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INTRODUCTION OF A PRODUCTION PLANNING AND CONTROL SYSTEM (PPC) IN AN AUSTRIAN FOUNDRY

A Master's Thesis submitted for the degree of
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supervised by
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Affidavit

I, **ANDREAS BRETSCHNEIDER**, hereby declare

1. that I am the sole author of the present Master's Thesis, "INTRODUCTION OF A PRODUCTION PLANNING AND CONTROL SYSTEM (PPC) IN AN AUSTRIAN FOUNDRY", 92 pages, bound, and that I have not used any source or tool other than those referenced or any other illicit aid or tool, and
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ABSTRACT

The selection of a PPC-system is a long-term decision which defines the enterprise frequently ten to fifteen years. In this time a company will change itself radically in its structure and its production kind. A PPC-system must be improvement-capable for that and be able to adjust with small expenditure onto the respective requirement because otherwise the danger that developments are slowed down exists (because the PPC does not approve that). A phenomenon which is to be found (unfortunately) very often.

For that the planning and data preparation phase (in which the examined enterprise is currently) of the introduction of a PPC-system (next to a professional implementation phase of the users) represents the by far most important section. Often the technical realization of requirements is put, however, into the center - without an efficient organization of the existing processes and the creation of a high user acceptance a perfect technical solution becomes however (as already thousands times occurred) to be condemned to the failure from beginning. It is to improve established work and thinking manners, as well as to use the “IT-technical-restart” for the adjustment of the available databases. Data are taken over frequent from old systems as e.g. calculation or old PPC-systems. These data are almost always inadequate. If a new system is introduced with higher requirements onto the accuracy, onto the informative capability and onto the reliability, the data must correspond to theses new requirements then.

The examined enterprise represents a classical representative of the „old economy" - it is active in the field of the heavy casting. It is very "traditional" organized - what is reflected very clearly in the existing processes and the working methods. The manufacturing is "workshop"-based: From a product only few pieces which have a very long machining time (up to a year) are produced. These factors built the base for the decision to implement an individual solution that can be fit exactly to the requirements of the enterprise. The first phases of the planning/implementation of this PPC-system are described within this thesis.

1 TABLE OF CONTENTS

2 PROBLEM FORMULATION

A renowned Austrian foundry (active in the field of the heavy casting) introduces currently a **PPC (production planning and control)-system** to be developed individually. This work describes the current/aimed situation of this enterprise in the field of the production planning and- control. For this purpose the raised problems (and already implementation approaches confessed) of the affected specialized departments (based on an actual state analysis) and the current/aimed use of the IT (including the difficulties of the deployment of SAP in the field of the PPC) are represented. Currently the first modules – e.g. the field of the working cycle data collection - are implemented. The findings from these early steps of implementation are supposed to enter also this work.

A PPC-system (part of an enterprise resource planning system-ERP) implementation should not be viewed purely as an IT-project. It is a multidisciplinary team effort. It cuts into the very heart of the business, upturning policies, practices and powerbases. If it successful then the rewards a bountiful. Transactions are speedily processed. Timely information provides awareness of what is happening. Actions become more proactive. The payback has a lot of positive effects on the bottom line (Harwood, 2003).

Next to the obvious cost savings potentials (better use of the available resources, increased machining times (capital investment in stock reduced by that) etc.) following important reasons for the introduction of a new PPC-system can be defined:

⇒ Optimization of the production / adaptation of the existing processes of manufacture onto new, modern organizations

⇒ Standardization of all process steps -also these that currently do not follow any defined organization -> complete and gapless illustration of the process of manufacture

⇒ Creation of an essential increased transparency of the production (and in this way increased planning quality, possibility of a better capacity smoothing etc.)

⇒ Elimination of multiple and error-prone, manual data acquisition

⇒ Creation of a structured database as a basis for detailed evaluations (Basis for pre- and post calculations, internal charging for services etc.)

⇒ Integration of supplier / customer to the process of manufacture (statuses, deviations etc.)

The introduction of the new PPC system is little in the mentioned company a technical, but an organizational challenge. The change/optimization of the existing processes (including the gathering and the understanding of the not documented, current working methods and methods) with simultaneous protection of the acceptance through the affected staff turns out currently as the greatest difficulty.

The task is to generate a comprehensive internal (production) and external (suppliers) „Supply Chain". The idea is hat the production of all but trivial goods and services can be thought of as a supply chain. The metaphor is very direct: a chain relies on interconnected links as does the production of goods and services. Notice that organizational, factory or office boundaries are not mentioned and it is not distinguished between goods and services. At some level of abstraction goods and services are the same, and moves between machines in a factory share important characteristics with movement of goods between factories (suppliers etc.). Perhaps the most important thing from the perspective of improving management practices is recognition that the entire supply chain must be considered whether it is entirely within one factory or spans many organizations. (Voß and Woodruff, 2000)

3 INTRODUCTION

The **"voestalpine-Gießerei" (VAGL)** increased in the last years and plans expansive activities also in the future. The accompanying turnover increase as well as the planned expansion of the external processing (relocation of activities) increases also the complexity in the production planning and control - the support of the agents through corresponding tools gains considerably importance through that.

3.1 Potentials / objectives / measures

The production planning and control is currently covered by SAP, some individual solutions as e.g. the QS-system, Excel lists etc., at which in the Status Quo the **following potentials are available**:

⇒ Easier handling / superior transparency

⇒ Several work schedule versions per task (original, reworked plan) hold

⇒ Support external processing

⇒ Scheduling considering bottleneck resources

⇒ Extension of the planning on TOS (technical operations scheduling), QA (quality assurance) and MCW (model construction workshop)

⇒ IT technical integration of the quality department

⇒ Support of scenarios on rough planning

⇒ Data collection of times and quality data

⇒ Learning-effect from current data collection (adaptation of work schedule...)

⇒ Support of the optimization of

- casting pit planning

- Stove reservation
- Etc.

⇒ Automatic creation of production identification numbers

The planned system pursues the following **primary objectives**:

⇒ Rise of the delivering service degree

⇒ Improved transparency

⇒ Improvement of the planning quality

⇒ Support sales / order taking respectively resource planning

⇒ Use of optimization potential (e.g. batch size formation)

⇒ Administration / planning of external partners and buffer warehouses

⇒ Integration of all processes (TOS, model construction, quality)

⇒ Improvement of production data entry

⇒ Early recognition of future problems/risks

⇒ Production controlling: deadlines / costs / quality

This leads to the **following measures**

⇒ Planning / control of deadlines / resources / costs / quality

⇒ Decision supporting system: PPC-system constructs by means of optimization approaches „good" initial solution that is adapted through agents

⇒ More precise job order planning (more detailed and more precise work schedules)

⇒ Integration TOS / model construction

⇒ Integration quality management

⇒ Integration of administration wounding-parts

⇒ Production rough planning: resource situation / order taking

⇒ Production fine planning considering all resources

⇒ Data collection shift-precise

⇒ Production reporting system respectively plan / actual state deviation analysis

3.2 Future positioning of SAP and PPC-system

The current occurrence of the active SAP-system was introduced in economical difficult times of the enterprise. A lot of functionality was implemented according to standard of the mother enterprise and adapted only deficiently to the available organization and to the special factors. These lapses are to be recognized in almost all used modules and make an in fact integrated use very difficult (next to that users were not trained effectively onto their field of action in SAP).

