of inventory within warehouses updating your ERP in a real-time relationship as well as assisting with the management of staff so that you will be able to keep better track of the staff required to help control movement and replenishment and in turn this can help reduce inventory while creating more space in your warehouse so you will

able to better maintain continuous real-time inventory count, so it will be easily able to increase visibility and easily monitor customer concerns such as obtaining order status in real time and so that you will be able to ship the right goods on time and every time all this while reducing your costs.

A benefit of the introduction of an intermediate step between transaction data and management data is that we can use the 'in-between' stage to merge data from several transaction processing systems. For example, if we had a separate sales system and a separate inventory system, we could combine data about sales orders and data about inventory levels to identify gaps between what sells well and what the organization still has in stock. In organizations with very large transactional data sets, an entirely new data set is often created in preparation for the management information system. It is common to refer to that intermediary data set as a data warehouse and it illustrates the flow model on Figure 5. We shall refer to the 'incoming' transaction processing systems as source systems, in that they provide the source data for the data warehouse[5].

In an enterprise besides textual documents, it is usual to generate and store the daily information manipulated by enterprise personnel in operational databases, using different kinds of systems, applications, and transactions. For business decision making, however, the information considered relevant and strategically is extracted from these operational databases and loaded into the decision processing system, that is reorganized or restructured, by extraction, transformation, and load tools into the data warehouse. Figure **5** visualizes this configuration. The data warehouse is a great repository of data; whose purpose is to support the strategic decision-making process in the enterprise. Precursors of this technology the data warehouse area subject oriented, an integrated, time-variant and nonvolatile collection of summary and detailed data used to support management decisions. Its main goal is to satisfy the user needs, storing useful and relevant information for business management. Finally, the Retrieval of relevant knowledge to each user, available on this collection or repository, may be carried out by ordinary retrieval tools such as:

- Customized tools, focusing the real needs of the users
- Tools that use metadata and eXtensible Markup Language (XML)
- Business intelligence (e.g. intelligent systems that help companies in their strategic planning process)

- Analytical tools that compose the portal decision processing system, capable of generating reports and analyses to be distributed to users through a corporate network, e-mail or portal web interface[6].

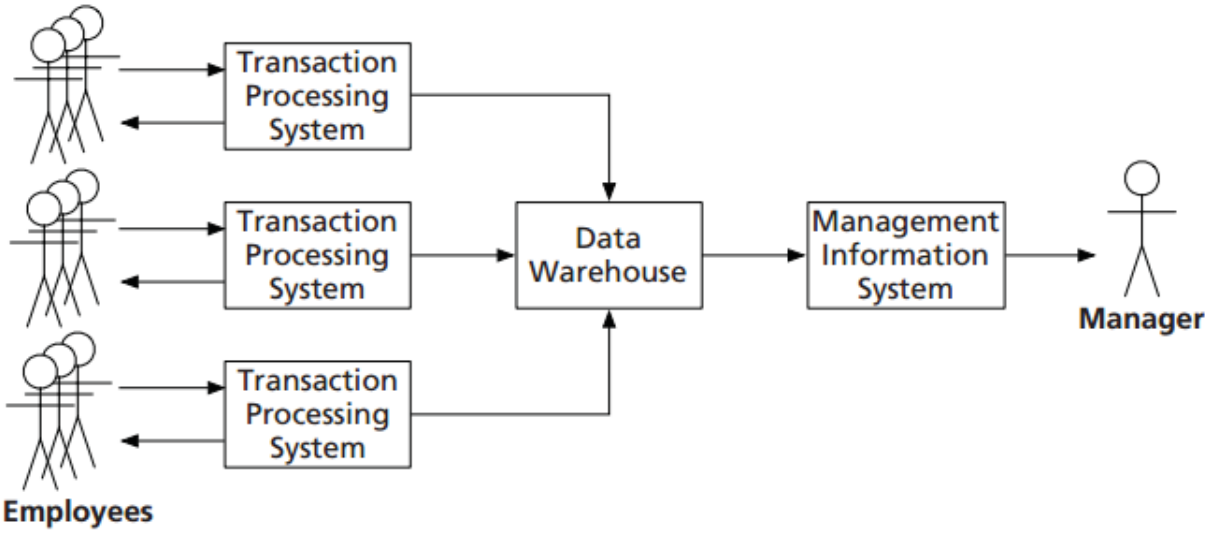


Figure 5 Flow system of Warehouse Management System[5]

2.6. Manufacturing Execution System

Manufacturing Execution systems implementing a complex system to continuously monitor the product from the beginning stages of the manufacturing to the final result while recording vital data like genealogy, traceability, Work-in-progress, performance measurement, material management and more and it means getting that valuable information into the hands of decision-makers so they can take the right actions to enhance manufacturing, reduce risk, lower costs and increase yield. It means that connecting complex systems and data flows to provide better efficiencies throughout an enterprise. The entity thrives to successful cost savings from shop floor to their top floor with end-to-end manufacturing execution systems or begins the process by assessing the current production monitoring systems and by identifying gaps in the flow of information.

The investigation of the current analysis is being applied to manufacturing issue and challenges and then develop a strategy for implementation of manufacturing execution systems to address found challenges connecting manufacturing processes with the enterprise layer. It requires a tightly integrated yet flexible ISA- 95 complaint solution leveraging the latest in advanced manufacturing techniques, technologies and standards after integration top floor

personnel seamlessly receive real-time information pertaining to everything from order status to inventory changes and from product history to test results the entire manufacturing process can be qualified and quantified for better efficiency, better yield and just plain better product implementing a value driven manufacturing execution systems is about connecting all the moving parts and ability to provide end-to-end solution that includes follow-up support with manufacturing execution systems with the three most important aspects of manufacturing the products, the processes, and the people.

Other advantages of profitable MES implementation might include an accurate analysis of cost-information, increased uptime, decreased inventory and waste with quicker setup time.

MESA (Manufacturing Enterprise Solutions Association) introduced some structures by explaining eleven functions that group the scope of manufacturing execution systems. Management of product definitions includes a bill of materials, bill of resources. It is a part of Product lifecycle management. Scheduling the production process which states the production schedule as a collection of work orders to fulfill the production requirements.

Management of resources which may include registration, dispatching and execution of production orders which inform other systems about the progress of production processes. Production performance analysis that creates useful information out of the raw collected data. Production Track & Trace and digitizing of the complete data and finally the audit interface which helps in the evaluation of the utility performance. Figure 6 shows that process and way of performance of manufacturing execution systems.

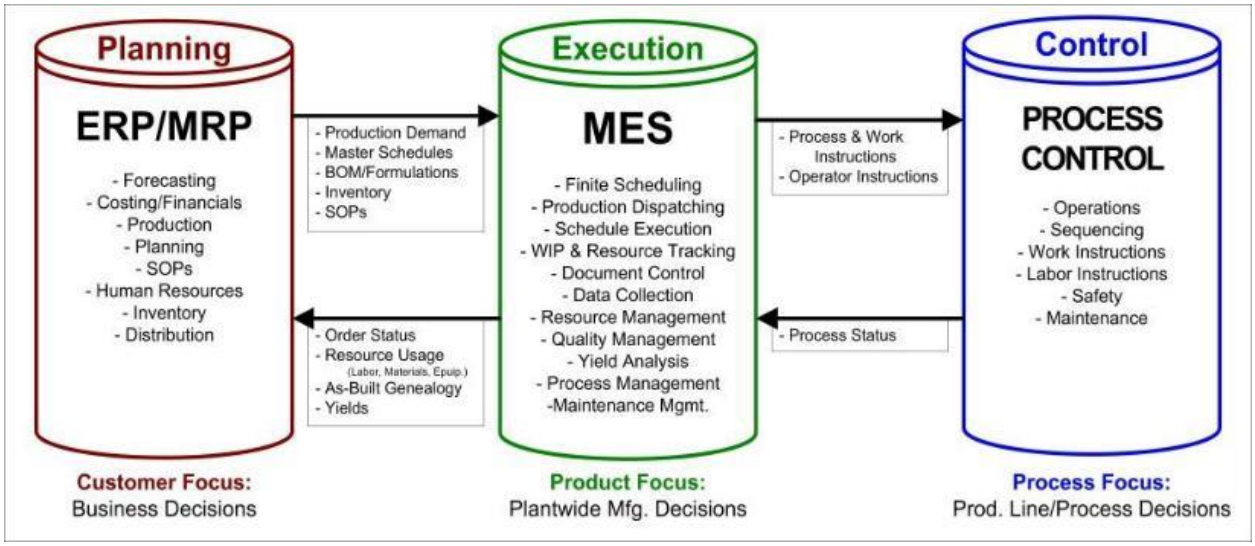


Figure 6 Manufacturing Execution systems [7]

2.7. Product Data Management

PDM backbones from traditional engineering design activities that created product drawings and schematics on paper and using CAD tools to create parts lists. The PDM and BOM data is used in Enterprise Resource Planning systems to plan and coordinate all transactional operations of a company like purchasing, cost accounting, logistics, Sales order management, Materials planning, etc.

PDM historically started as a Design Document Management System. Over the last decade and a half, PDM has evolved into a cross-functional, multi-department truly collaborative framework. PLM was the exclusive domain for Workflow, Notification, and Life Cycle Management and encompasses the processes needed to launch entirely initiative products, manage changes to existing products and retire products at the end of their lifecycle. Not anymore, PDM is a subset of the larger concept of product lifecycle management (PLM), has evolved rapidly and seen active deployment since; its genesis has been the design department and Engineering Department, in contrast to PLM that evolved from ERP experience.

PDM or PLM, it all depends on priorities and pain points that Management wants to address. Today, PDM is used to meet the requirements of APQP (Advanced product quality planning), TS 16949, 21CFR Part 11, ISO 9000 among others. These Standards are not isolated to Design Department but encompass the entire Organization. Be it Quality, Manufacturing,

Engineering or any other department, the teams deal with Documents that have versions, revisions, life-cycle states, and deliverables in a workflow among others. If the PDM can address these, then it is able to address the Organizational requirements. Product Data Management (PDM) products are primarily designed for use by developers and designers in the enterprise to serves as a central knowledge repository for process and product history and promotes integration and data exchange among all business users who interact with products. These systems manage product technical data such as CAD models, drawings, bills of quantities, NC programs, analyzes, etc. It is basically the "explorer" of CAD programs.

The operative function of the PDM System is easy and it precisely shows on Figure 7 and intuitive as well and costly mistakes can also be avoided and the data is backed up, saving much time and money in the end. However, the introduction of a PDM system requires good planning. It is the use of software tools to track and control data related to a certain product. The tracked data usually involves the technical specifications of the product, specifications for manufacture and development, and the types of materials that will be required to produce final items.

The advantage of PDM allows an entity to track the various costs associated with the design and implement of new products. PLM systems can create, manage and distribute technical data as well as PDM systems, but throughout the entire product lifecycle, PLM systems can also be more easily fulfilled. PLM allows authorized users to work with product data during its creation or change when using approval and change management, where the system monitors the versions of individual documents. These systems also include SCM systems, process scheduling, product configuration management, and so on.

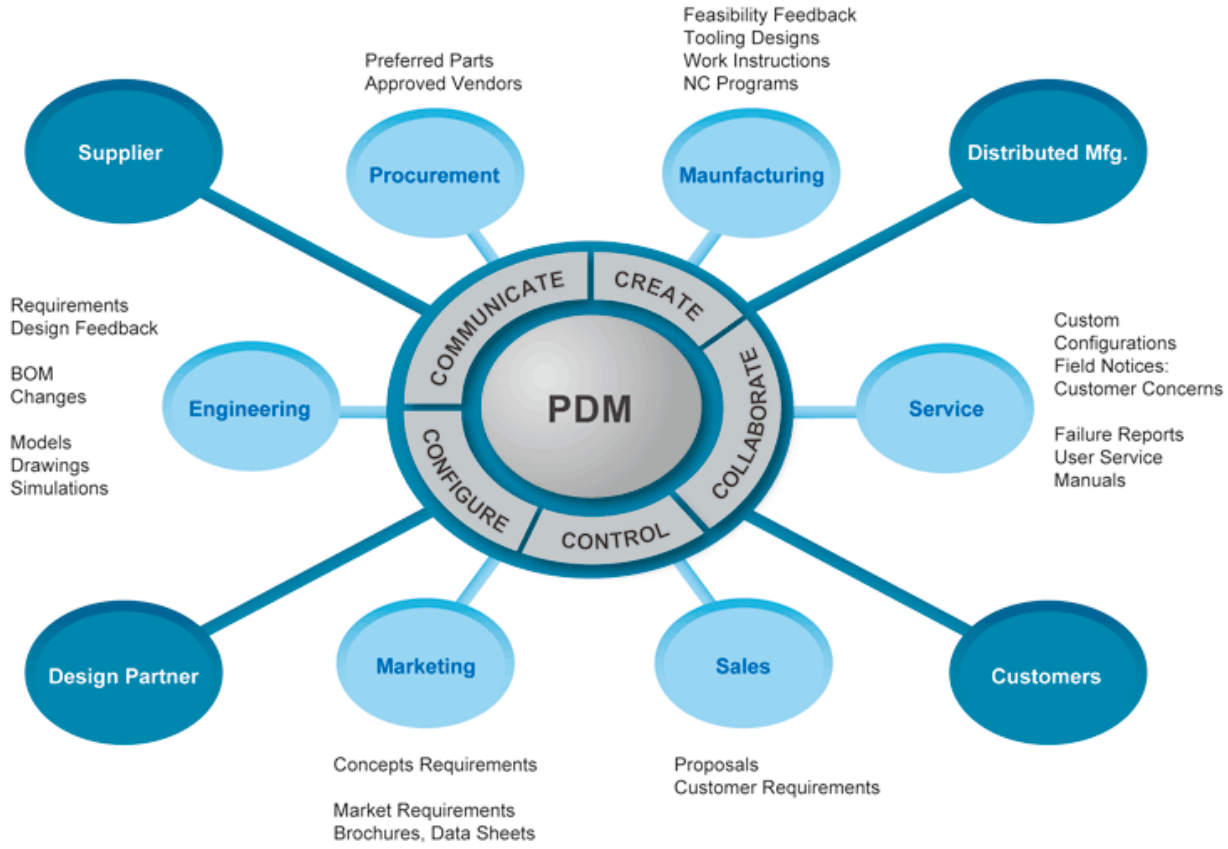


Figure 7 Functions of PDM [8]

Benefits of PDM

- Managing and tracking all changes to the product related data
- Allocating a lower time organizing and tracking the design data.
- Enhance productivity through reuse of product design data.
- Improve Collaboration
- Helps using visual management

2.8. Self-Regulating Mechanism

Planning and especially planning using APS systems is very sensitive to data quality. It is very difficult to keep the data in the information systems still accurate and well-to keep up with the changing market conditions and the variations in production. At thousands the entries in the system, each containing a large number of parameters, are as follows problems for system users are unmanageable if they want to keep a high percentage of data purity.

As a result, inaccuracies occur in system calculations, no matter what is the amount of inventory or inappropriate terms. This creates unnecessarily high binding warehouse capital and long delivery times. Therefore, it is advisable to automate this data customization process. This is the concept of cyber-regulation - self-regulation mechanisms SRM from the Selbst Reguliernde Mechanismen. These mechanisms are through control circuits and are part of software modules.

Such circuits then compare business goals, reducing inventory, shortening delivery times, the reliability of deliveries, etc. with reality and have a rapid response to market changes due to the appropriate setting, which is achieved by constant calculation of parameters by the control circuits.

The SRM works like a temperature controller when a deviation from the desired temperature is followed by the controller's response. Business information system category, the ERP can be compared to the heating, the valve corresponds to the layout parameters of the system, and the business objectives can be imagined as the required temperature. The SRM continuously detects deviations and appropriately sets the parameters of the information system to meet defined business goals.

An application using the SRM concept is referred to as AMC Adaptive Manufacturing Control, where SRM represents one of the AMC's. With AMC, Bergh of System was launched and can be integrated into lots of ERP systems. The SRM module in this application mainly serves to maintain the accuracy of master data, as defined by the SRM definition. It also generates forecasts of consumption parts it calculates based on historical data and future needs that are known. ACM / SRM contain many other tools based on the essence of operation SRM.

3. DESIGN TOOLS FOR INFORMATION SYSTEMS

In any industry or the managerial environment, we can assume that there is some understanding of what it is that needs to be organized in the content of employees, budgets, customers, production processes, and so on. We can say that these are the entities of the particular management domain what we are going to understand it precisely to support the management of these entities to design and structuring information systems. It can be done by model the structures of data using conceptual diagrams. Importantly the whole set of diagrams describing the entities from our managerial domain represents the data model and it can be drawn using a variety of diagramming techniques.

In most of the industries, there are a plenty of techniques around to represents a data model. I will introduce and explain the three popular among them in this thesis namely Entity relationship diagrams, Data flow diagrams and finally one of the most accessible techniques to graphically represent entities is that Unified Modeling Language Class diagrams. These tools should have recommended the collection of phases, procedures, rules, techniques, tools, documentation, management, and training to improve the quality of a software development effort in an entity. It can be transforming an artistic idea into a science through structured methodologies. The system is composed of interacting parts that operate together to achieve some objective or purpose.

A system is intended to absorb inputs, process them in some way and produce outputs. Outputs are defined by goals, objectives, or common purposes with the expanding role of software in the information world forced attention to software & development needs of acceptable speed & cost, Traceable time schedule with high quality, longevity and assurance which used or maintained over a long period of time with the accommodate the changing requirements of the user and their compliance on the structure[9].

3.1. Entity-Relationship Diagram Technique

The technique continues to be broadly accessed to graphically represent the entities, even though lots of techniques have been developed that extend or replace it. In this data modeling, there are two important items which are entities and relationships. The entity is the first item to define a ‘thing’ which can be distinctly identified[5].

In the Entity-Relationship technique, that when we structure the data, we should be considering for the abstract concepts because they are two concepts, the other one is concrete examples of abstract concepts. Abstract concepts will provide the structures that will allow us to store the examples. The label for an abstract concept is the entity set and of the concrete examples as the instances of the entity. In an attempt of structuring the information methodology, you need to shift from the concrete instances to the more abstract concepts by instance with various choices. In the Entity-Relationship diagram, the entity should be drawing in a rectangular box with the name of the entity.

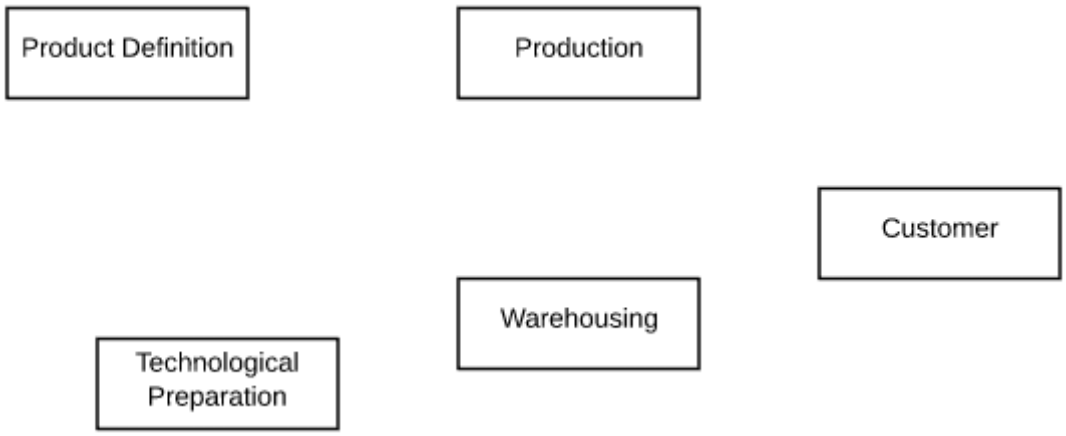


Figure 8 Entities*[Source: own]*

Figure **8** gives an example of five entities that we might encounter in this thesis. First, the position of the entities on the diagram is arbitrary. The fact that the product definition is at the left and the entity customer at the very right does not carry any meaning. Also, it is a convention to put the name of the entity in a singular form. Entity names are written with a capital letter, and in bold typeface as a standard format and these conventions are used to distinguish them from attributes.

Databases store instances of entities in special kinds of tables called R-tables or relational table, that entity is going to correspond to exactly one R-table. There are two naming conventions; the name of the R-Table is always in lowercase letters. Second, spaces in names are not normally allowed and encouraged to replace those with the Underscore Character (_).

Attributes are identifying the characteristics of the entities and it has some values, for instance, it has no value for a particular attribute, it is a NULL value. Attribute in an Entity-Relationship can be represented by circle notation and it is corresponding to exactly one attribute. The attribute does not start with a capital letter to set attributes apart from entities.

Figure 9 Attributes*[Source: own]*

Figure 9 shows that the instance representation of attributes model with production. In attribute showcase the important data that should be monitored while doing production for the entire operation along the schedule.

Table **2** indicates that the columns should represent the attributes of the entity and it has a unique column name and it does not have any order preference. Rows should represent an instance of the entity, with one row corresponding to exactly one entity. Rows do not have a name in the same way columns do and no order preference as well. Row duplication that states that can be no duplication of rows. Each row represents exactly one instance. To avoid row duplication to occur accidentally, it is easy to introduce an extra column called ID column which gives each row a unique identifier called as the primary key. It never gives a NULL. They are by convention always lower case and do not contain spaces.

Table 2 R-table

component_id	name	price
1001	Bolt	10
1002	Nut	6
1003	SteelRod	50

Attributes have different types that number that states any numeric value which specified into integer and real numbers. The text states that free text, not predefined, it is called a string. The category which states that predefined and non-numeric values. Another type is true/false which an attribute that is modeled as a True/False question which usually worded as a question. Finally, a special attribute type is the timestamp, which is a date or time that a specific event occurs. The event is the attribute and the time stamp is the value. Many management information systems need those time stamps for analysis the process to check the total volume of sales generated this year compares to the volume of sales generated last year.

Entities are important aspects of any data model but they do not exist in isolation, relationships make it much interested to showcase and clarifies them. The Entity-Relationship diagram models such a relationship with a straight line connecting two entities with some name in a diamond shape between them or put close to the line in the middle. Relationship lines can have more features to give some more detail on the type of relationship.

The entity which is always associated with one sales agent, and the other way around, it named as a one-to-one relationship. Then model a one-to-many relationship by giving the ends of the connecting line an adornment, which can be done in three ways. First one is by giving a symbol 'N' at the 'many' end of the relationship line. The second one is by an asterisk (*) at the 'many' end as same in the UML class diagrams that we are going to discuss later in this thesis study. Finally, you will also encounter elegantly Figure 10 so-called crow's-foot at the end of the connecting line.

Then there are two more optionality endings with a circle and the dash which representing 'zero' and 'exactly one' respectively. The circle indicates that a zero relationship is allowed. The dash would be used to indicate that the relationship is not optional but mandatory; sometimes dotted lines are drawn instead of these. It has implications for the foreign keys to having a NULL value when the relationship value is optional. The attribute type is categorical, and then the most appropriate way to model the attribute is to create an entity with the one-to-many relationship from the categorical entity.

The advantages of getting rid of categorical values are to allow us to examine the categories on their own to modify. Finally, a many-to-many relationship is that overlapping and interpreting of two one-to-one relationships in either direction. The auxiliary entity should connect the two original entities using two one-to-many relationships. The reason why you need to transform many-to-many relationships into auxiliary entities is that this will facilitate the transfer of the diagrams into R-tables. We will have to introduce an auxiliary R-table to link entities that have many-to-many relationships[5].

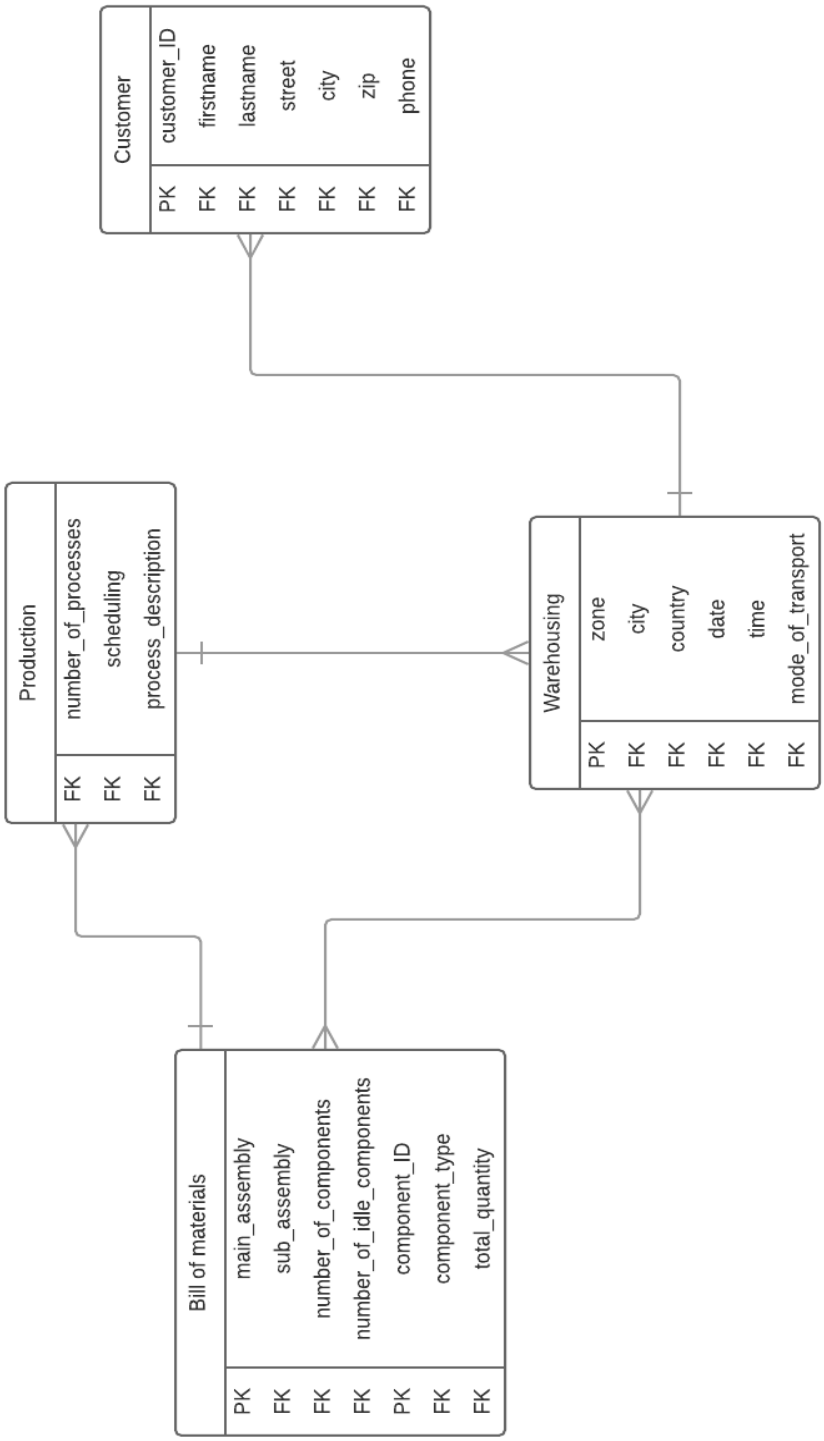


Figure 10 Relationship data flow*[Source: own]*

3.2. Unified Modeling Language

By studying through the literature review under the topic of UML class diagrams and architecture building of information system, I can illustrate the process through this platform that carries the information flow and transfer or decision between the modules on the very precise way. Zhuang Jun explained that the major purposes of the UML case diagrams. By introducing the object-oriented visual modeling technology UML into the development project drawing censoring information system, we tend to establish a system model up to sensible situation based on totally researching the object-oriented modeling idea, UML which means the characteristic, conjointly style and complete the models function such as task reception, task distribution, task censoring, task reply, charge, task approval and task inquiry[10].

Asma Boussellaa has published a journal paper on reverse logistics management to design information system using UML with a generic and integrated information system for the management of all the processes of reverse logistics was proposed. The first step of work was to make a literature review of various research projects related to the management of reverse logistics process. The majority of the research conducted on this theme are very recent and limited. Secondly, our Information System design was modeled using oriented-object approach UML and was presented according to two aspects which are dynamic and static. These aspects were modeled respectively by a use case diagrams and a class diagram. This modeling is based on the process map proposed by Lambert et al and it is generic for a company which recognizes good practices in reverse logistics. In addition, it will be used for developing the specifications of an IT project[11].

Jiri Benda published a thesis in the topic of an information system using UML class and case diagrams to visualize the important aspects of various departments in JRM speedway factory and he analyzes the state in the company and designs the information system flow with the demands of production planning and management in the entity[3]. Florian Pauker published a journal with the emergence of cyber systems in the manufacturing domain creates new requirements for shop floor devices. Due to their diverse structure, build up a seamless communication is one major challenge[12].

Throughout this literature review, I could figure out some suggestions and proposal for new information system on the technical museum of Liberec in following design part. The main

usage of this proposal will be the production scheduling and data repository for accessing all the departments from one place. It would be done through MES and ERP systems implemented programming using this information data flow.

Unified Modeling Language is developmental software modeling language tool to give a structured way to conceptualize the design of a system. It was initially evolving at the period of the 1990s to standardize the way of approaching to software designing and dissimilar notational systems by Grady Booch, James Rumbaugh, and Ivar Jacobsen who derived the Booch, OMT, and OOSE method respectively[13]. They proudly name it as new, unified, modeling language: The Unified Modeling Language or UML. The UML was set up under the non- profit organization called the Object Management Group and continues to be revised and extended part of it. The origins of the Unified modeling language in software engineering were raised from the object orientation.

At the risk of reducing, it is an approach to software development that details the integration of data and functionality into small software compartments called objects. It has some advantages that when a software error occurs, it is easier to isolate the error and contain the damage because this is in contrast to the more classical approach in which the data is separated from functionality.

The object orientation structure spawned a great deal of all new diagramming techniques, which unluckily were not all in the same compatibility with each other. Instance, the first technique would model the object with the rectangle as the ER diagrams did, and another would model it with the circle, led to a rather confusing situation. In those years it described as Modeling Wars that languages became increasingly famous, experts became increasingly outspoken about the importance of their techniques that are the vital reason to resolve this issue, a number of harmonization and standardization efforts took place and they begin to merge theirs large unsuccessful until proponents of popular object-oriented diagramming techniques.

Design of UML offers a way to visualize a system's architectural blueprints in a diagram in any activities, particular components of the system and how it will interact with other software components, how it will run in the whole system, with the knowledge of external user interface that the how entities interact with others. It has been extended to a larger set of design documentation and it originally intended for object-oriented design documentation. It uses the methods of OMT, Booch Method, objector, and especially RUP that it was intended to be used with the rational software. In other words, the UML is a language for Visualizing, specifying, Constructing and documenting the artifacts of a software-intensive system.

In UML, we need to form a conceptual model of the language, and thus requires learning three major elements in the UML's basic building blocks, the rules that dictate how those building blocks may be put together, and some common mechanisms that apply throughout the UML. Things, relationships, and diagrams are the three major vocabularies of the UML encompass of building blocks. Things are the abstractions that are first-class citizens in a model and then relationships tie these things together and finally, diagrams are the group interesting collections of things[13].

Four kinds of things and relationships and nine kinds of diagrams are used in the UML to write well-formed models. It has some semantic rules for names that what you can call things, relationships, and diagrams and for the scope that deals with the context that gives specific meaning to a name and visibility that how those names can be seen and used by others. Integrity which consists that how things properly and consistently relate to one another and execution that what it means to run or simulate a dynamic model.

For the development team that it should elide to certain elements are hidden to simplify the view, Incomplete to certain elements may be missing and inconsistent that the integrity of the model is not guaranteed. Specifications, adornments, common divisions and extensibility mechanisms are made simpler to apply consistently throughout the language. A system's architecture is perhaps the most important artifact that is used to manage these different viewpoints and so control the iterative and incremental development of a system throughout its life cycle.