That, for a production planning and control most relevant SAP module PP (production planning), is generally not the strength of the Walldorfer software company. It is laid out to the predominant part for serial manufacturers - the requirements of job-shop / project manufacturers are covered only very much rudimentary. The SAP-module PP is component of the SAP business suite / SAP ERP Operations and is characterized as follows (covers following applications):

⇒ Production planning

- Support a wide variety of basic strategies for production planning and execution
- Optimally plan, schedule, and sequence production on the factory floor to deliver promised orders

⇒ Manufacturing execution

- Support the capture of actual production information from the shop floor, providing visibility and transparency across all shop-floor processes
- Perform production plans by managing production processes and deploying workers and other resources on the shop floor
- Document, monitor, and dispatch inventory during the entire production life cycle (SAP, 2010)

The PPC-system currently to be developed will represent a quantum jump in the efficiency increase, planning capability and organization of the production to the VAGL.

The taken way, to extract the PPC functionality and database from SAP, states economically and functionally the complete correct solution. A clean and secure connectivity to SAP is created, means that SAP supplies the new PPC-system with the necessary data (tasks etc.) and receives in return all necessary information to cover the classical business task (invoice creation, purchase order processing etc.).

SAP will be in future almost exclusively responsible for the handling of external processes (procurement, transportation, order procedure) as well as the accountancy.

The PPC-system will be positioned as the second leading system beside SAP, gathering all production-relevant data (“central production database”).The planning and control of internal processes to the biggest part will be taken over from SAP.

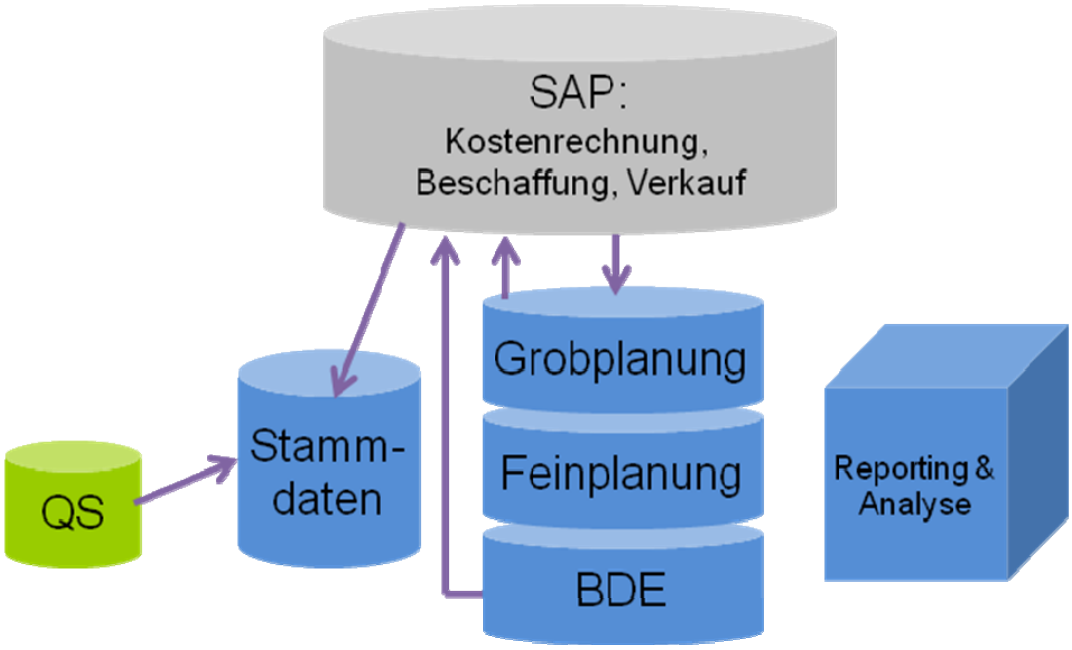


Fig. 1: Positioning the new PPC-system

Beside the "pure" introduction of the IT-system there are three major building blocks in production system, which have to be taken into consideration:

⇒ The machine technology base, or tools of production

⇒ The organization of the production system

⇒ The techniques of production management that are applied to control the operation of the system (Elsayed and Boucher, 1994)

4 FUNDAMENTALS

4.1 Overview of the enterprise

The **voestalpine-Gießerei Linz GmbH** is the leading enterprise within the voestalpine foundry group with plants located nationally and internationally.

The voestalpine-Gießerei Linz is a 100 % daughter of voestalpine Stahl GmbH.

Since 1st April 2002 voestalpine-Gießerei Traisen GmbH is a 100 % of daughter of voestalpine-Gießerei Linz.

Since 9th of May 2004 Kocel Steel Foundry Co. Ltd China is a common joint venture of Changcheng Suzaki Machine & Foundry Co. Ltd (CSMF) China and voestalpine-Gießerei Linz GmbH.

A further joint venture was closed on 04th May 2008 (with Jiaxing NYC Industrial Co., Ltd.) (voestalpine, 2010)

4.1.1 Vision

⇒ Market Leadership in the production of cast components

⇒ Overall supplier of read-for-installation, finish machined cast components in all weight classes and materials, including the possibility of assembling

⇒ Competence centre for the manufacture and development of cast parts for or in collaboration with the customer (voestalpine, 2008)

4.1.2 Identification numbers

⇒ 400 employees

⇒ 10.000 tons / year

⇒ Cast steel to 170 tons delivering-weight / piece

⇒ Nonferrous metal casting to 1,5 tons delivering-weight / piece (voestalpine, 2010)

4.1.3 Products

The voestalpine-Gießerei Linz produces steel and nonferrous metal casting in two separate manufacturing halls:

Cast steel for (**this thesis deals exclusively with this branch)**:

⇒ Machine building

⇒ Power generation

- Steam turbines
- Gas turbines
- Compressors
- Offshore

up to a delivering-weight of approx. 170 tons/piece

Nonferrous metal casting as e.g.:

⇒ Maintenance-free gliding-elements WF 750 etc.

⇒ Leading manufacturer of compact slides and norm slides, which main area of application lies in the automotive industry (voestalpine, 2010)

4.1.4 Understand general organization

The examined enterprise is very “traditional” organized - what is reflected very clearly in the processes and the working methods:

⇒ The organization of the production is heavily influenced by the master craftsmen and „long-employed technicians"

⇒ Working methods are hardly adapted onto new factors

⇒ High degree of "manual flow of information" (telephone, documents etc.)

⇒ Self organization of the departments (missing „global" understanding)

⇒ The IT is deficiently structured - departments constructed relative autonomous solutions of simplest nature (predominant Excel sheets)

In order to adapt the existing organization to the new factors (and to guarantee the successful introduction of the PPC-system) following basic rules of an „effective organization" have to be taken into consideration:

⇒ The total organization, the significant subparts, and individuals manage their work against goals and plans for achievement of these goals

⇒ Form follows function (the problem, or task, or project determines how the human resources are organized)

⇒ Decisions are made by and near the sources of information regardless of where these sources are located on the organization chart

⇒ The reward system is such that managers and supervisors are rewarded (and punished) comparably for:

- Short-term profit or production performance
- Growth and development of their subordinates
- Creating a viable working group

⇒ Communication laterally and vertically is relatively undistorted. People are generally open and confronting. They share all the relevant facts including feelings

⇒ There is a minimum amount of inappropriate win/lose activities between individuals and groups. Constant effort exists at all levels to treat conflict and conflict-situations as *problems* subject to problem-solving methods

⇒ The organization and its parts see themselves as interacting with each other

and with a *larger* environment. The organization is an "open system"

⇒ The organization and its members operate in an "action-research" way. General practice is to build in *feedback mechanisms* so that individuals and groups can learn from their own experience (Gallos, 2006)

In order to apply new rules and working methods a change in the minds of the employees has to take place. People do not necessarily resist change. The issue is what people perceive to be the impact of change. People resist change when they perceive the consequences as negative. While individuals will differ in how ready they are to anticipate negative consequences, and even though their reasons may appear illogical or even wrong to an outsider, people are not automatically resistant to change. People resist change for a *reason*, and a manager's task is to try to identify those reasons and, where possible, to plan the change so as to reduce or eliminate the negative effects and to correct misperceptions. (Cohen, et. al., 1995)

4.1.5 Customers

The following graphic shows the most important customers of the voestalpine-Gießerei and their international distribution:

Fig. 2: International distribution of the customers (voestalpine, 2010)

4.2 Understand production steel foundry

4.2.1 The principle of the customer-specific production

Customer-specific production offers the possibility to customize the product according to individual wishes. Thus the customer-specific production represents the contrast to the standardized manufacturing, at which the products are offered without having been specified by the customer before.