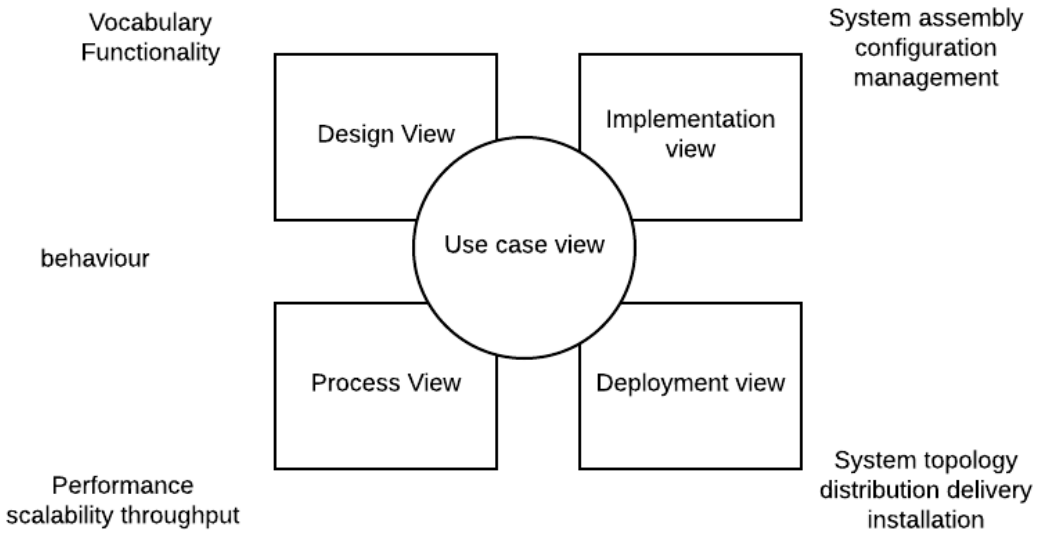


Figure 11 Modeling a system's architecture[13]

Figure 11 shows that the modeling the information system architecture with a system performance scalability throughput, functionality of the system, and assembly configuration management and delivery installation of the system view to structure the well friendly User interface information system. Figure 11 Modeling a system's architecture[13]

3.2.1. UML Class Diagrams

The Unified Modeling Language (UML) will assist model systems in varied ways that one in all the additional in style varieties in UML is that the class diagram. In style among software system engineers to do document software system design, class diagrams are a sort of structure diagram as a result of they describe what should be present within the system being modeled. In spite of the level of familiarity with UML or class diagrams, UML software system is meant to be straightforward and simple to use.

UML was discovered as a homogenous model to explain an object-oriented programming approach. Since classes are the building block of objects, class diagrams are the building blocks of UML. The assorted elements in a very category diagram will represent the categories which will truly be programmed, the most objects, or the interactions between categories and objects. The class form itself consists of a rectangle with 3 rows. The highest

row contains the name of the class, the center row contains the attributes of the class, and also the bottom section expresses the ways or operations that the class could use. Classes and subclasses are sorted along to indicate the static relationship between every object.

Class diagrams provide a variety of advantages for any organization. Use UML class diagrams to: Illustrate information models for data systems, despite however straightforward or complicated, Better perceive the overall summary of the schematics of an application, Visually categorical any specific desires of a system and circulate that data throughout the business, Create elaborate charts that highlight any specific code needed to be programmed and implemented to the represented structure, Provide an implementation-independent description of varieties employed in a system that are later passed between its components.

The standard class diagram consists of three sections are upper section contains the name of the class. This section is often needed, whether or not you're talking concerning the classifier or an object, the Middle section contains the attributes of the class. Use this section to explain the qualities of the class. this is often sorely needed once describing a selected instance of a class, the Bottom section includes class operations (methods). Displayed in list format, every operation takes up its own line. The operations describe however a class interacts with information.

All classes have completely different access levels looking for the access modifier (visibility). Here are the access levels with their corresponding symbols: Public (+), Private (-), Protected (#), Package (~), Derived (/), Static (underlined).

Classes are a template for creating objects and implementing the behavior in a system. In UML, a class represents an object or a set of objects that share a common structure and behavior. They're represented by a rectangle that includes rows of the class name, its attributes, and its operations. When you draw a class in a class diagram, you're only required to fill out the top row. The name is the first row in a class shape. Attributes deal the second row in a class shape. Each attribute of the class is displayed on a separate line. Methods brief the third row in a class shape. Also known as operations, methods are displayed in list format with each operation on its own line[14]. Figure 12 shows the structure and operations of UML Class diagram.

Signal shows symbols that represent one-way, asynchronous communications between active objects. Data types are classifiers that define data values. Data types can model both primitive types and enumerations. Packages meant to be shapes designed to organize related classifiers in a diagram. They are symbolized with a large tabbed rectangle shape.

Interfaces are a collection of operation signatures and attribute definitions that define a cohesive set of behaviors. Interfaces are similar to classes, except that a class can have an instance of its type, and an interface must have at least one class to implement it. Enumerations deals with the Representations of user-defined data types. An enumeration includes groups of identifiers that represent values of the enumeration. Objects are instances of a class or classes. Objects can be added to a class diagram to represent either concrete or prototypical instances. Artifacts are model elements that represent the concrete entities in a software system, such as documents, databases, executable files, software components, etc.

The term interactions refer to the various relationships and links that can exist in class and object diagrams. Some of the most common interactions include Inheritance details with the process of a child or sub-class taking on the functionality of a parent or superclass, also known as generalization. It's symbolized with a straight connection line with a closed arrowhead pointing towards the superclass. Bidirectional association states that the default relationship between two classes. Both classes are aware of each other and their relationship with the other. This association is represented by a straight line between two classes. The unidirectional association is a slightly less common relationship between two classes. One class is aware of the other and interacts with it. The unidirectional association is modeled with a straight connecting line that points an open arrowhead from the knowing class to the known class.

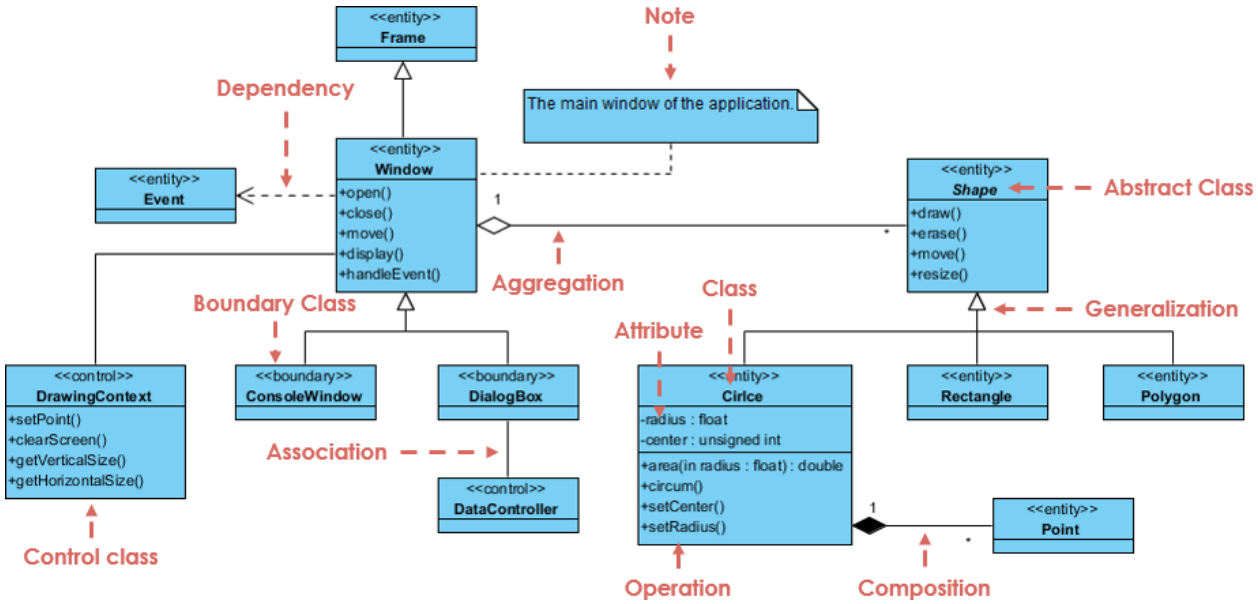


Figure 12 UML class diagram Relationship[14]

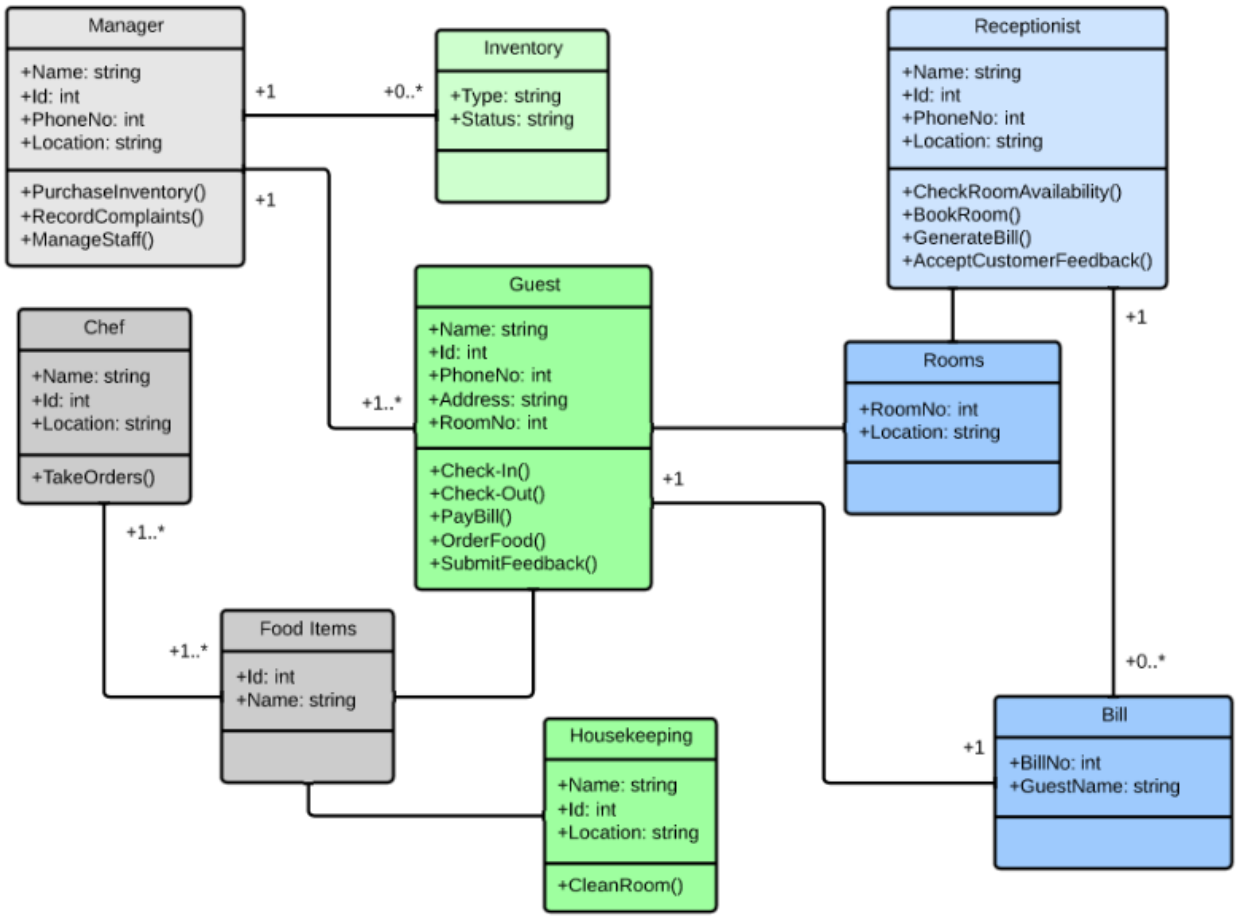


Figure 13 UML Class Diagram Example[15]

Creating a class diagram to map out method flows is straightforward. Figure 13 UML Class Diagram Example will show the relationships between every object in a hotel management system, as well as guest data, workers responsibilities, and room occupancy. The instance below provides a helpful summary of the hotel management system.

3.2.2. UML Use Case Diagrams

The purpose of a use case diagram in UML is to demonstrate the various ways in which a user would possibly act with a system. In the Unified Modeling Language (UML), a use case diagram will summarize the main points of your system's users also referred to as actors and their interactions with the system. to make one, we have to use a collection of specialized symbols and connectors and a good use case diagram will facilitate the team discuss and represent the eventualities within which the system or application interacts with folks, organizations, or external systems and goals that the system or application helps those entities known as actors accomplish the scope of the system.

UML is that the modeling toolkit that may use to make your diagrams. Use cases are drawn with a labeled oval form. Stick figures represent actors within the method, and also the actor's participation within the system is modeled with a line between the actor and use case. To depict the system boundary, draw a box around the use case itself. UML use case diagrams are ideal for are representing the goals of system-user interactions, process and organizing functional needs during a system, specifying the context and needs of a system, modeling the fundamental flow of events during a use case[16].

Common building block components include actors are the users that interact with a system. An actor may be an individual, a company, or an outdoor system that interacts along with your application or system. They need to be external objects that manufacture or consume information. The system is a particular sequence of actions and interactions between actors and therefore the system may additionally be stated as a situation. Goals are the top results of most use cases. An eminent diagram ought to describe the activities and variants accustomed reach the goal.

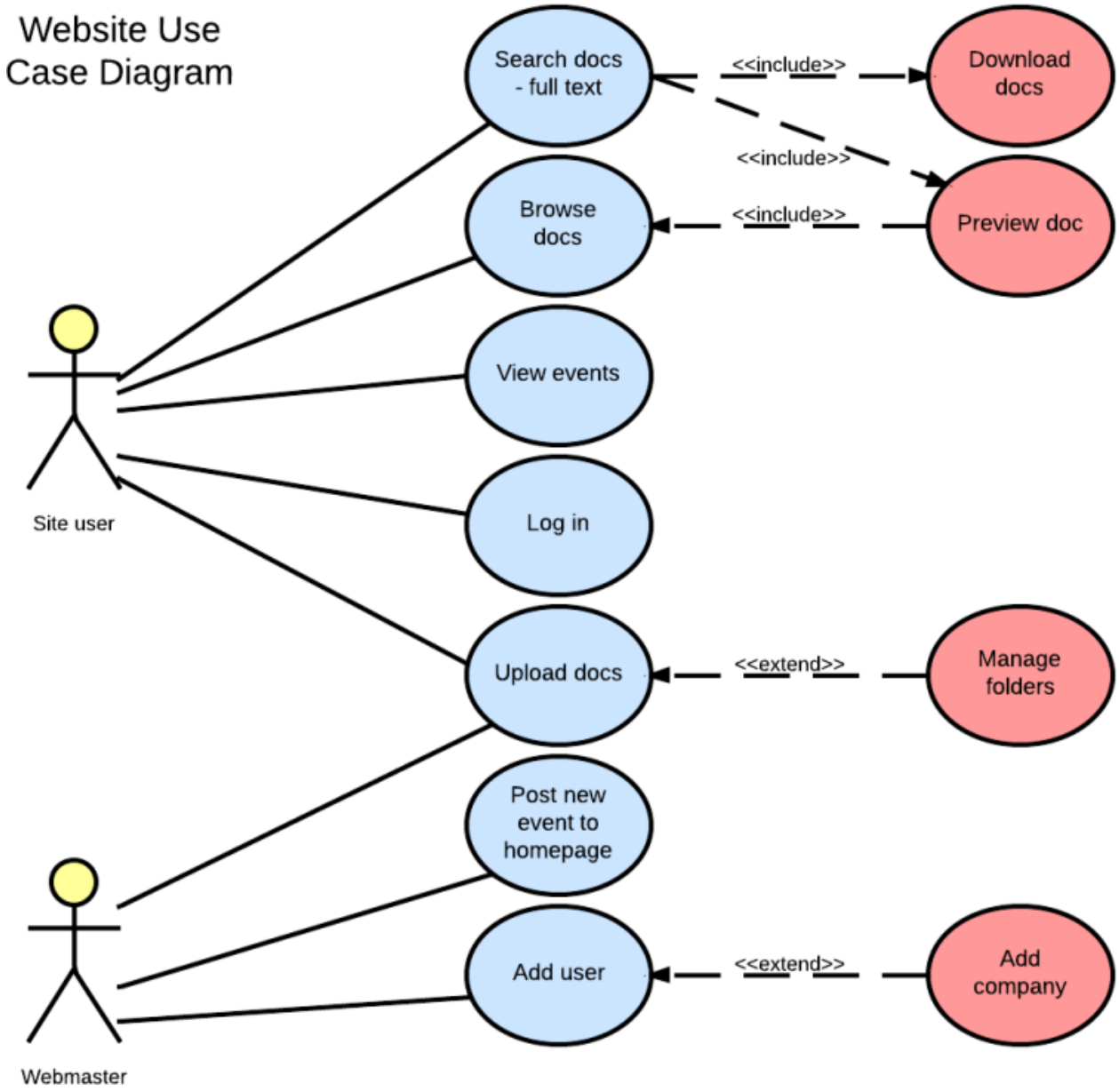


Figure 14 UML use case- information flow for User Interface[16]

The notation for a use case diagram is pretty simple and does not involve as many varieties of symbols as alternative UML diagrams. Here are all the shapes that may figure it out are use cases are usually horizontal informed ovals that represent the various uses that a user might need where the Figure 14 represents the simple user interface to create. Actors are stick figures that represent the individuals really using the use cases. Associations are a line between actors and use cases. In advanced diagrams, it is vital to grasp that actors are related to that use cases. System boundary boxes are a box that sets a system scope to use cases. All use cases outside the box would be thought-about outside the scope of that system. Packages

are a UML form that enables you to place completely different components into teams even as with component diagrams, these groupings are described as file folders.

3.3. Data Flow Diagrams

During the analysis part, it's important that the development team gain an honest understanding of the present system so they will be in a position to understand however the current system produces information. This understanding should be at a really low level of detail, at the extent of the processes accustomed produce information. This level of understanding is best obtained by developing models of the present system. Typically, the present system is first diagrammatically represented using a diagramming method referred to as a data flow chart (DFD).

This methodology provides an easy way to describe the system graphically. The diagrams will be made quickly by the event team nonetheless will offer an upscale level of detail as they are expanded on lower levels. They are additionally easy for novices to read, which implies they will be powerful communication tools among the event team, managers, and users. Finally, they will be decomposed, that is, logically broken down, showing increasing levels of detail while not losing their ability to convey meaning to users and management.

DFDs are drawn with simply four symbols: data sources and sinks, processes, data flows, and data stores. data sources are entities that provide data to the system which is a source or receive information from the system which is a sink. These sources lie outside the boundary of the system and are not active participants in the processing that happens inside the system. A method is any activity that converts data into information. Generally, processes are named with a verb of the action within the process and are numbered at the highest of the symbol. Numbers are helpful for cross-referencing processes on lower-level diagrams to the activities in higher-level diagrams. Processes are interconnected with alternative processes by data Rows which represents on Figure 15 Data flow diagrams symbols[17].

Data flows are symbols that represent information in motion. Every data flow is called with a noun that describes the data represented within the flow. A data, however, should be connected to a method at some purpose, either as a supply or as a sink. A data store could be

an illustration of the information at rest. samples of information stores may embrace electronic information files, a database table, or a physical file folder. when the symbols are employed in combination, they trace the movement of knowledge from its origin, the source, through all of the steps that rework that data into information for the users, to its eventual destination, a sink. The feature of DFDs that build it therefore helpful within the context of system development is that the diagrams are complex. Each system should be understood at a high level of detail. DFDs allow the same system to be analyzed at many levels of detail, from the context diagram level through whatever level the development crew choices to take a stop at and the lower level of detail in a DFD is called a context "black box" because it shows only the sources and sinks and their connection to the system through aggregate data flows.

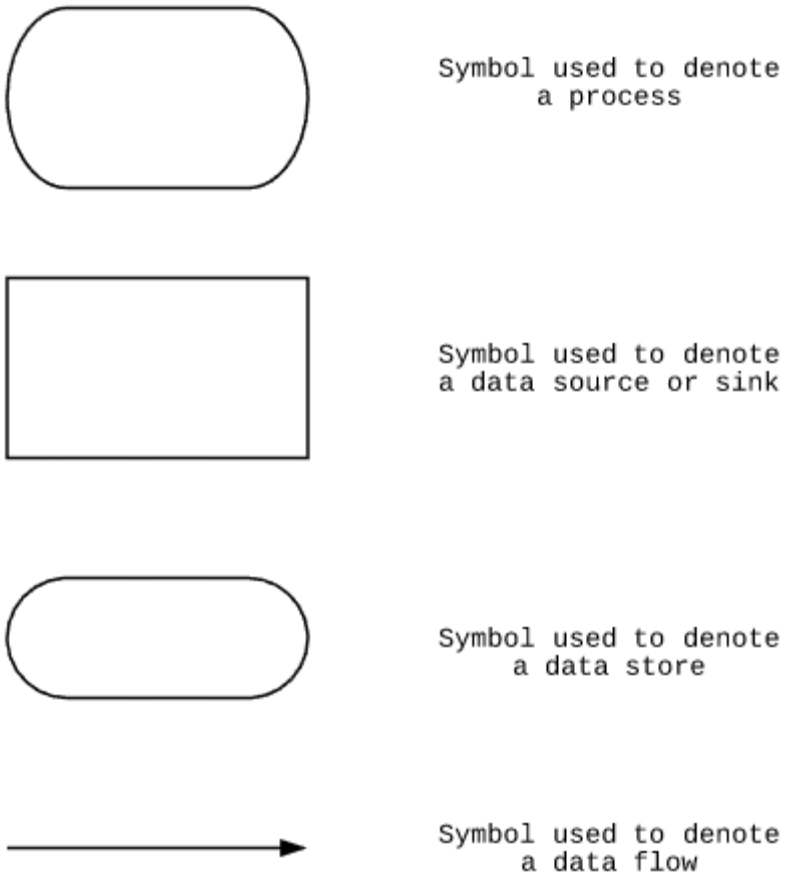


Figure 15 Data flow diagrams symbols[17]

4. VOICES OF INFORMATION SYSTEMS

Nowadays Information system and project management workplace struggles with time, cost and resource management challenges. With multiple operational and strategic comes below analysis, it will be tough to step back and isolate information data and inputs from the assorted voices and contributors. characteristic that project and activity can meet business objectives needs a replacement and deeper level of visibility into the factors and insights of those key influencers.

Solving Information and project management problems depends on the approach that is taken and also the level of engagement by all contributors. By specializing in optimizing information system outcomes with multi-level insights, organizations can do a major breakthrough in bottom-line results[18]. Optimizing integrated information system and portfolio management is important for fulfillment, and staying attuned to the inputs of the business, customers, processes, and staff will go a protracted way toward achieving that goal.

4.1. Voice of Customer

By the requirements of the customer, there have been seven modules of the entity to be demanded the restoration process at the technical museum. Initially the requirement of the customer to be defined in terms of data about the exhibit item and it is price of the product, what type exactly it is and the time of production along lifespan and then the product type whether it is owned or borrowed, technology implemented on the products, processed material, production technology and it is quality control plan and finally the audit to the customer along the required documents and records.

Then the exhibit of the product details has to be notified in the information module to get know about the status. It has a module of when the contract of the exhibited product has been signed and where it has been done and estimated price of the entire contract, who will be in charge for the restoration of the assigned contract with the specified name or serial number on it. Furtherly the details should be indicating the requirements and demands of the customer and their contacts and additional information for the work which has to be helpful for complete the restoration project during the scheduled period.

Consecutively, there is a module for technological preparation which initially creation of design and technical documentation with tool design modeled in 3D data, and then agreed to create production documentation in 3D(models) and 2D (drawings). Determination of materials of individual parts, the specification of purchased standard parts, heat treatment, surface treatment etc. In subcategory, technology which deals with the creation of technological bases, determination of the production technologies of the individual parts as well as of the entire assembly of tools, production and assembly procedures and use of inter-operation inspections. It meets customer requirements and respects the technical documentation.

Next module deals with the production along the detailed description whether it is own production process or cooperation with the other services, assembly line, setup time for adjustment in the equipment and testing the equipment and the process periodically.

Following the production module, the customer requires creating the module to check the entry when it is registered to deliver if there are any parameters missing to do repair or production. Is that the right material in proper proportion with the appropriate technology used? Overall it briefs about checking the entry, production and project management and controlling the contract requirements.

Finally managing the technical documentation, there is a various information which is sorted by individual customers and orders. The following files are stored confidentially using high secured encrypted modules, it starts from 3D documents which contain the input data, and their parts, drawings, specifications, handbooks, instructions, photo documentation, design data, data for machining including the programs, measurement and control protocols, libraries with standard parts and procedures and additional valuable information which has been used for restoring the product as secure in data repository, and that has been summarized on Figure 16 List of modules that require creating an information flow[Source: own]

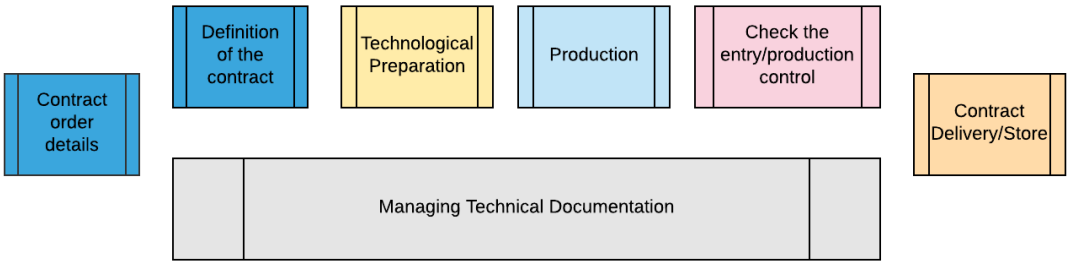


Figure 16 List of modules that require creating an information flow[Source: own]

Summary

- Contract order details
- Definition of the contract
- Technological Preparation
- Production
- Check the order/production Control
- Contract delivery / store
- Managing Technical management documentation

4.2. Voice of Process

The process requires the summarized module of the bill of materials, logistics control and planning, production cooperation and the control plan of the product to be restored at the technical museum of Liberec using the ERP which is a complex system with an envelope around numerous applications and related information.

Standards play a very important role in achieving ability. With regard to ERP systems, Opportunities exist for establishing commonplace interface specifications with different manufacturing applications. There is a noticeable interaction purpose between ERP and PDM systems. Thus, there is a requirement for interfaces between the two systems to share on an individual basis captured engineering and sourcing specifications. within the long run, the goal ought to be to own PDM systems capture all the product and method engineering specifications and to extract resource needs data to be used in ERP-supported coming up with activities. Conversely, sourcing data, together with contract engineering services ought to be captured

within the ERP system. To do this, one wants seamless interaction as seen by the engineering and operation users.

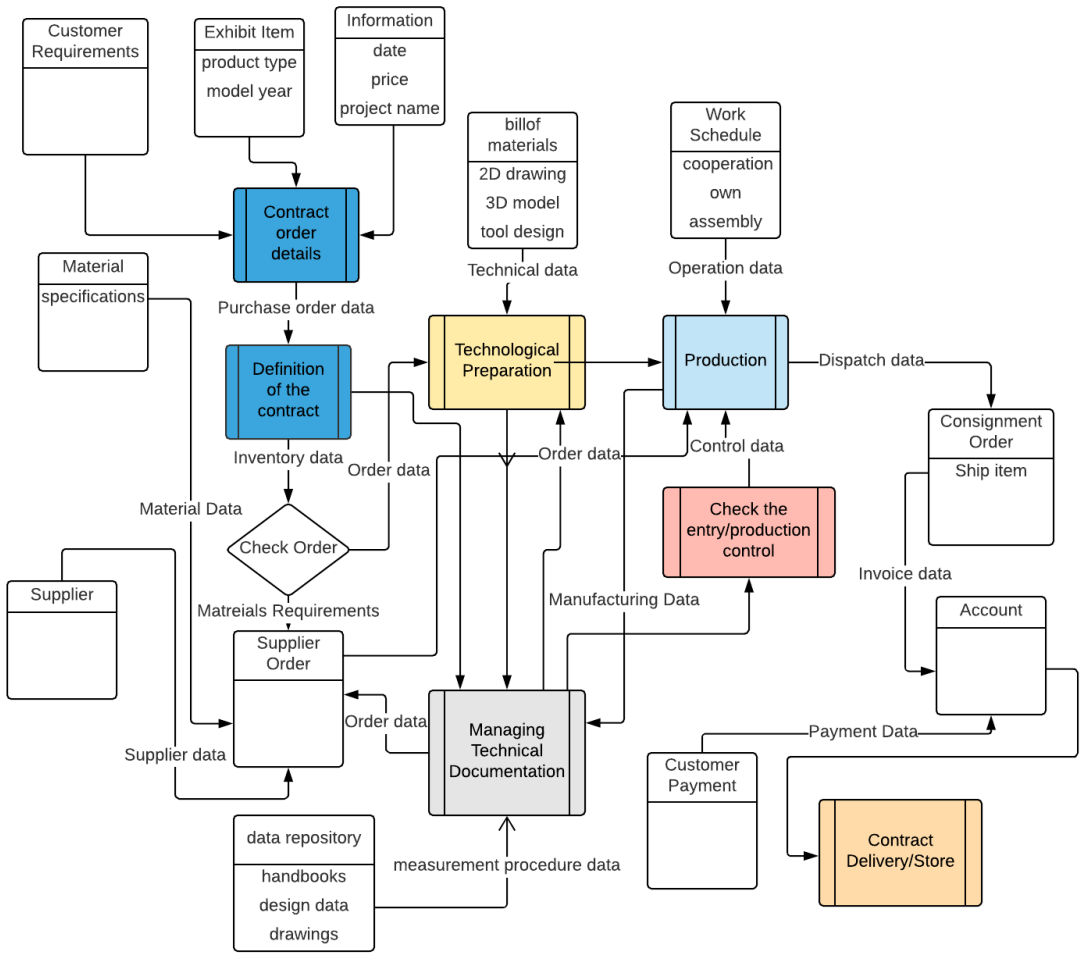


Figure 17 General architecture of information flow using ERP process*[Source: own]*

Figure 17 illustrates the information objects of the business process. Information objects describing the environment of the process using ERP process. These data are necessary to create information services. For example, when orders are checked, the customer's credit is checked and inventory is checked for availability. Because data flow is triggered by the functions that are linked to the information objects, it is more or less possible to read the function flow in Figure 17. Besides information flow modeling the static description of data structures is a very important modeling task. Static enterprise is used to develop proper data structures in order to implement a logically integrated database.

Future ERP systems should expect to interface with such companion manufacturing plant management systems during a vital variety of client facilities. There is the requirement to share resource planning data, resource status data, order/job/lot release, and status data. However, developing such user interfaces is not a simple exercise. The separation of responsibilities and also the data to be changed very in line with several factors each at the enterprise level and also the production level. Pre-standardization work is critical to spot and perceive those factors.

4.3. Voice of Employee

As the Voice of customer and Voice of employee programs become additional tightly integrated aspects to develop the structure efficiently. Organizations are beginning to recognize the crucial role that each voice play in driving future success.

As from the employee point of view, would like to implement the data repository. Figure 18 Frequent occurrence components of the most integrated CASE products [19]which is a vital role to access all the information regarding the organization in a short time period. Thus deals with the operation from the supplier side till the customer fulfilments.