The customer-specific production normally occurs

⇒ Customer order-covered (= task manufacturing) and

⇒ In job-shop or batch production.

During the job-shop manufacturing all activities standing with the production in context are not activated before the case of presence of a customer order. The precise specification of the final product is given first with entry of the customer order, a warehouse manufacturing therefore mostly impossible. There are normally only implementation concepts for the product design available, means that after order entry further activities as projecting or elaborating are necessary. Through that it comes to long delivery times on job-shop manufacturing.

At that job-shop production every product is produced according to customer requirements separately. During the batch production the lot size is typically up to 20 pieces - the products of this series are homogeneous.

Characteristically for these two forms of production is the

⇒ Frequent retooling of the machines

⇒ high partial variety and

⇒ many working cycles.

During the customer-job-related job-shop or batch production a high measure of flexibility is necessary, because production is confronted with frequently changing products and production programs. Therefore the fundamentally useful order of the

principle of the assembly line production is hardly realizable. During the job-shop manufacturing the order of the jobs occurs according to the performance principle, at what same or at least similar (e.g. shaping-works) are combined into one (the turnery) spatially.

At that production the product must run through a couple of workshops, at which a complex flow of materials arises. The single workshops can be coordinated through a PPC-system with which guarantees for instance the required parts being available on schedule, the single workshops and workplaces to be synchronized and delivery dates staying in time.

Advantages:

⇒ Work is generally of a high quality

⇒ A high level of customization is possible to meet the customer's exact requirements

⇒ Significant flexibility is possible, especially when compared to mass production

⇒ Workers can be easily motivated due to the skilled nature of the work they are performing (Wikipedia, 2010)

⇒ Fast introduction of new products

⇒ Also being economical on small lot sizes

⇒ Big action and deciding match rooms for the employees

Disadvantages:

⇒ Higher cost of production

⇒ Requires the use of specialist labor (compare with the repetitive, low-skilled jobs in mass production)

⇒ Slow compared to other methods (batch production and mass production)

(Wikipedia, 2010)

⇒ High transportation efforts between the jobs

⇒ Intermediate warehouse charges and waiting times, through that interest and warehouse costs, standstill costs of the jobs not busy

⇒ Uneven capacity utilization of the jobs (small productivity)

⇒ Difficult manufacturing planning and control

Advantage flexibility:

⇒ Flexibility expresses the adaptability to different situations. Production flexibility is a measure of that, as fast and in which scale a company in the field of production can adapt onto changed situations and – particularly - onto changed customer requirements.

⇒ Workers of a workshop must overcome a wide task spectrum. They are for many purposes trained and must be, like the machines, for many purposes usable. Possible employment deviations can be handled through adaptation of extra work, additional shifts or initiation of reserve machines. Ill workers, holidays or machine failure rates can be bridged through short-term disposition onto alternative work places. The production is the more flexible, each more possibilities and ways are available to a part to be produced during the cycling of the manufacturing. Buffers in the form of stocks between the single work places serve the compensation from different operating times and prevent the spreading of mail functions.

Disadvantage small productivity:

⇒ The flow of materials during the job-shop manufacturing is marked by a high number at transportation and through long distances which long transport times arise through.

⇒ Due to the shop order backlogs it results in long downtimes (often 85 % of the cycle times) of the parts. The repetition degree of identical / or similar

tasks is small, thus the operating times last (unlike the assembly line production) longer.

⇒ Job-shop manufacturing is further characterized through high adapting-frequency and a high number of work places must be gone through, where each time again transportation, tooling times etc. is accumulated.

From that following the job-shop manufacturing (due to all the mentioned points) is characterized through long cycle times and a small productivity.

4.2.2 Definition of PPC-systems

Production planning and control activities deal with the planning and control of manufacturing processes, and therefore include materials, machines, operators, suppliers, customers and products. The operational tasks of an industrial enterprise can be referred to as the production planning and control system (PPC), and their problems encompass a wide range of fields and industries. (Onwubolu, 2002)

Any PPC-system in an industry should invariably –though not exhaustively-serve the following three purposes:

⇒ Minimize the mismatch between demand and supply

⇒ Maximize the capacity utilization of facilities

⇒ Minimize the work in progress (WIP) inventories

There are other surrogate purposes also such as to:

⇒ Maximize productivity and

⇒ Maximize flexibility of products range (Mukhopadhyay, 2004)

Recent market-trends indicate that manufacturing firms are being required to excel in a variety of dimensions (6). Low cost manufacturing, quicker product development, faster delivery, wider variety of products, wider range of efficient production volumes, and steadily increasing quality standards have all become more important. The environmental conditions faced by the manufacturing function can be

characterized by (1) product volume and variety, (2) competitive priorities and (3) process technologies an infrastructure available within the firm. (Adelsberger, et. al., 1995)

4.2.3 The production of the examined enterprise (steel cast)

The field of the production planning and control at small and serial manufacturing is well treated with deterministic (means confessed) production parameters with Standard ERP/PPC-systems. In contrast, the existence of high process insecurity prevents the application of standard planning algorithms and planning parameters for the job-shop Production.

At the example of the development partner voestalpine-Gießerei Linz the situation is supposed to be clarified by means of concrete potentials.

At the voestalpine-Gießerei it is a question of manufacturing customer order-driven, in a series of work operations, the customer-specific and unwieldy ones (up to 200 tons) products with a machining time of 6 to 18 months (approx. 350 cast irons per annum). In this case several main production steps are to be distinguished:

On basis of the customer requirements with the aid of construction-know how and / or technical simulation model constructions are drawn and built as wood-models.

In the step of moulding department / foundry at first the wood model is formed (negative-model consisting of sand). Then the delivery or production and treatment of the liquid steel as well as the realization of the casting (which the cooling time is approx. 3 weeks according to size) occur. After some post processing processes and a surface treatment (to 80 % away) the finishing and/or the material testing is the next main production step. In this case a quality control (gas bubbles etc.), elimination the corresponding deficient quality and a renewed control to which quality is flawless, occur. The steps of the quality control and error recovery must be gone through frequently repeatedly. In dependence for the cast quality and/or the quality of the finishing steps carried out the operating time per work piece varies around +/- 50 %, in exceptions also strong about that. A finishing follows away.

For the production planning and control -mentioned as already - the SAP system (PP,

MM) is used.

In the status-quo the following deficits are shown:

⇒ Difficulty of the capacity planning: Capacity planning is concerned with defining the long-term and short-term capacity needs of the organization and determining how those needs wants be satisfied. Capacity decisions consider customer demands and the available resources and coordinate both to decide to estimate the required capacity. (Rama Murthy, 2005)

The current and / or future workload situation is considered at the spooling and / or deadline promise for lack of corresponding simulation support (what-if-scenarios) only inadequately. Being behind deadlines, high capacity adaptation costs (overtime, special transportation...) as well as bad adherence to schedules opposite the customer is the consequence. → Simulation/scenario calculations

⇒ High work in progress supplies and the costs combined with that in the manufacturing. - That particularly in fields with high process insecurity. The question to which part these supplies are necessary for the cushioning of the process insecurity is open and to clear within the framework of the project.