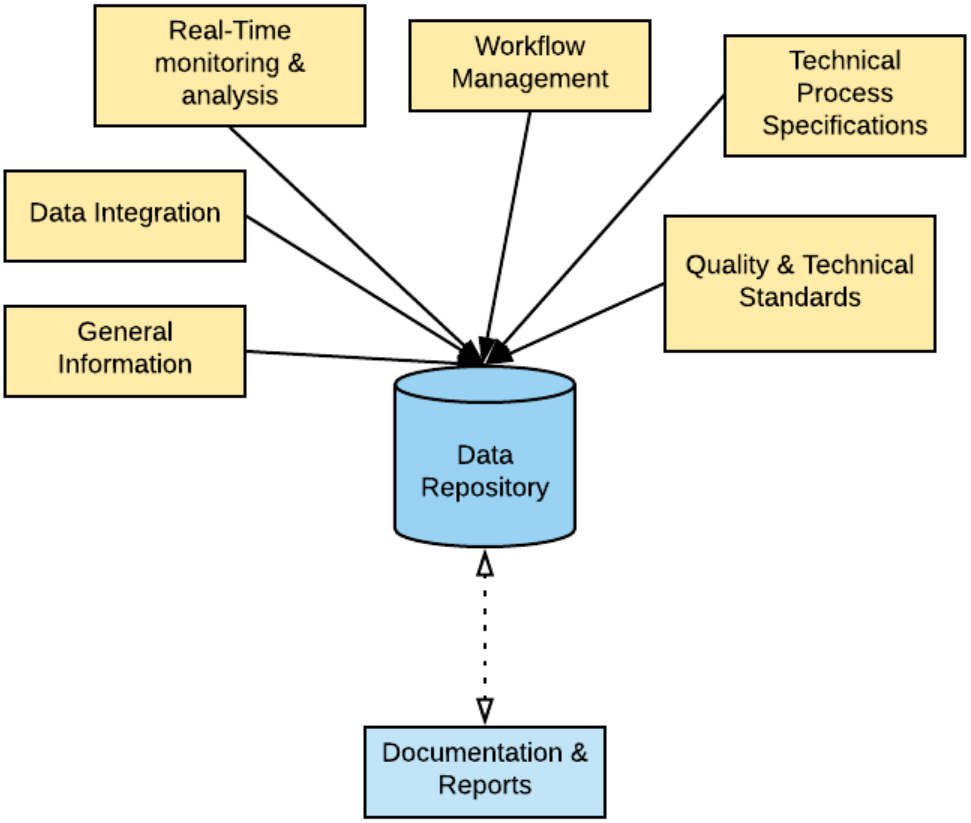


Figure 18 Frequent occurrence components of the most integrated CASE products [19]

The main usage of proposing the new information system as the way of automating and integrated modeling tools, it additionally permits for the creation and maintenance of information of knowledge and repositories which give organizations with a tool to ascertain a central place to store all of their data components. Thus, it will be able to solve the highly critical calculation for the machining and cost estimation according to our class programming to the newly planned layout of the workshop.

The design of Use Case Figure 18 relies on inputs that produce entries into the information repository. Knowledge of information repository is outlined as a “robust data wordbook.” A data dictionary primarily provides the definition of the information component itself. A knowledge repository, on the opposite hand, stores info about the information element’s behavior. This may embrace the element’s hold on procedures, descriptions, and documentation regarding however and wherever it's used. Therefore, the information

workbook can really be thought of a set of the information repository. It is capabilities thus leave the storage of varied design-specific options which will with the options of mechanically manufacture output which will then be employed by a different product.

As discussed in outputs, documentation, reports which they delivered the required final products with the Information systems. In that way, MRP-1 and ERP are using for regulating and initiate the restoration or new production process in an efficient way. Data repository system holds as a vital role for managing the information systems of an entire entity as a data warehouse.

5. INFORMATION FLOW

Since there is very little use of machines in the museum from the total capacity and the production procedures of most products contain some operations, better to focus primarily on the implementation of the tracking system of the individual orders, not primarily to monitor the use of production capacities. However, this option should also be offered by the system. This data can further be evaluated to reduce the wastage, on the restoring, create new one's production capacity.

5.1. Development Diagram – Flowcharts

In order to design the structure of Information system, it was necessary to design a flow of information in a system. A flowchart was developed for this proposal, including all separation of businesses that are relevant to the introduction of a new Information system for restoration of the technical museum of Liberec along the enterprise resource planning principles.

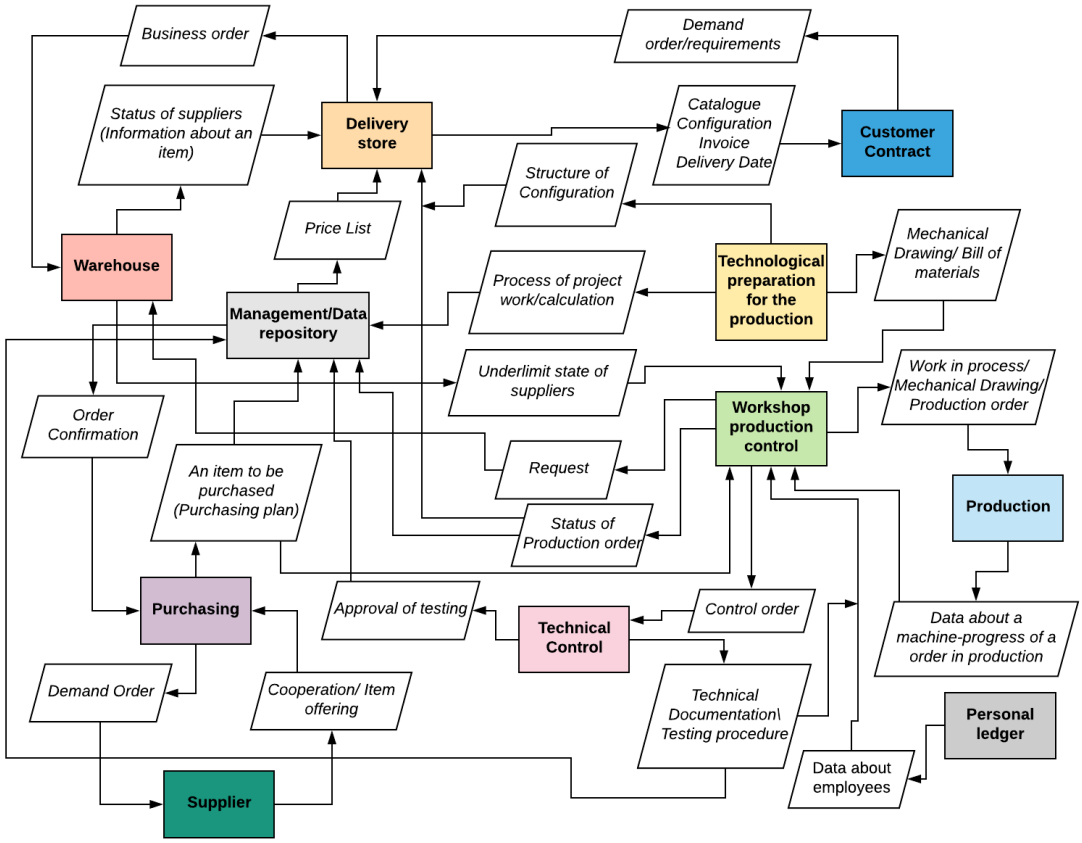


Figure 19 Summary flowchart across relevant departments in the enterprise*[Source: own]*

In the diagram, the individual sections are separated by color for better legibility, and the arrows illustrate the flow of information between departments Figure 19 where each arrow is always described according to which data are transmitted between the departments.

5.2. Functionality of Modules

The flowcharts for the individual departments shown in the previous summary flowchart have also been developed. The circle means a reference to the next diagram, diamonds have decision making meanings, action deals on rectangles, and parallelogram deals on inputs/outputs. The notes icon shows the database entry and the document icon shows the running program.

5.2.1. Information Flow- Delivery Store

Essential for business is a product catalog available both internally for the delivery store and customers. To ensure up-to-date data in the catalog and avoid mistake, catalogs should take data from the central database with information about products to easily supplement or repair data. At the same time should be linked to the bills of materials from which the catalog should be based.

Catalog database would be available the following information:

- Identification number
- Structure of the product
- Product type
- Business data
- Technology of production
- List of all customers and suppliers

By facilitating the work of the Customer Relationship department, so-called configurator would be provided which would allow for more complex assemblies that can be produced in multiple possible configurations. Customers to select the desired configuration. The configurator should define a narrower selection of the assembled product, which means if the customer, for example, selected a shorter connecting rod, the configurator would no longer allow him to choose a longer cylinder.

The delivery store should also have available information about the expected completion date of the production orders in case there is not enough stock in the warehouse and the delivery shop needs to give the customer information on the time assumption of satisfying its demand. This means that it is necessary to link production planning with customer contract.

If there is the insufficient quantity of purchased items, the store should also have the purchasing department information where the purchase would record the ordered products and their estimated delivery dates. With the known information listed above and the entry of required items and their numbers, the system could automatically generate a bid including generating prices and calculation of discounts. The user of the information system, in this case,

the delivery department, would only check the accuracy of the data and adjust the discount if necessary etc. Furthermore, the delivery department should be able to record and monitor business orders. Here, it would be advisable for the system to combine business deals with customers. After retrieving the customer identification number, a list of all customers, including the content of the orders in question products, returns, claims, invoices, etc. When creating a new business order, the required items should be booked immediately in the system and should be reflected in the inventory level to the warehouse.

After the goods have been removed, the status of the business order should change such as "ready to ship" in the list of orders and the sales department would be on this the order was ordered the parity of the parcel would be generated from the system since weight should be recorded for each item. After the goods have been handed over to the customer, the system should enable the automatic generation of an invoice that should be available in the business order list.

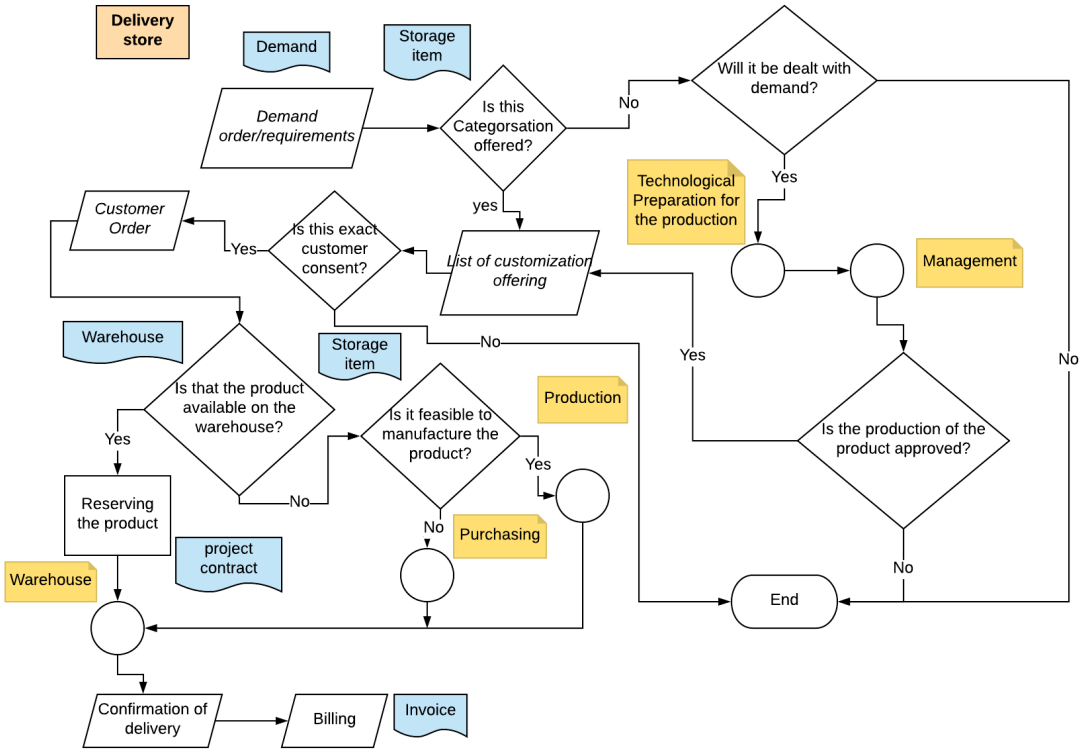


Figure 20 Information Flowchart- Delivery store*[Source: own]*

Figure 20 shows the flowchart of a business where it flows and in addition to the above-described patterns, it is still to be seen that some figures are listed, respectively with their classes concerned. On the delivery diagram, all classes are pale blue, which means that they are part of a system other than the one to be reintroduced.

5.2.2. Information Flow- Purchasing

The first major thing to buy is to determine the number of ordered goods. It would be generated by the information system, then checked by the buyer, or adjusted to a satisfactory quantity. Inventory records and their pairing with purchased items are very important. The vendor database should be available, including historical prices. At the same time the necessary data for planning purchase, an average delivery time, delivery reliability, average number of defective products delivered. Suppliers should be broken down by type of service and material.

In addition, the purchase should be linked to the entire production planning through the planning of orders so that the system can also plan the purchase in this context. Purchase Planning should calculate the supply of required purchased parts at the required quantity at the lowest possible cost, the system should take into account in addition to prices and poor quality supplies, unreliability, etc. The purchase plan should also be including both internally secured and external suppliers. The suppliers details are entitled in a list of reports to be review later for mishandling or poor performance by quality audits as showcased in Figure 21 Information Flowchart- Purchasing*[Source: own]*. It should have the details of value added tax, configuration, structure of the supplied products as well as the suppliers profile.

This developmental system would have gathered information data and that they must also have access to these data for proper functioning. The diagrams are ranked according to how the information flows across departments. The start is at the delivery store where the customer's first demand comes into the system.

Additionally, an order is issued from the request for customer approval and the whole flow of information flows across all interested departments which end with the expedition of the goods and subsequent invoicing to the customer. It would also allow electronic clearance of invoices and orders for competent persons. Additionally, the system should allow the billing of receipts with incoming invoices.

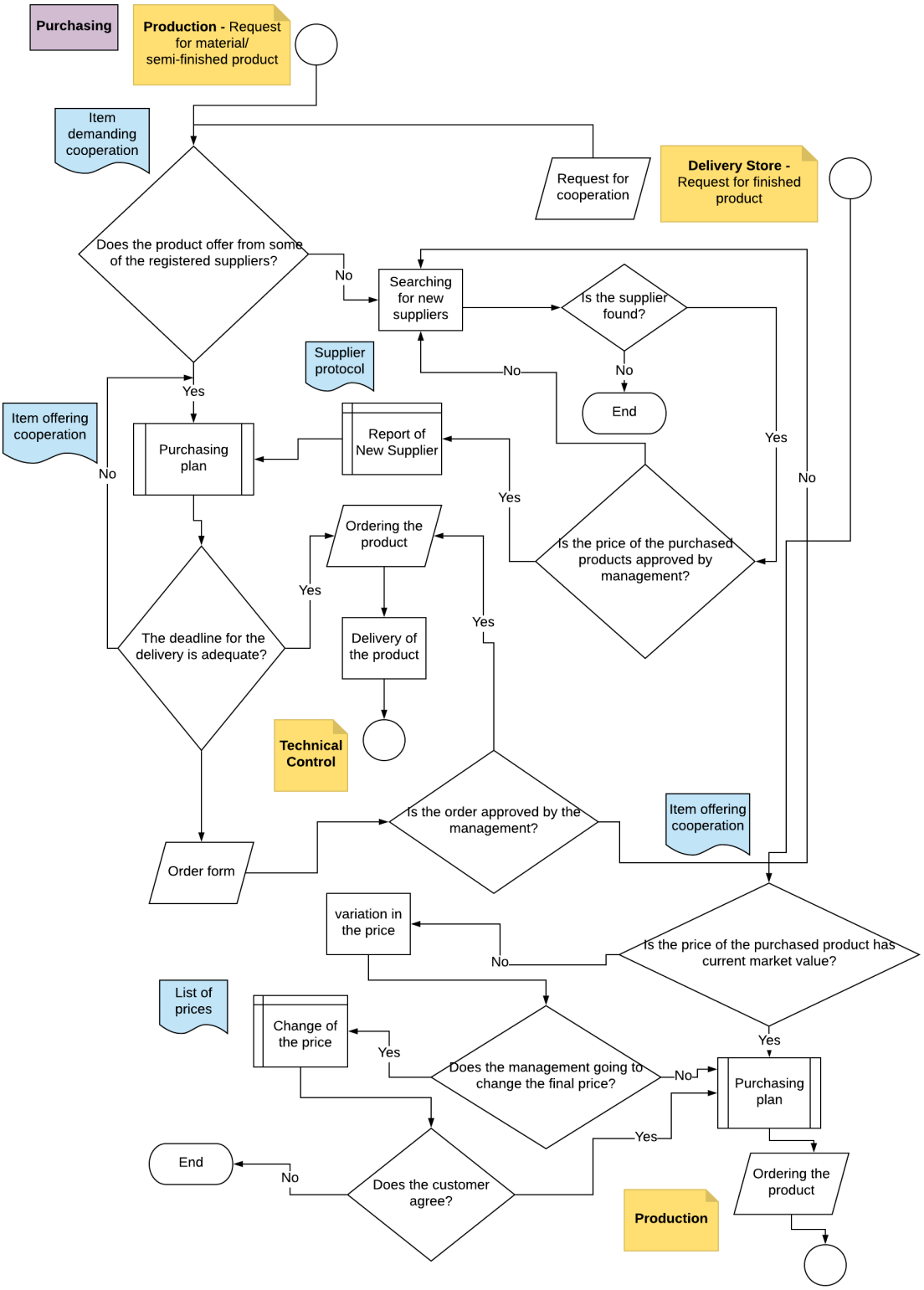


Figure 21 Information Flowchart- Purchasing*[Source: own]*

5.2.3. Information Flow- Technological Preparation for the production

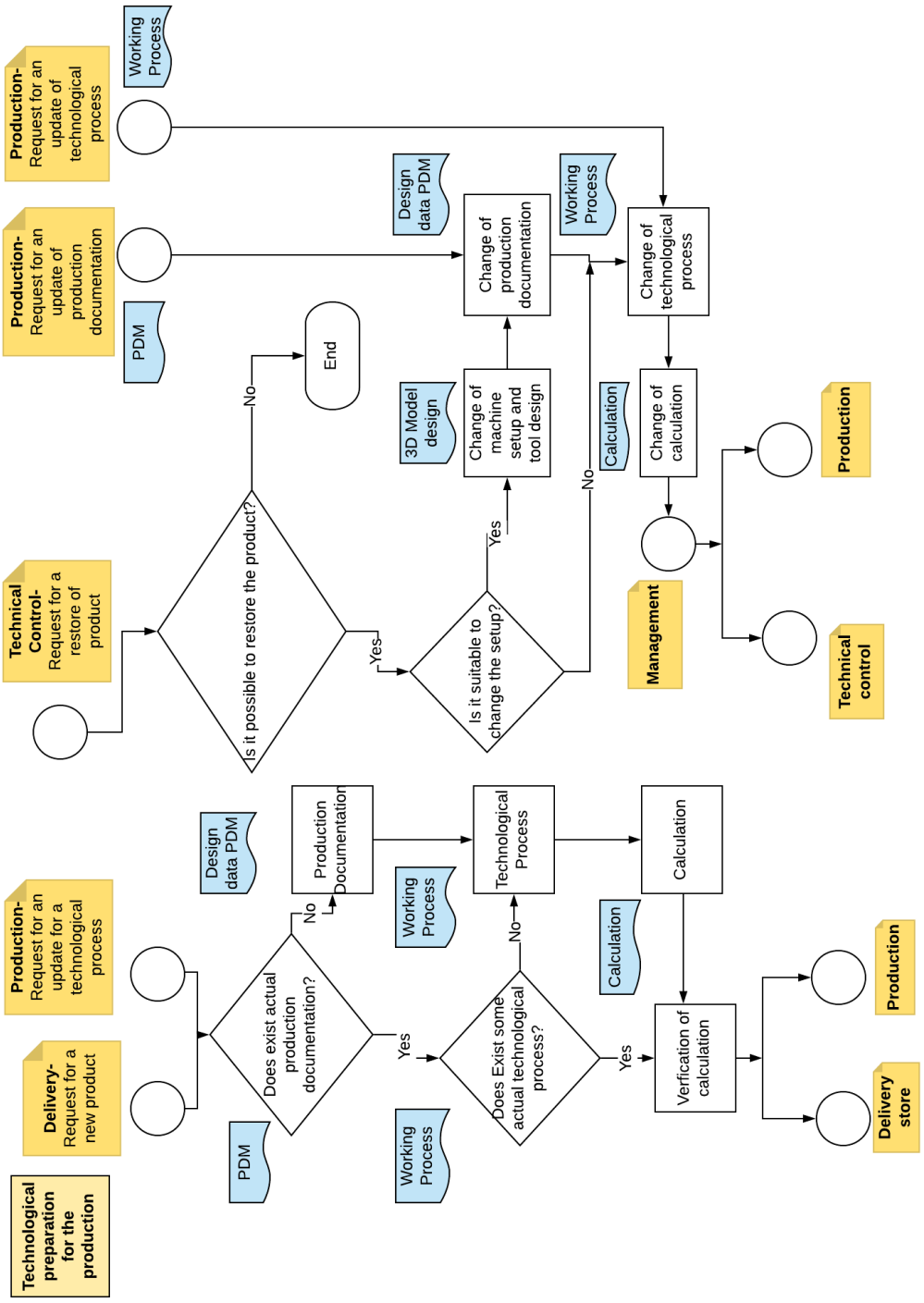


Figure 22 Information Flowchart- Tech. Preparation for the production*[Source: own]*

The technical preparation for the production involves the construction and technological production. It is very important that these two departments of the company work closely together, and it must also be adapted to the Information System that these two areas need to be able to connect.

An important thing is, therefore, the link between Information system and Computer-aided designing and manufacturing. The technical preparation for the production must have access to the current drawing documentation for which it should help the PDM module that is part of SolidWorks which illustrates the 3D model and 2D drawings and described in the previous chapter. With PDM the Information System should be able to cooperate. Figure 22 Information Flowchart- Tech. Preparation for the *production[Source: own]* illustrates the structure and the flow of each data modules throughout the technical preparation.

Another functionality of the system should be to create and manage Bill of Materials. For assemblies that consist of multiple configurations example engine would be good for the system to be able to generate variable bills of lading and variant request the BOM would be sent from the configurator.

The manufacturing process should include the following data:

- Product identification
- Product name
- Description of operations
- Determining the workplace. machines - with the possibility of multiple workplaces option their listing
- Determining the qualifications of the worker required to perform the operation
- Time of work required to complete the operation
- Ability to assign more workers to one operation
- Definition of fixed limits or at least a minimum limit for the workplace, where a certain number of pieces is needed before work starts at work.
- Collaboration offerings - Expected completion time
- Preparations and calculations
- Tools

Furthermore, the system should allow a choice of multiple production processes, if any for example when the same product can be produced on both a conventional machine and a CNC machine, there should be two production processes. It should also be possible to copy documentation from similar products.

Equally important is the possibility of change management. The change is subject to the features of the produced items, bills of materials and production processes that changes to the product documentation should be addressed in the Product Data Management module. All changes must include time validity and identification number. The other edited change should move the previous one change for the item in the archive. The system should also allow for the definition of calculation formulas and balance with costs. It should be possible to include all the costs involved in the calculation with contracts that should be closely monitored.

Machining time (1) can be calculated based on the cutting parameters and the feature geometry and dimension. It is used to estimate the production cost and time. It is also used in scheduling for determining the machine time. For turning and drilling, machining time can be calculated by the following formula:

$$T_m = \frac{L}{V_f} \tag{1}$$

$$n = \frac{V}{\pi D} \tag{2}$$

where T_m is the machining time in minutes, L is the length of cut in inches, V_f is the feed rate in ipm where $V_f = f_n$, f is the feed in per revolution, n is the tool rpm and D is the tool diameter(2). For complex features, it is harder to estimate the length of the tool path. A rough estimation may be used. The material removal rate of the tool is calculated. The machining time is, therefore, the feature volume divided by the material removal rate. MRR = $V_f A$, where A is the cross-sectional area of the cutting.

For hole drilling, A = $\frac{\pi D^2}{a}$, For turning A =$2\pi r^2 a$, where r is the cutting radius and a is the depth of the cut. Machining cost can be calculated by the machining time times a machine and operator overhead rate[17]. Process detailing involves filling the details for the process selected and includes determining the tool parameters, process and process parameters, in depth of tool selection, process optimization with speed, feed, depth of cut and cutting length with machine cost. These parameters are involved in the calculation part of the technical description of production to determine the efficient way of machining.

5.2.4. Information Flow- Management

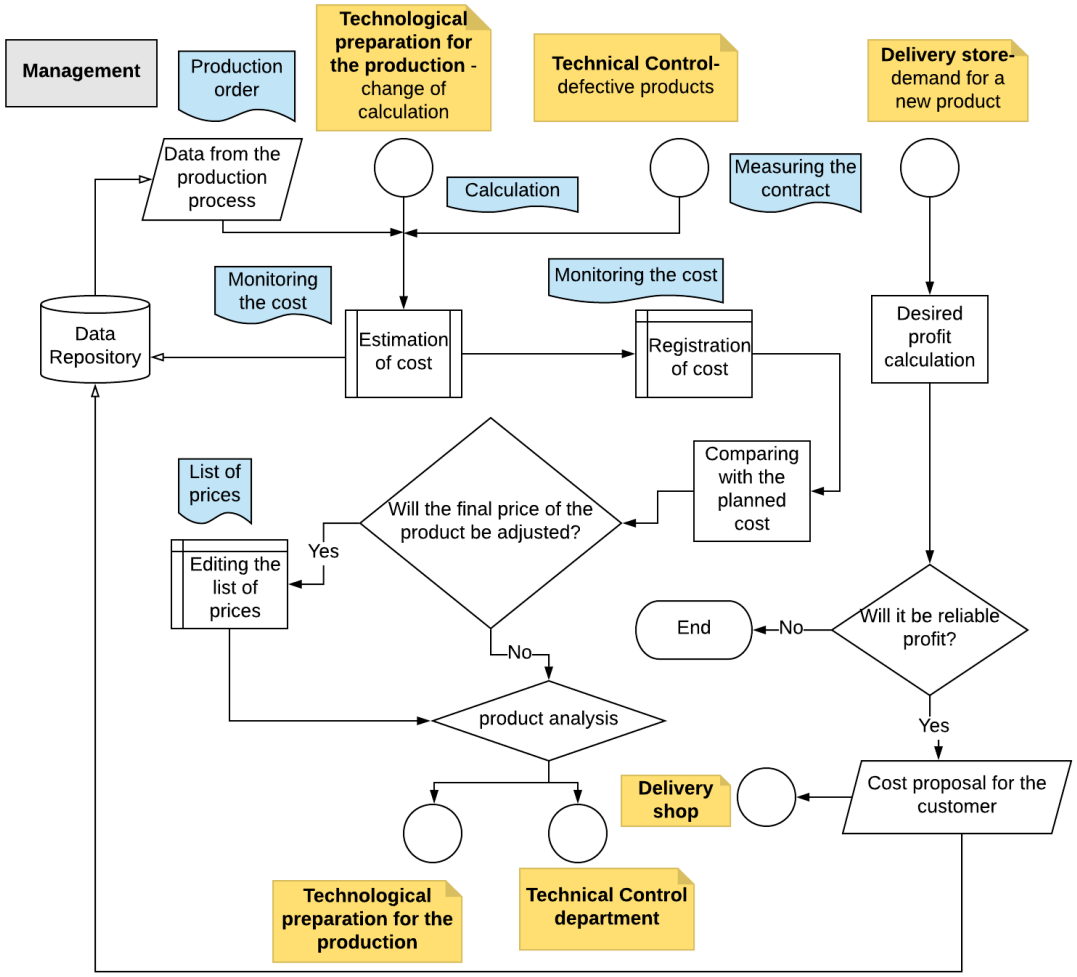


Figure 23 Information Flowchart- Management*[Source: own]*

Management behaves the authority to instruct the entire production and planning system order. It initiates from the technological preparation of production, control and gets reconnect to the source with a decision making orders. Costing along registration, comparing, managing the technical documentation in the data repository. These are the vital data that machine area indicators that should be tracked:

- Records of speed – machines
- Process capability analysis and cost model
- Quality-Machine Records
- Records of downtime - machines
- Records of preventive maintenance and cleaning

- Records of repair and investment in equipment
- Prescribed tests and checks
- Training on equipment, number, and staffing

When conducting a feature to process mapping, one may find several candidate processes for the feature. Which process to choose also depends on the cost of the process. The process cost equation consists of a few terms: tool and machine costs, the material rate and the energy consumption. The relative cost of a process is the cost of removing a unit volume of material. Since the machining time is the inverse of the material removal rate. C = tool and machine rates+ energy cost/Material removal rate, where tool and machine rates are the overhead cost of using the tool and the machine and energy cost is the energy cost per unit time[17].

A process cost model can be stated as the sum of labor cost, machine cost, tool change cost and tool cost and it can be rewritten as the cost of machine + cost of the tool with the product of the volume along the whole divided by material removal rate and conversion value of hours to minutes as estimated in Figure 23 Information Flowchart- Management*[Source: own]*.

Processes such as drilling, milling, and turning have higher material removal rates and thus can finish a job faster at a lower cost, finishing processes such as grinding, boring, and polishing have very low material removal rates and also consume more energy for the same amount of material removed with higher relative cost.

These calculations could be involved in the management to approve the process and comparing with the planned cost. If a customer needs it in low-cost service, we can change the specifications accordingly to their requirements.

5.2.5. Information Flow- Warehouse

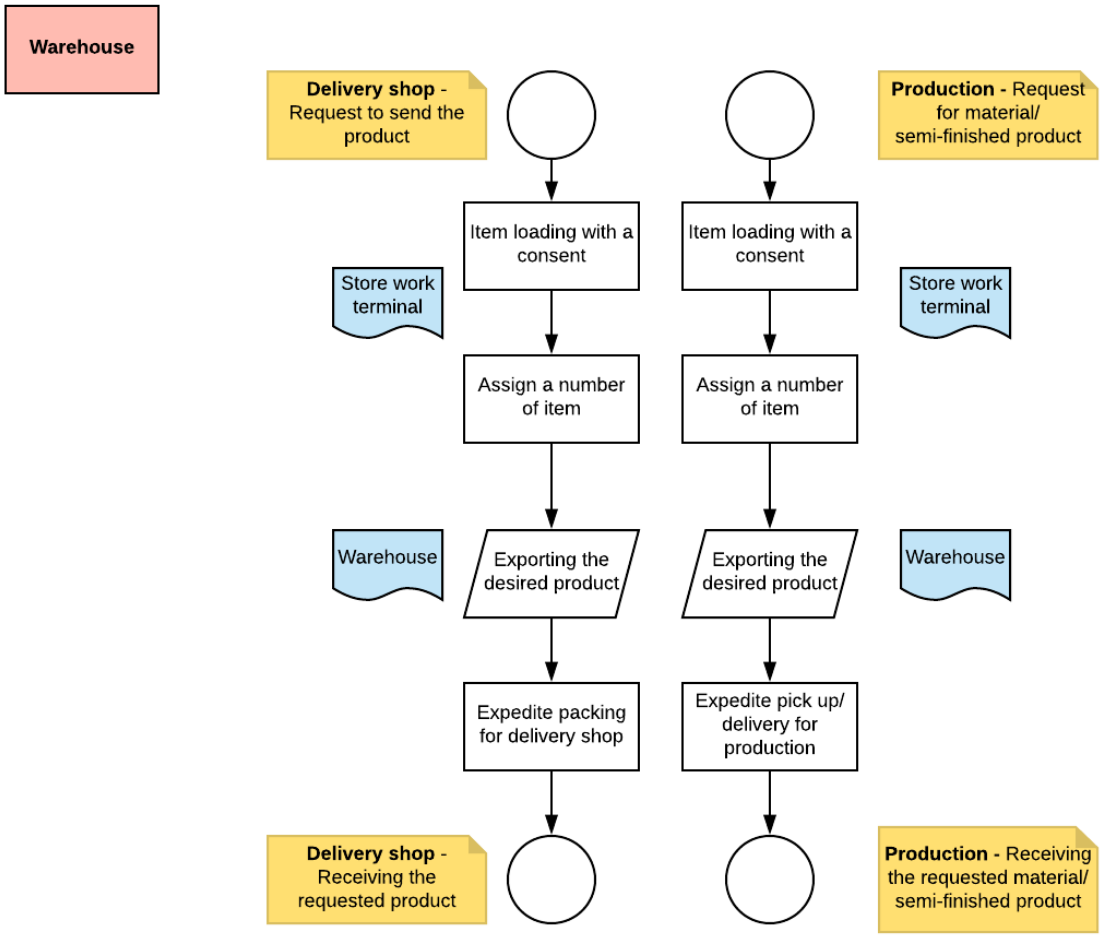


Figure 24 Information Flowchart- Warehouse*[Source: own]*

As can be seen from the warehouse flow diagram Figure 25, it is included workshop control for a better representation of its linkage to production. and delivery shop depends upon the request to send the product or request for the material, semi-finished product.