⇒ In the standard-ERP-system (SAP) the task scheduling is not feasible considering the available resource offer (personnel, flasks, casting pits, stoves...). The current scheduling without resource restrictions supplies only a very inaccurate picture of the future deadline- and capacity situation. Relevant decisions as staff-capacity-management, production in-house or away meet often too late. → Automatic scheduling with multi-resource restrictions

⇒ The imprecise (delays) schedules at full workload intensify the situation wider, since the delivering-delay results in a re-planning at the external supplier with often considerable cycle time increase. → Automatic scheduling with multi-resource restrictions, alarm system on deviations

⇒ The gathering of deficient quality and /or its cause analysis (model, alloy,

environmental impacts as used sand or outside temperature/moisture) and the derivation of immediate consequences (e.g. adaptation of the order route) takes not and/or only little formalized place. The knowledge here potentially gathered is not provided for all relevant persons and/or is only hardly discoverable. (Operations scheduling, model construction, metallurgical preparation, finishing, quality assurance, controlling...). → Knowledge base, document management and workflow system

⇒ The lacking error tracking (costs of failure, bending measures...) leads sometimes to error repetitions (avoidable). Also the external supplier responsible would have to be bound into this process!

⇒ It lacks a rule-based work schedule generation and/or –adaptation system, that in dependence to test results, adapts/generates the necessary finishing operation steps and carries out the corresponding resource-dependent task scheduling. The consequences onto other tasks due to the changed capacity demand situation become very much late visible. → rule-based, learning work schedule generator

⇒ Due to the deficient planning support through the standard-ERP-System as well as the missing formalized feedback-loop of costs of failure the transparency is often not given (actual and anticipated performance comparison of costs, quality and deadlines etc.) → production and quality controlling system

This starting position applies in analogy to many similar companies (100 to 1000 employees) (e.g. single and limited-lot production manufacturing in the field of steel cast, machine building with high construction parts.

4.3 IT structure

The following chapter is supposed to give an overview of the current IT structure of the enterprise. Moreover the communication of the systems is described.

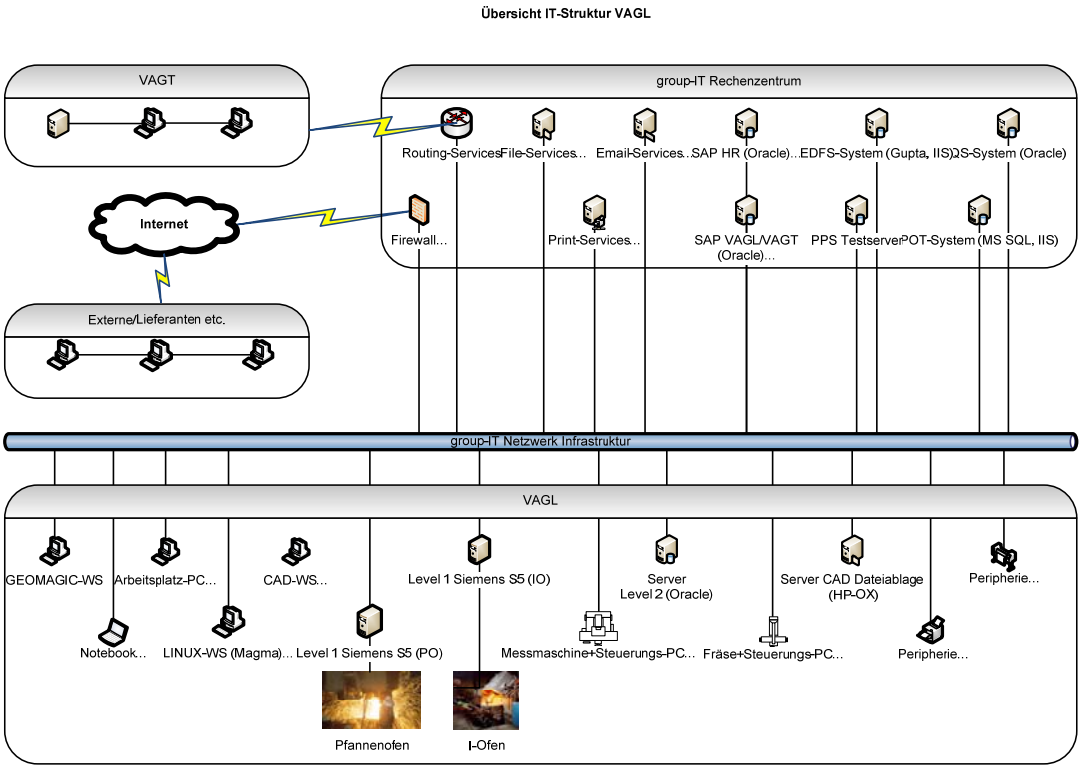


Fig. 3: Overview IT structure

4.3.1 In-house-infrastructure

The base infrastructure (server, PCs, LAN, WAN/Internet connectivity, periphery etc.) is been in charge almost exclusively by an external service provider.

The base support (problems PCs, SAP etc.) is finished also through this service provider (helpdesk). Only few systems are been in charge of through other providers - these are mentioned in the descriptions of these systems explicitly.

Almost all the in the use contained devices the final user (PCs, printers etc.) are leased.

4.3.2 SAP

VAGL (voestalpine-Gießerei Linz) and VAGT (voestalpine-Gießerei Traisen) use own SAP-systems. The VAGL System has 2 mandators (VAGL and NEM).

The HR module is used together with other companies at the location (voestalpine, group-IT, Grobblech, Europlatinen etc.).

The pre-calculation is carried out in MS Excel over a data connection to SAP).

Data exchange with external systems:

The SAP-system of the VAGL/VAGT is connected to the voestalpine (Holding company) central SAP-system (HR-module).

Numerous connections to external systems (POT, QS-system, PPC-new etc.) exist - Information following details see.

4.3.3 POT („purchase order tracking")

Übersicht IT-Struktur POT

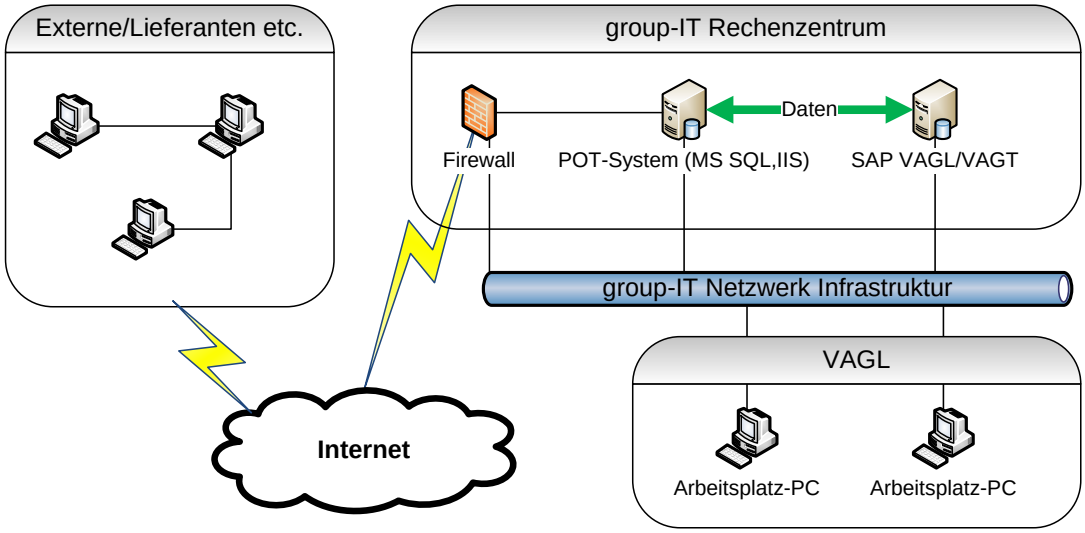


Fig. 4: IT structure POT-system

Abstract

The system is used for the connection of suppliers, which offer external services for the foundry. It is supposed to standardize the communication with the suppliers, to set an obligatory workflow (how is worked off e.g. one inquiry, how is gone on in the case of a deviation etc.) and creating an overview for all participants (Access to same correspondence, coarse status etc.).