Warehouse co-operation behaves in the same way as internal production operations in terms of production planning. From this point of view, it is necessary to link with supplier's records and in connection when it is necessary to have an overview of the expected terms of delivery of the parts in the cooperation on the given contract. Prior to the cooperation operation, an authorized project head should be notified and relocate the production batch to the warehouse where the packaging work begins. When the batch is ready for shipping, the system should generate a delivery note, taking into account the waste to a written statement.

In the case of making a certain product it is necessary to bring together several parts together at some point in the production process, but at the same time these parts are not kept in a warehouse, it would be advisable to the system allowed the existing operations to take up existing orders and create a new one. It would be essentially an imaginary warehouse that would not physically exist.

When the production order is created, the system should generate a requested material, barcode technology, and production commands. At the same time, it should automatically book input material and semi-finished goods in the warehouse and automatically send the material request to the warehouse. This moment should take the planning algorithm as a starting point that the plan should also include a pick-up order.

5.2.6. Information Flow- Production and production control

The production process starts with the creation of a production order. The system should allow when creating a production order to determine what kind of engagement is involved. It can be in a warehouse, internal, development or cooperation contract. Furthermore, it should be possible to deal with special cases that would behave in the same way as the contract. Such cases would for adjustments and restoration of their own products, where it would be appropriate for the scheme to match the case concerned with the contract in question or for modifications and restoring preparations.

Production Planning does make a production order to create a production order planned in the production plan. Here is one of the planning mechanisms such as a simpler MRP II. In each case, it is necessary for the planning mechanism to count on all the production resources and their capacities, which will be read out from the technological processes.

Furthermore, to the planning system production was linked to the purchase plan in case it was not for the contract a sufficient number of input items, and the scheduling algorithm could plan the purchase of these items into their plan. The planning system should also allow the inclusion of the employee attendance calendar with the attendance of workers on certain shifts, taking account of reported holidays etc. Such a calendar should be recorded by the senior project manager.

Production occurs when the material comes along with the work procedure and drawing to the workplace of the first operation. There should be an operator under a production order have a work order with him and barcode. The operator would only have read the barcode and write off the operation. He would then enter into the system whether he completed the operation or not, in the second case how many pieces are done, or about how many percents. At the same time, he would specify how much he had done. If the worker on the machine go to do the maintenance, cleaning or operations necessary to activate the operations functions that he would reload with the barcode.

Data entered via terminals into the system should be monitored in the form of an online overview for the production manager. It should be possible to compare this with the production plan as diagramed in Figure 25. The overview should be visible at first glance if it is contract delayed or waiting between operations etc.

The planning and scheduling process is critical for proper manufacturing management in all branches. It ensures the effective management of processes and optimized usage of manufacturing resources. Production planning and scheduling reduce manufacturing costs, as well as it enables you to increase efficiency, calculate material requirement accurately and prevent material overflow and shortages. Owing to work in production schedules, executives are able to fully control the process, and if required to respond quickly to any deviations. In this scenario, Gantt's chart is a very useful tool used for planning and scheduling projects and production. It is a graphical method for the visual presentation of schedules, including project phases, tasks, jobs scheduled on the timeline[20].

The Gantt's chart enables the user not only to plan and control scheduled milestones but also reschedule the task by adjusting the snap targets on the timeline. Planning and coordinating scheduled actions on the timeline is an important part of building and managing an organization. With performance charts, the system analyses actual events entered and deviations (such as employee absences, unavailability of materials, insufficient instructions, machinery maintenance, power failures, contractor's proficiency, holidays, strikes, insufficient competencies of contractors, lack of orders).

After completion of any custom manufacturing operations, it should be done control of material consumption and actual time needed for each operation. The system should evaluate whether the actual material consumption corresponds to the planned one consumption. If it

does not answer, it is necessary to identify the reason and choose the necessary measures, changes in technological preparation for the production. The same should be done at different times of operations and the search for causes of excess scrap. Data gathered directly from production should be further used across all departments and the correct measures would be more advantageous for the use of detailed tracking actual costs.

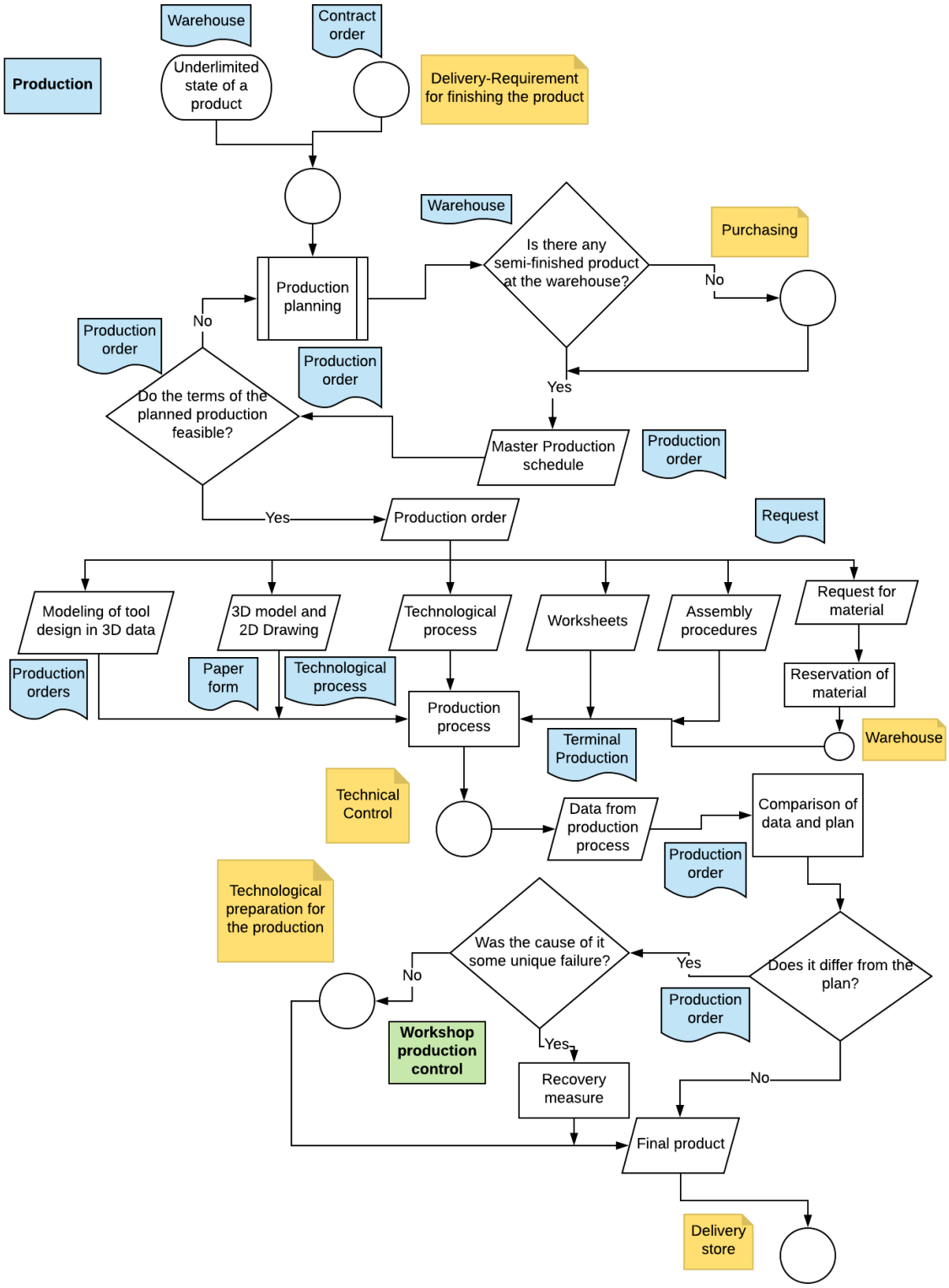


Figure 25 Information Flowchart- Production linkage with workshop control*[Source: own]*

5.2.7. Information Flow- Technical Control

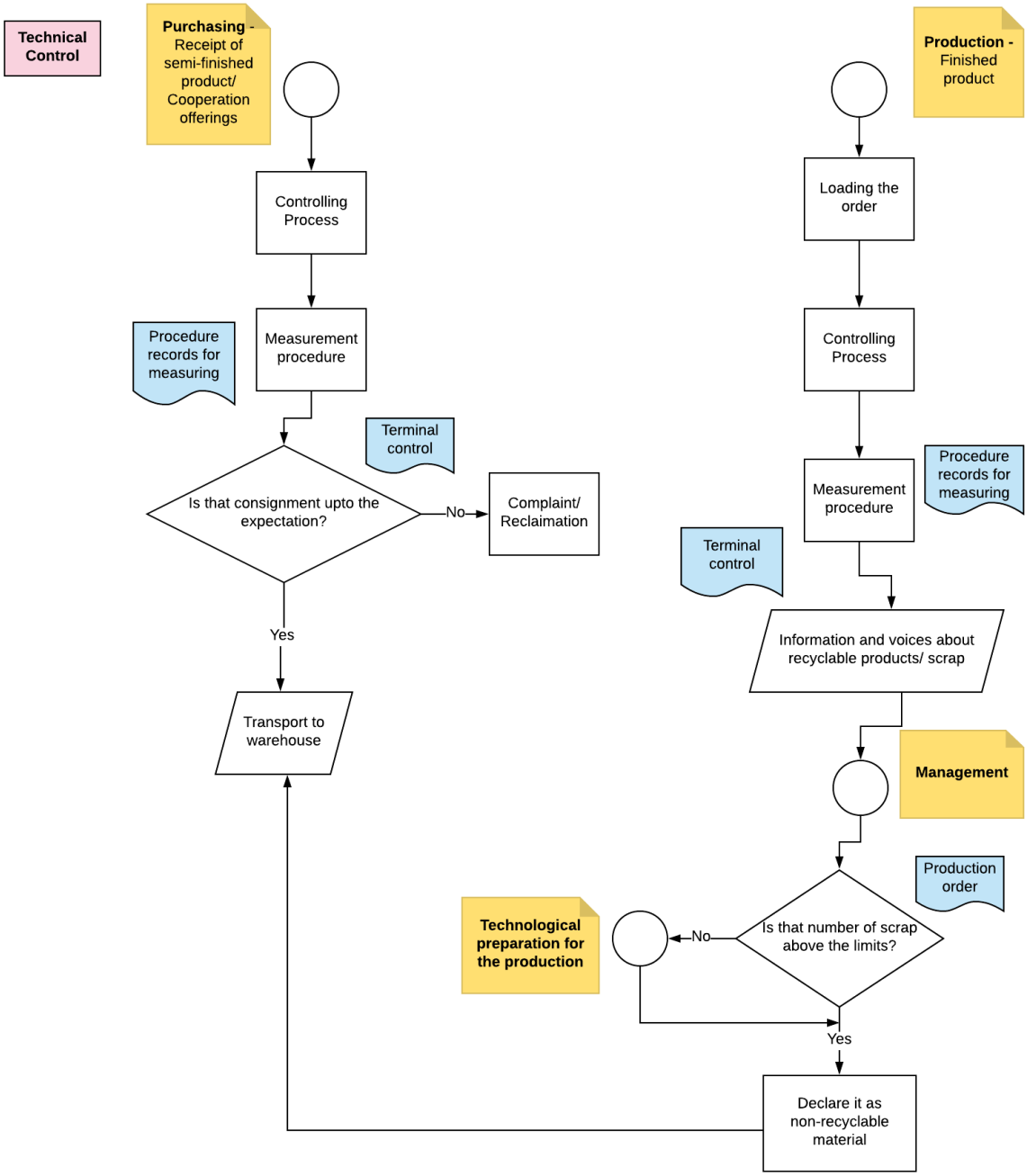


Figure 26 Information Flowchart- Technical Control*[Source: own]*

Technical control, as well as all the manufacturing operations, is part of the whole robust process and should also be recorded, tracked and included in the production plan as represented in Figure 26. Once the control activities have been completed, the system should allow

recording of measurement and report the records. Since a supervisor would be assigned to the job that he is working on, the system should pre-populate the protocol and the report familiar with the contract. In addition, the supervisor should enter the type and description in the report defects, and on which workplace the defect occurred, the number of pieces with the same defect.

Measurement procedures should be included in the relevant contracts, including removing scrapes. Furthermore, the system should alert the responsible staff to the waste would decide how to deal with them and implement preventive measures. The system should also include all these data in the actual cost calculations along orders.

5.3. Data Transfer between Modules

In style among software system engineers to do document software system design, class diagrams are a sort of structure diagram as a result of they describe what should be present within the system being modeled. When a complete flowchart for the departments was designed, another one the step was to build a more detailed Diagram of Class Diagrams. It visualizes the important data flows between the various departments in the updated Information system of the technical museum of Liberec using the definition of enterprise resource planning.

Derived by a lecturer with decades of expertise in needs engineering and domain modeling, this technique can equip you with the ability of in-depth understanding of a UML class diagram and can modify you to evaluate the functional work of a UML class diagram as a blueprint for the development of an enterprise information system.

Figure 27 Data Transfer between the modules*[Source: own]*

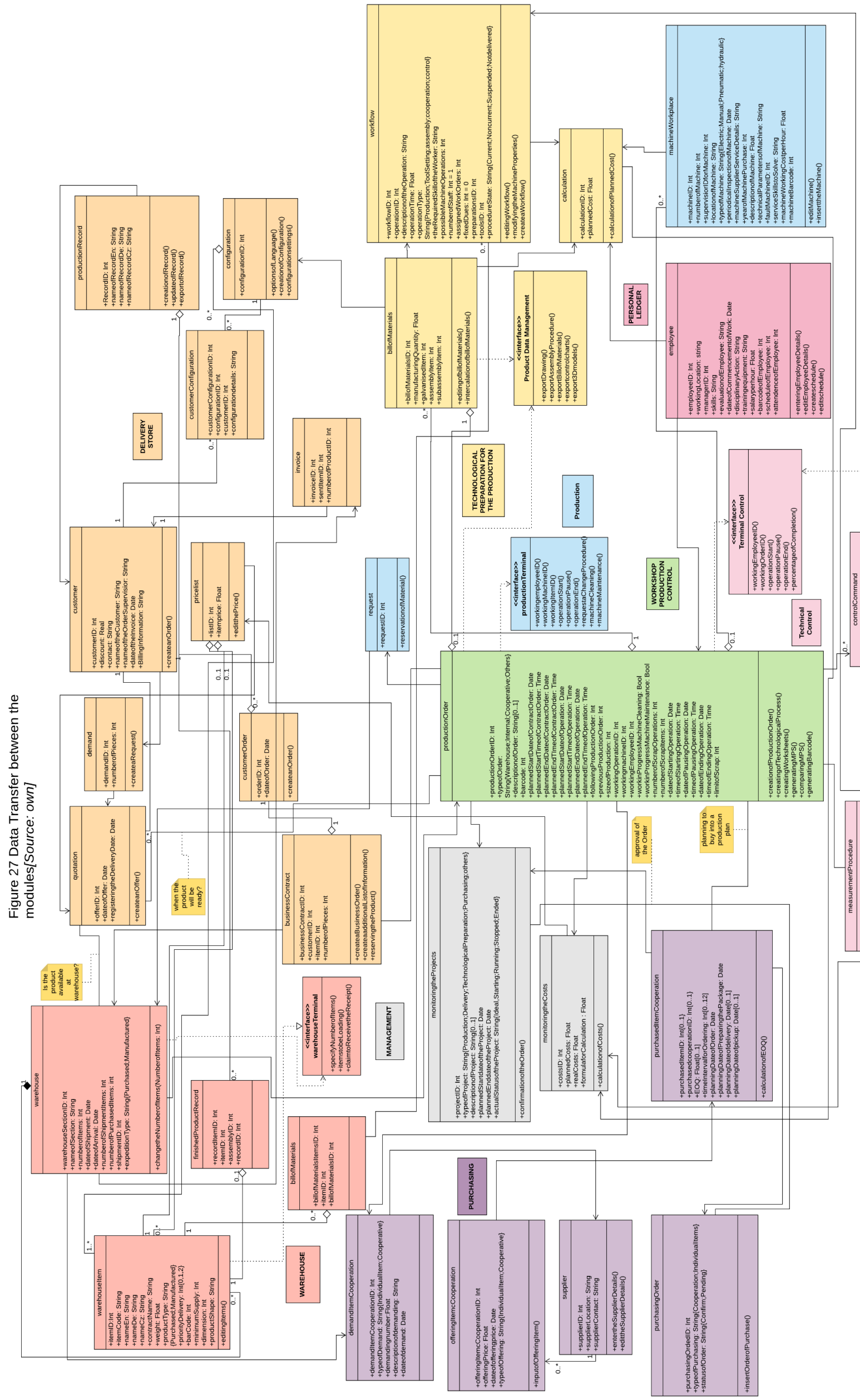


Figure 27 Class Diagram – Data Transfer between the class modules,

Shows that the programmer should be able to create the desired information systems. Each class is marked with a color rectangle, where the color is again selected according to the department of the enterprise for which the part of the system is primarily intended, is divided into three fields which have been discussed earlier in this thesis along how the relationships and functionality will be working along the information

Individual classes are interconnected with links that have more meaning. If the solid line ends with a simple arrow and it means that the class to which arrow is pointing is based on the default class. In addition to the line shows line termination in the shape of an empty diamond. In this case, binding means that the class at which the rhombus is composed of the items of the class from which the link is directed.