Currently the fields of rough machining and final machining) are served by POT - the finishing will be next field.

Data exchange with external systems

Data from SAP: Relevant task and/or ordering-data for the processing in POT (job number, task details, BANF etc.), data are exchanged hourly by flat-files (CSV)

Data according to SAP: Only some date values are returned (current, however, not active).

4.3.4 EDFS („electr. document forwarding syst.")/Level2/QS-System

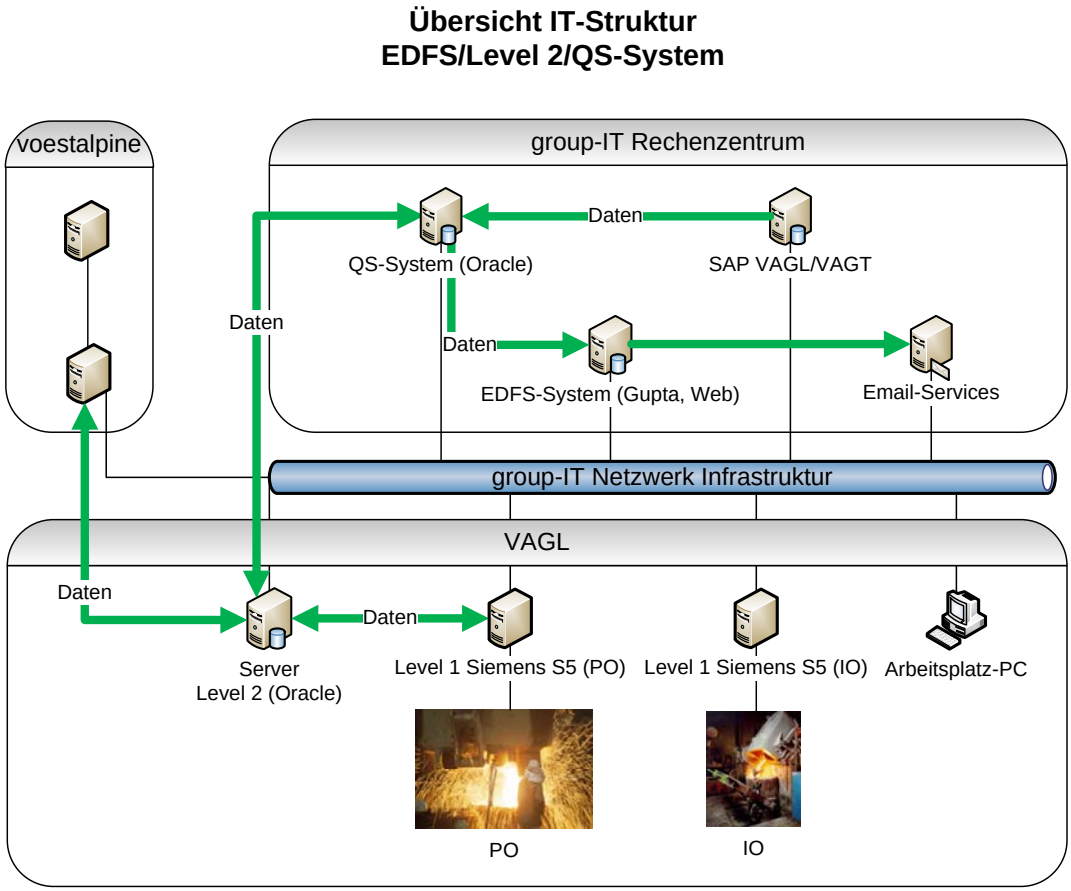


Fig. 5: IT structure EDFS / Level 2 / QS-System

4.3.4.1 EDFS

Abstract

Fundamental function of the system is it to create so called deviation reports. Objective of these deviation reports is to document it various errors (also by upload of photos etc.) and to bump one workflow for the elimination of these („emergency

procedure”) (most different users are informed by e-mail). Moreover become so called „ bending measures "activated.

Such deviation reports" are created "only at „bigger" errors - otherwise an immediate elimination occurs.

The system is used by many departments (TOS, quality, production planning, etc.)

Data exchange with external systems

Order data come of QS-system (Oracle). No data is returned onto the QS-system.

4.3.4.2 Level 2

Abstract

Pan stove:

Control (Level 1) by Siemens' S5 process computers. An individually developed level 2-system was implemented.

This level 2-system is used only for small part currently (available data is transferred into Excel sheets manually, the raw material administration occurs also by Excel and the raw material administration will render then into the SAP system manually, the available process step logic is not used)

Induction furnace:

Currently only the control by level 1 process computer is active. No level 2-connection.

Manual administration of the necessary data by means of Excel-sheets.

Data exchange with external systems

The level 2-system communicates with the level 1 process computer (Siemens S5).

Moreover connections to the voestalpine are implemented (e.g. LD3) via VACOMS (voestalpine data exchange) - this communication is not, however, and/or only in part operative (for that communication is mainly finished by telephone).

Order dates (+regarding quality criteria) come from QS system (from Oracle database via DBlink) - in future also current-cast analysis are supposed to be returned onto the QS system.

4.3.4.3 QS-system

Abstract

The system became developed over the period of 10 years and covers the user needs relatively well from professional view. It contains all quality-relevant information as well as the data collection. Various paper/documentation/certificate are created and administered. The inspection planning is also integrated.

Data exchange with external systems

The QS-system receives flat-files with various data (order dates etc.) from SAP.

External data (lab-analyses, cast reports etc.) are captured manually (automatic communication with lab stands shortly before activation).