In the diagram, there is still the same bond with the difference when the rhombus is full. In such a case means that the composition is unconditional which means item class from which link it cannot exist without the next class to which it is embedded. The interface class outside the system is labeled "interface" under the name. For these classes, bindings are represented by dashed lines that are ended with either a simple arrow that is a class from that interface takes the data. The second option is that the arrow at the end of the dashed line is a triangle, in such a case means that the interface from a given system draws data.

Figure 27 shows that the data flow between the major departments with adequate interface which elaborates each attributes character of the class and it is operations which have the controlling authority of documentation, technical parameters of the final product, production planning, controlling on shop floor as well as for the products which have to be purchasing from the supplier.

5.4. User-Interface of Modules

Finally, a Use Case Diagram could be defined. This diagram shows the proposed system from the perspective of the user that how each user functions of the system will use. The use case diagrams are shown in Figure 28 Use case diagram for User-Interface*[Source: own]* and Figure. 29.

From the end of the receiver, it automatically opens the form to display information to base class forms. In additionally it imports the data of the receiver to edit or create a new base class operation. From the other side, it successfully transfers the information to the receiver in the closed form. Despite it verifies the insert data with the advantage of task information which has inserted already.

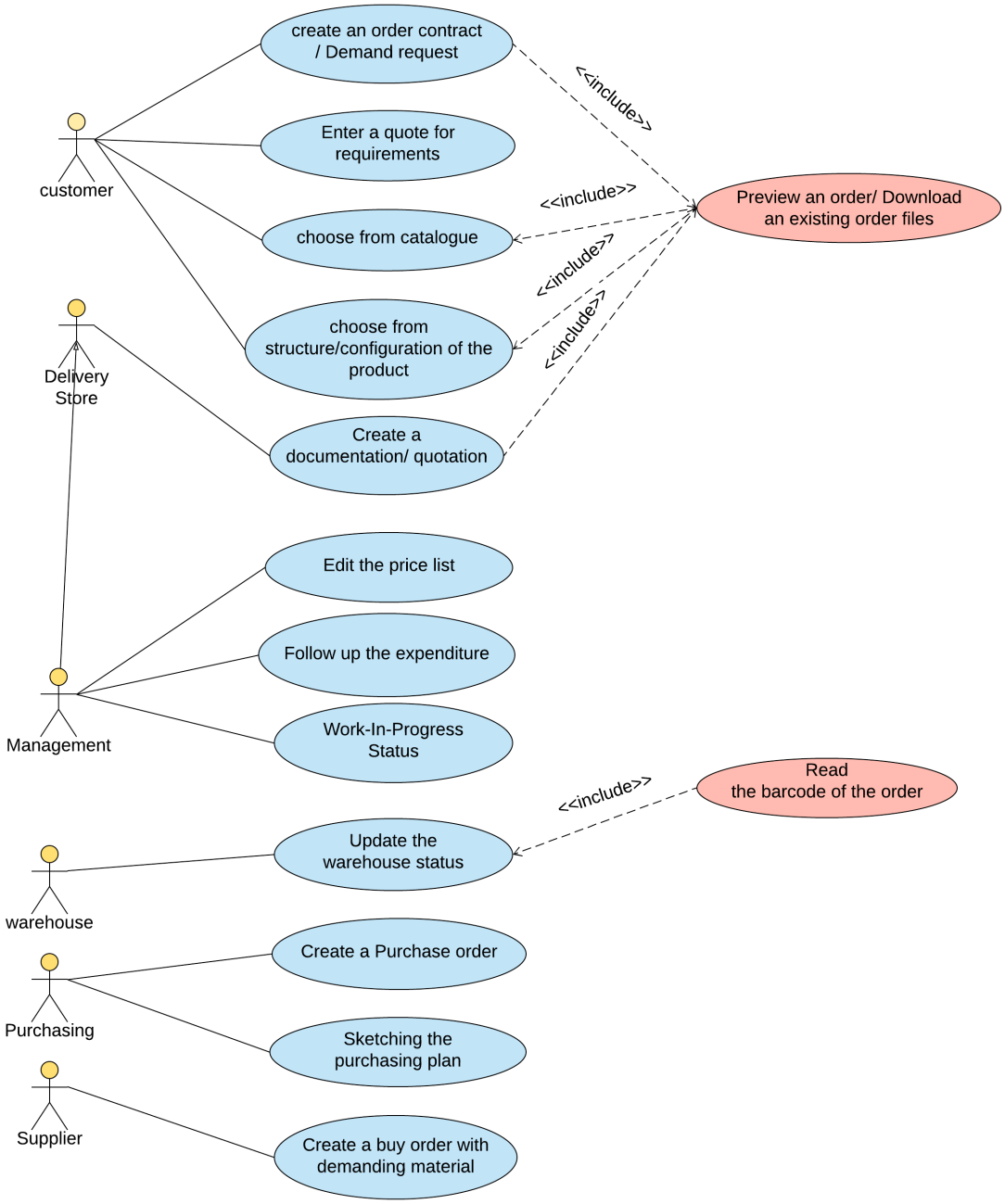


Figure 28 Use case diagram for User-Interface*[Source: own]*

Figure. 29 User-Interface *[Source: own]*

Bill of materials is obvious that there is a possibility fabricated assemblies and the need for these assemblies proved necessary in the process analysis of the middle part of the product. From the logical structure of the BOM that the most numbered item must always be a purchase.

The data in the worksheet should be entered via the terminals by using barcodes placed on a workflow, which are unambiguous identifies the order.

In addition, the worker should retrieve the barcode with his identification and in the last row the barcode with the machine identification on which the operation will be performed. The system can then combine the data and generate it on a work card.

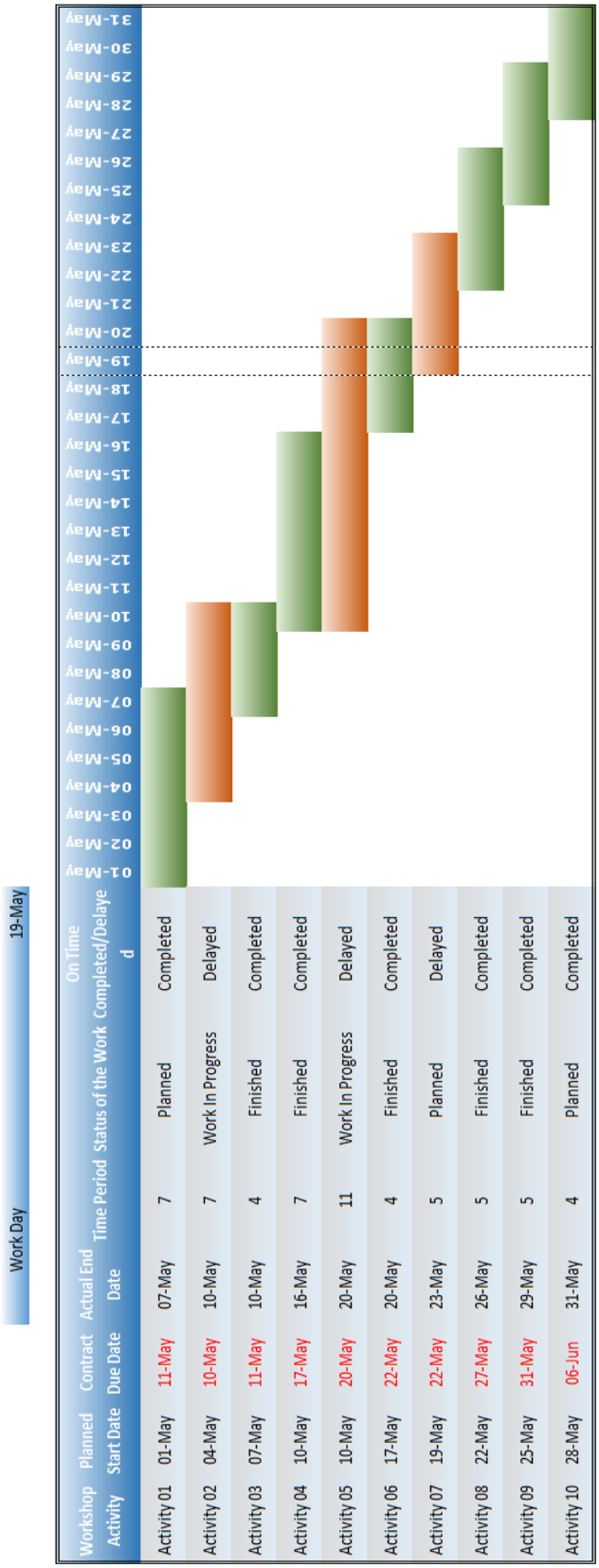
Project	Type	Customer	Item	Catalogue Number	Quantity	Status of the filling	Creation Date	Plan End Date	Department	Assigned Employee
10111	Restoration	AAA	Piston	273-888-411	3	Completed	20-04-18	30-06-18	Purchasing	XXX
10112	Cooperation	BBB	Cylinder	85-78-111	4	Delayed	24-04-18	24-05-18	Technical Preparation	YYY
10113	Production	CCC	Rolling Bearing	889-89-9	2	Delayed	25-04-18	31-05-18	Production	ZZZ

Table 3 Project Monitoring in Management

To monitor business processes, a tracking tool is designed for management projects, there are different types of projects, such as regular business orders, cooperation, restoration, production, etc. For good orientation in project activity implementation, red for projects with a delay, green for projects without delay.

In addition, it is possible to monitor the stages in which the order contract is in progress supply, production, technological preparation, control, etc., when, after the click of an individual the system should redirect the assigned person to the environment by the phase, in which project is. This means that when the project is in the "Production" state, the system redirects the assigned person's users into production orders. When the project is in the "Design" state, it redirects the user's system into Technological preparation for the production, Table 3 shows the simple User interface programming using Microsoft excel.

The tracking of Work flow accordingly scheduled time, see Table 4 , is shown using the Gantt diagram as well as it should be with the production work flow activity tracking. The activity may vary according to the project requirements from the customer. Its course and update should be supervised primarily by the construction workers themselves as well as the management by the scanning of bar code of bill of materials along simple User-Interface.



Workshop Activity	Planned Start Date	Contract Due Date	Actual End Date	Time Period	Status of the Work	On Time Completed/Delayed
Activity 01	01-May	11-May	07-May	7	Planned	Completed
Activity 02	04-May	10-May	10-May	7	Work In Progress	Delayed
Activity 03	07-May	11-May	10-May	4	Finished	Completed
Activity 04	10-May	17-May	16-May	7	Finished	Completed
Activity 05	10-May	20-May	20-May	11	Work In Progress	Delayed
Activity 06	17-May	22-May	20-May	4	Finished	Completed
Activity 07	19-May	22-May	23-May	5	Planned	Delayed
Activity 08	22-May	27-May	26-May	5	Finished	Completed
Activity 09	25-May	31-May	29-May	5	Finished	Completed
Activity 10	28-May	06-Jun	31-May	4	Planned	Completed

Table 4 Gantt Chart - Status of the work flow activity

6. BUDGET SCHEDULE

Program budgeting as a concept belongs more to the realm of budgeting infrastructure than to the frontline of topics.

Before drawing up the budget, it is necessary to get an overview of the type of inputs needed to achieve the objectives of the project. Typical categories may be.

- People (such as programmer staff-time, Operator)
- Equipment (such as machinery, measuring instruments and other tools)
- Consumables and supplies (such as material, semi-finished material, pallets or containers)
- Subcontracts (services and construction offerings)

Once we have identified the type of expenditures the project will have, the next step is to classify them according to standard budget categories. Budget's items are generally divided into two classifications: direct costs and indirect costs.

According to the European Commission (EC 2009) [21] "direct costs are all those eligible costs which can be attributed directly to the project and are identified by the beneficiary as such, in accordance with its accounting principles and its usual internal rules". Direct costs can be personnel cost, durable equipment, consumables, and supplies. Machine costs can be analyzed from online merchandise based on the budget allocation[22].

Indirect costs are all those eligible costs which cannot be identified by the beneficiary as being directly attributed to the project, but which can be identified and justified by its accounting system as being incurred in direct relationship with the eligible direct costs attributed to the project (EC 2009)[21]. Indirect costs, also called overheads, Facilities & Administrative Costs, typically are costs of operating and maintaining buildings (electricity/gas/water bills), grounds and equipment, depreciation, general and departmental administrative salaries and expenses and library costs.

As for the personnel programmer, I have done a survey of the most enthusiastic java and SQL programmers through the questionnaire of software skills around the Czech Republic.

From what I have illustrates the best three with their expecting salaries per month as well for the whole project. Their demands are following in:

Programmer	***Duration in Months***	***Cost per Month in €***	***Net Cost in €***
Programmer A	*9*	*1740*	*15660*
Programmer B	*8*	*2110*	*16880*
Programmer C	*6*	*2480*	*14880*

Table 5 Proposed software programmer salary per month

From this proposal Table 5, project manager of technical Museum of Liberec can pick up one of the efficient and realistic budget requests. Additionally, for the better user experience to control and inspect the data, it will need a barcode scanner and high configuration computer. It would cost around 3000 in Euros. As per the proposed budget schedule, hardware and software cost would be around 20000 in euros to implement the proposed information systems throughout the technical museum within the duration of six to ten months of time period. It will satisfy the project manager requirement with high productivity.

7. CONCLUSION

The aim of this work has been analyzing the current requirements in the technical museum of Liberec including the flow of information through the future build-up production system and further to propose the information flow and the structure of the information system for planning and production of customized orders in the technical museum of Liberec. The thesis was divided into the theoretical part (see chapters 2 and 3) and the design part (chapter 4 and 5).

In the theoretical part, the classification of information system has been defined and the methods are described for production planning information system through their individual design tools. The methods were ranked according to their developmental over time.

In the design part, there have been various voices (chapter 4) to propagate detailing the information flow in the whole of the system (chapter 5), when it is envisaged to interconnect the current information system with the new proposed information system. Based on the information flow, a structure was created information system in the form of a class diagram and various department modules were structured according to the working and decision making principles through flowcharts.

At the end of the design section, an example of how the structure of important objects in the information system should look like when a project tracking tool for user interface was designed at the highest level through use case diagram. This tool should have a supervisor an overview of all the events in the business, covering all of its areas. In addition, the suggested budget schedule (chapter 6) for the proposed information system for restoring the data in the technical museum of Liberec has been estimated along quotation from the experienced software programmer who has relative knowledge with Java and SQL.

Proposed structure information system calculates the type of production where the range is offered products are very diverse and customized by the customer order and most of the production would have been produced in the planned new layout. At the same time, the structure was designed in view of the relatively large complexity of planning.

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