4.3.5 CAD/measurement/milling machine

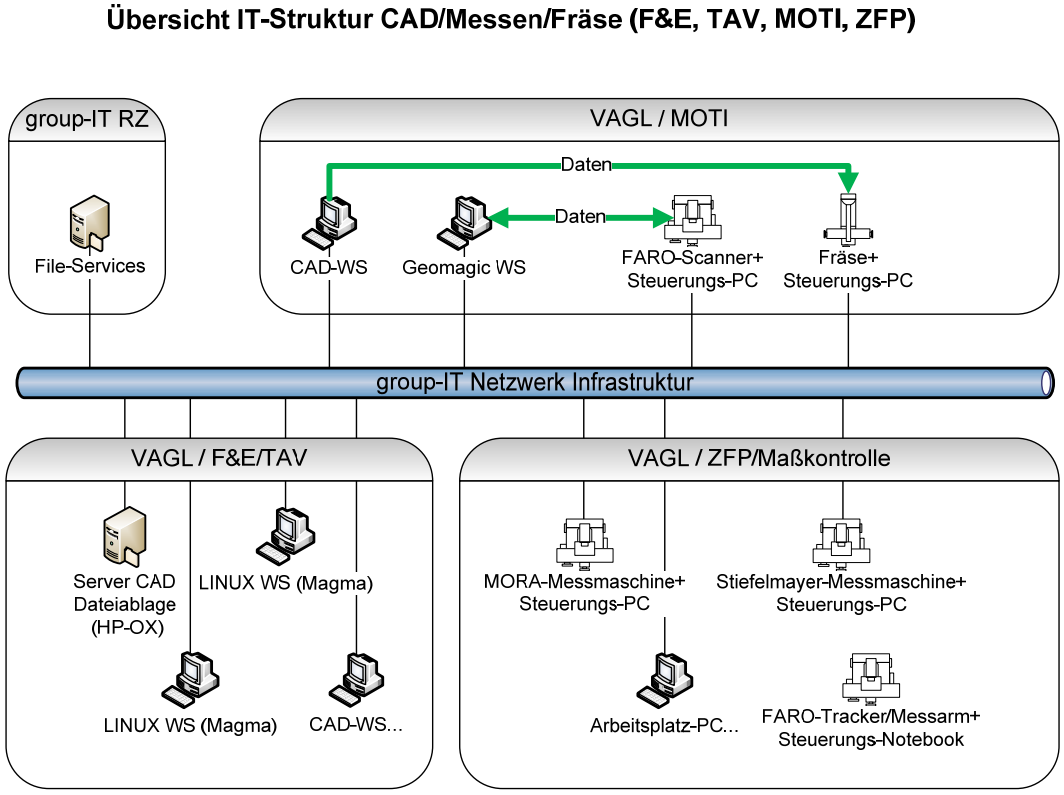


Fig. 6: IT structure CAD/measurement/milling machine

4.3.5.1 R&D / TOS

Abstract

The departments R&D and TOS use the Unigraphics-CAD-System and the Magmasoft-System for various simulations (Solidification, turbulence etc. - is carried out only near certain, especially relevant cast irons, there very much extensive creation.

Data exchange with external systems

The systems Unigraphics and Magmasoft run in principle autonomously. Constructed CAD-drawings are used in the most different departments.

4.3.5.2 Model construction shop

Abstract/technique

Scan system FARO, Software Geomagic:

In order to get determined analyses (surface) the model is compared with the CAD drawings (sent by the TOS) by means of the FARO scanner. Through that deviations can be recognized and corresponding corrections be taken.

CAD system/excitation CNC milling machine:

On a workstation (similar TOS, same Unigraphics system) CAD drawings are adapted (provided by the TOS) onto the layout, necessary for the milling machine (Stock allowances, extras etc.). From the adapted model data a program for the CNC milling machine is created which one by UNIX shell onto the control unit of the milling machine is sent.

Data exchange with external systems

The Geomagic-software communicates with the FARO-scanner. The Unigraphics-system sends the necessary program data for the excitation onto the CNC milling machine.

Otherwise the data exchange is mainly restricted to CAD-drawings (TAV).

4.3.5.3 NDE (non destructive examination) / measure control

Abstract

The essential software for this department represents the QS-system.

Three measuring devices are currently used:

*FARO: Measuring syst*em which can process three dimensional data. The FARO-system exists hardware-sided on the FARO-Tracker and the FARO-index arm.

The FARO system was changed recently onto the DELCAM-Powerinspector (installed on Notebook) software (up to now Commeasure that was very sluggish).

Stiefelmayer: Analogous measuring system (no processing of three dimensional data). Currently the control software runs on a Windows 98 system. It is supposed to

be changed also to the DELCAM-Powerinspector (current problems with reading heads, exchange of these heads in processing).

MORA: Analogous measuring system (no processing of three dimensional data)

Currently the control software runs on a Windows XP system. It is supposed to be changed also to the DELCAM-Powerinspector (current problems with reading heads, exchange of these heads in processing).

Data exchange with external systems

Data mainly come from TOS (CAD-drawings) and the QS-system. Various results of measurement are reported back into the QS-system (manual input).

5 REQUIREMENTS AT THE PPC-SYSTEM

The following draft describes the general requirements at the future PPC-system.

5.1 Finished products, materials

The article and material base is taken over by SAP and complemented where appropriate.

Relevant data in the case of **articles**:

⇒ Measurement (in the respective production status)

⇒ Weight (in the respective production status)

⇒ Material

⇒ Production-Relevant Data (Duration, temperature etc.)

⇒ „Stackability" as support for batch size formation

Relevant data in the case of **materials**:

⇒ Replenishment times

⇒ Suppliers

⇒ Costs

Data which is captured already in the SAP system is maintained exclusively in SAP.

5.2 Work schedules and parts lists

5.2.1 Work schedules

SAP holds a coarse base work schedule for the note of charges / calculation. Here the necessary processes are described in order to relate data collection correctly.

In the PPC-system this work schedule is adapted (e.g. rearrangement, etc.).

Moreover the PPC-system holds at least the initial one and the current work schedule per task.

Alternative work schedules (external processing Y/N) are to be planned.

Also for external companies a resource overview (capacity demand...) is to be created.

5.2.2 Parts lists

These are maintained in SAP and handed over onto the PPC-system.

5.3 Bottleneck resources

Managing bottleneck resources implies no wastefulness of time. Time slacks and switch-over times should be minimized, and production time should be used for products that contribute to an increase of the flow. Production planning of personnel and material should strive for minimal time slacks, and switch-over times should where possible be squeezed to zero. (Enarsson, 2006)

The following bottleneck resources are to be considered

- ⇒ Personnel (including whose qualification)
- ⇒ Machines
- ⇒ External companies for processing of the pieces
- ⇒ Pits (face, depth)
- ⇒ Resources (models, cores, flasks...)
- ⇒ Storage area (also external)

The mentioned resources are to be considered at the planning (scheduling) as bottlenecks and / or to be planned optionally also against infinite capacity (optional and terraced per resource group).

In the case of the personnel resources a presence planning (vacation list...) is to be

realized.

Larger downtimes / reconstruction etc. are also to capture and to consider at the planning. A gathering within the framework of the utilization planning (Gantt) is necessary.

5.4 Task: Calculation / scheduling / deadline monitoring

Entering customer orders but also capacity reserve requests for customers are captured in SAP and passed on then to the PPC.

Pure plan tasks (for „What-If-Scenarios...) are captured direct in the PPC. The plan tasks of the active scenario are acknowledged onto the SAP-system.

The task calculation and scheduling as well as decisions on external processing are supposed to occur in the PPC. The corresponding cost unit rates and surcharges are to be maintained.

The scheduled processes according to PPC order bill of material are aggregated to the SAP processes and acknowledged changes to SAP.

The deadline monitoring as well as deviation analyses occur in the PPC-system.

5.5 Rough planning

With the rough planning the future resource needs as well as the general bottleneck situation on an exact period basis (Period: 1 week, range: 3 years) are to be planned.

For this purpose different scenarios are to be administered.

The planning is supposed to occur either against the defined capacity offer or however against infinite capacity (pure scheduling). In this case also grading per bottleneck group is conceivable (e.g. currently planned 2 shifts; 3. Shift and/or overtime may be planned). Latter one is used for the determination of the capacity offer.

The decision concerning manufacture by subcontractors (Scrubbing, finishing) is also supposed to be defined.

The rough planning is to be designed as a decision-supporting system: By means of optimization algorithms should the (cost-) optimum resource use under consideration of

⇒ Resource availability/capacity offer

⇒ Possibilities for the capacity increase

⇒ Possibilities external processing

⇒ Possibility of buffer warehouses / Conscious produce in store

⇒ Deadline / Permissible delays

⇒ Risk because of insecurity of the planning (repair expenditure)

⇒ Etc.

occurring. This automatically determined solution can be adapted now if required manually from the planner. Already fixed assignments (e.g. in detailed planning) must not be changed more automatically.

With several rough planning scenarios these must be able to be compared with each other (-> which Effect has a certain measure onto the overall system?).

The result of the rough planning (vote between sale and production!) is a valid plan (Capacity offer & demand) among other things.

This is the basis for the cost objective accounting/profit and loss account on marginal income-basis! To what extent the system is supposed to be broadened to a plan balance is to be cleared within the framework of the continuous specifications phase. The system is supposed to be in any case prepared on that since this step (possibly) is supposed to be realized in a second project phase.

5.6 Detailed planning

The detailed planning is the main item of the PPC-system. IT is supposed to define the planned reservation of all bottleneck-relevant resources by means of task

scheduling algorithms (with / without capacity restrictions) and to create in this way transparency in the manufacturing to the next 4-8 weeks.

The basis for the detailed planning comes from the current coarse plan (resource offer, coarse start-/end dates).

5.6.1 Technical operations scheduling (TOS)

The technical operations scheduling is supposed to be incorporated in the future also into the detailed planning, in order to be able to schedule the affected operation steps considering the available personnel resources and to define the consequence deadlines better thus can.

The communication to the customer (e.g. urgent actions at customers: If drawings are missing, etc.) is supposed to be supported also (-> see workflow).

5.6.2 Quality department

The quality-referred operations scheduling (material, heat treatments, examinations...) is supposed to be integrated also into the detailed planning. It is still to be cleared in this case to what extent the available QS-system is supposed to be tied to the PPC-system or to be dissolved by the PPC-system itself, however.

Test tasks etc. are supposed to be administered within the framework of the workflow/document management.

5.6.3 Model construction

The planning of the jobs, necessary for the model construction, is supposed to occur in the detailed planning. A corresponding model administration (inclusively the planned model reuse's, the necessary repairs' as well as the stock location's) is to be realized.

Models (cores etc.) are to lead as bottleneck resources.

5.6.4 Melting plant

The steel comes either from the steelworks (heavy casting or partial tap) or scrap is

melted.

Except for heavy casting the secondary treatment is done in the foundry (pan stove, planned vacuum-facility).

The corresponding charges are to be planned and to be ordered where appropriate. -> Data exchange with steelworks. Quality data (analyses, temperature...) are to be imported.

Corresponding batch sizes are to be formed during the creation of the foundry program (-> heavy casting).

A trouble management (e.g. pan problem, analysis error...) is to be realized (-> alternative program...).

5.6.5 Moulding department / foundry

All bottleneck-relevant resources must be considered at the detailed planning:

⇒ Pits (Face, depth)

⇒ Burst next to pits

⇒ Model availability

⇒ Flask availability

⇒ Cranes

⇒ Personnel

⇒ The planning must consider premature lift out from lighter work pieces

The current / planned pit reservation must be represented in appealing graphic form. Interactive planning must be possible.

The planning of heavy casting / partial tap / own enamels must occur.

Errors must be recorded and analyzed.

Batch size formation in the case of heat treatment (min. / max. temperature, min. / max. duration) must occur.

5.6.6 Scrubbing

Scrubbing occurs for the most part external. A capacity overview of the external companies as well as their planned completion dates must be administered.

Corresponding data collection of the external companies must be considered.

Supplier selection and evaluation must be supplementary.

Longer-term capacity reservation with the supplier is supposed to occur (on basis rough planning). Info at suppliers if a deadline change turns out.

For the transportation planning timely out corresponding transport jobs must be generated (Consideration of measures and weight from order data)

Note: The financial handling even with the external companies and / or protractor occurs in SAP.

5.6.7 Finishing

The initial order route must be updated after current status of knowledge (e.g. after examination etc. -> more / less repairs, precedence change due to deadline situation or partial availability).

The detailed planning of the finishing requires the consideration of the complexity of the task as well as qualification of the employees (e.g. individual degree of performance per job type).

5.6.8 Buffer warehouse

The use of buffer warehouses away is recommended to the production smoothing (-> former start e.g. of serial parts...).

⇒ Before the foreman burning (if possible)

⇒ Before scrubbing

⇒ After scrubbing

⇒ After 1st examination

⇒ Warehouse planning, transportation planning

These warehouses must be administered from the PPC-system.

5.6.9 Resource management

Various resources (e.g. flasks) must be administered also from the PPC-system. Within the framework of the detailed planning their availability must be guaranteed.

Possibly resources are stored in external warehouses.

The procurement of resources occurs via SAP

5.7 Control / papers

The papers, necessary for the manufacturing, (TOS / QA) are supposed to be directly in the manufacturing available and to be able to be printed from there. This facilitates the version management.

Only a sentence of papers is supposed to be created in future!! (Consolidation TOS / QA).

The current situation of the manufacturing, parts currently dealt with, available personnel etc. have to be clear directly in the manufacturing.

Additional information (an error in the case of similar tasks etc.) must also be able to be called up.

5.8 Data collection

5.8.1 Operation steps

The operation step data collection occurs through shift engineer / foreman in each case at the end of the shift:

⇒ who has worked how long

⇒ Judgment: How many hours are still necessary for the open operation steps?

⇒ Evaluation attendance time versus time settled on task

The gathering must occur as simple as possible and to be carried on reasonable checks validity checks.

Simultaneously it must be possible at this place, to revalue the current jobs (their planned finishing). This results in a reworking of the detailed planning. Greater postponements must activate automatically a corresponding workflow (configurable).

5.8.2 Quality

The feedback of all quality-relevant information (Errors etc.) as well as possible documents (photos...) occurs in the PPC-system. In this case a workflow is activated - That one that finds the error indicates who keeps on having to process with this case (->workflow, possibly further steps).

The consequences onto the order route (number/duration repairs) must be defined also. Proposed values which consider the correlation to be defined between error and repair expenditure are considered at that.

5.8.3 Stock transactions

Stock transactions (Store) must be acknowledged. Possibly this occurs indirectly via SAP (Product-input / output).

The current stock of parts and resources must be simply able to be called up.

Warehouse identification numbers (capacity status, envelope frequency...) are calculated.

5.8.4 External processing

External processing is fixed in the work schedule.

The financial handling occurs in SAP (Order...)

Time-near feedback of achieved / still being achieved working-hours, planned finishing as well as quality-relevant information must be considered.

It is to be cleared still whether a web-based data collection system is to be realized for external companies within the framework of the PPC-system or the POT-system can be integrated. In this case the roll out of the POT-system is supposed to be waited for.

Greater postponements must activate automatically a corresponding workflow. (configurable)

5.8.5 Procurement

The need-deadline turns out on basis of the current rough planning. The procurement process results into a workflow.

Ordered parts must be pursued in a with regard to deadlines way. Certain statuses („date confirmed", „ ready for shipment etc.)" as well as quality-relevant information must be acknowledged.

It is to be cleared still whether a web-based data collection system is to be realized for external companies within the framework of the PPC-system or the POT-system can be integrated.

Greater postponements must activate automatically a corresponding workflow. (configurable)

5.9 Workflow

Both internal and external processes must be supported by a corresponding workflow-functionality.

The information obtained through data collection and / or status change of tasks („active"->„accomplished") result in a status change of the current processes. Corresponding actions (information onto users, examinations, re-planning, etc.) are activated automatic.

These processes must be configured within the framework of the PPC-system. A

corresponding version management is to be planned.

5.10 Document management

Documents (Word, Excel, PDF, CAD, E-mails + those one appendixes), processes and / or PPC-objects as well as other documents are supposed to be able to be linked with. These documents are supposed to be able to become besides indexed and/or - if reasonable - to be able to be used even for a full text search the contents.

5.11 Production controlling / Reporting

All plan-/current data is gathered in a production data warehouse and evaluated multi dimensionally (OLAP).

Corresponding identification numbers and indicators are calculated. These must be definable from the customer.

Standard reports are created regularly and provided in the web browser.

An interface according to Excel must be available.

The data to be analyzed must be updated at least daily.

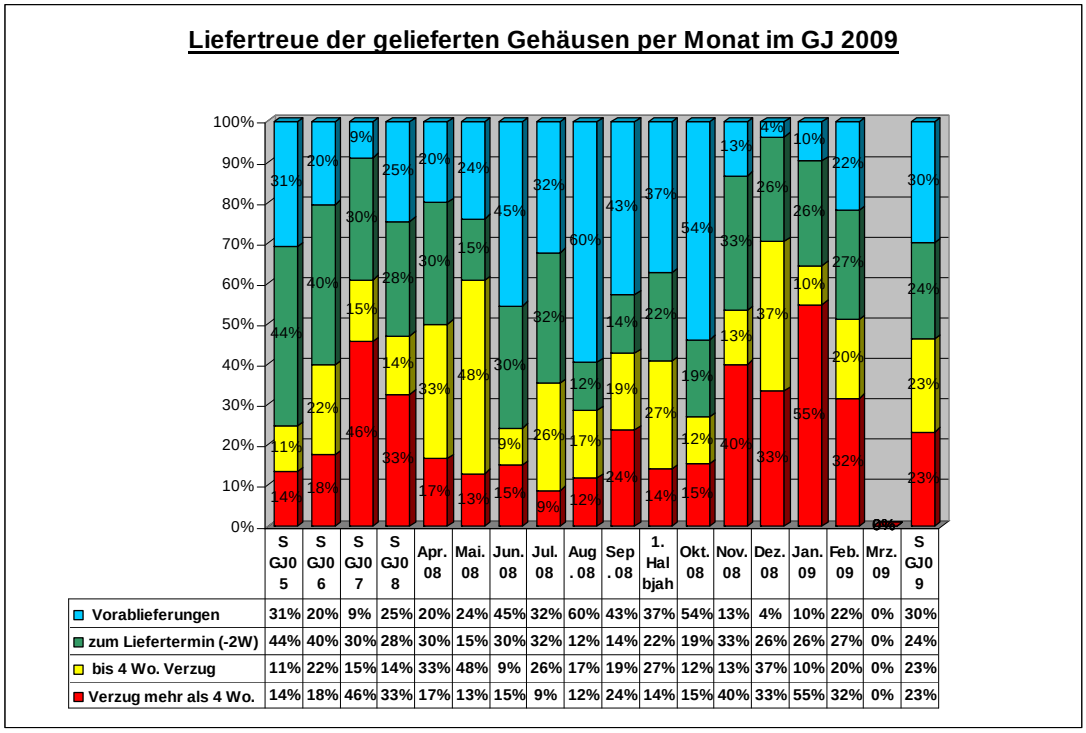
Possibly also data must be integrated from external systems (QS-system, POT-system)

The production controlling module must offer the possibility to gather plan numbers (e.g. budgeting, changed prices and times, etc.) in same form as the pure reporting and in an ad hoc way to carry out calculations. (e.g. in the rough planning usable)

6 BENEFIT CONSIDERATION OF THE PPC-SYSTEM

In this chapter the potentials too realizable through the new PPC are emphasized once again. The relevant potentials are found in the fields „planning quality (PQ)" and/or „marginal income (MI)".

6.1 Increasing PQ with regard to delivery date faith



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Vorablieferungen	31%	20%	9%	25%	20%	24%	45%	32%	60%	43%	37%	54%	13%	4%	10%	22%	0%	30%
zum Liefertermin (-2W)	44%	40%	30%	28%	30%	15%	30%	32%	12%	14%	22%	19%	33%	26%	26%	27%	0%	24%
bis 4 Wo. Verzug	11%	22%	15%	14%	33%	48%	9%	26%	17%	19%	27%	12%	13%	37%	10%	20%	0%	23%
Verzug mehr als 4 Wo.	14%	18%	46%	33%	17%	13%	15%	9%	12%	24%	14%	15%	40%	33%	55%	32%	0%	23%

Fig. 7: Punctual delivery by month in the fiscal year 2009

⇒ Currently about 30 % of the tasks become too early ready and fix production capacity for other more urgent tasks, which become delivery date deviated in consequence then. (about 23 % of more than 4 weeks and about 23 % until 4 weeks)

- Benefit PPC new: Avoidance of
  - Penalties
  - To expensive transports

- Overtime

⇒ Avoidance of quickness shots, e.g. scrubbing and finishing

- Benefit through transparency / conflict early recognition:
  - One can give the initial scrubbing-responsible answer on time concerning late delivery and does not have to switch to a more expensive one
  - Avoidance of additional special transportation

⇒ Present situation buying-parts: these come often too late, the workflow in the finishing is adapted -> Suboptimal manufacturing flow as a consequence, several additional work piece manipulation / repair cycles are the consequence -> capacity is tied unnecessary

6.2 Rise of the PQ with regard to capacity smoothing production

- Potentials:
  - Overtime at work stage x vs. Idle times at work stage y
  - Make or buy decisions -> avoidance of a lower use load in the own company vs. Task onto cheaper extended workbench finishing or scrubbing
  - Dynamic capacitive scheduling of the production program
    - Through a detailed planning unnecessary back-up times in the manufacturing flow are avoided
    - Smaller cycle time necessitate smaller capacity link
    - Increase of the adherence to schedules
  - Avoidance of too high supplies in the intermediate bearings
    - Frequent cast iron manipulation is the consequence-> Usage of the crane capacity and of processing spaces

6.3 Rise PQ optimized utilization planning/detailed planning

- Potentials:
  - Optimization of the cast iron batch size
    - with regard to big foundry ladle / heavy casting
    - with regard to an optimal heat treatment-stove usage

- pit occupancy optimization to avoid bottlenecks
    - The correct flasks are evacuated
    - To avoid planned preproduction of a cast iron around later bottlenecks
    - Correct format of the flasks -> less sand and hardener for the filling up

6.4 Increase PQ integration work stages TOS/model construction

- Potentials:
    - Model administration / repair -> the model is unavailable, in further consequence a deadline] problem turns out again due to late forms, moreover additional transportation is necessary

6.5 Rise marginal income through improved rough planning / Reporting

- Potentials:
    - Integration of the calculation into the PPC
        - Avoidance of too cheap offers at the customers, because by means of current - manufacturing hours the plan calculation can be tightened
        - -avoidance too high price for simple parts -> avoidance, that a task disappears onto the cheaper competition
    - Increase of the cost transparency
        - Simpler cause analysis with regard to margin development
    - Reporting
        - Tracing of the learning curve |in the case of various products and corresponding reaction

6.6 Rise margin with production orders

- Potentials:
    - through more transparency in the manufacturing flow

        - Learning curve effects -> permanent adaptation of standard times due to permanent current-order-calculation
- Correct decision make or buy with regard to margin-optimal production program in a bottleneck situation
    - Extensive pieces with smaller margin are shifted onto cheaper extended workbench
    - Patches up with high margin are produced in Linz

7 REALIZATION OF THE FIRST STEPS

Currently the first system parts of the PPC-system are realized. The following chapter gives an overview of the corresponding functionality, the first proposals of the user interface (screen forms as well as an overview of the data structure: Tables, relations etc.).

7.1 System topology

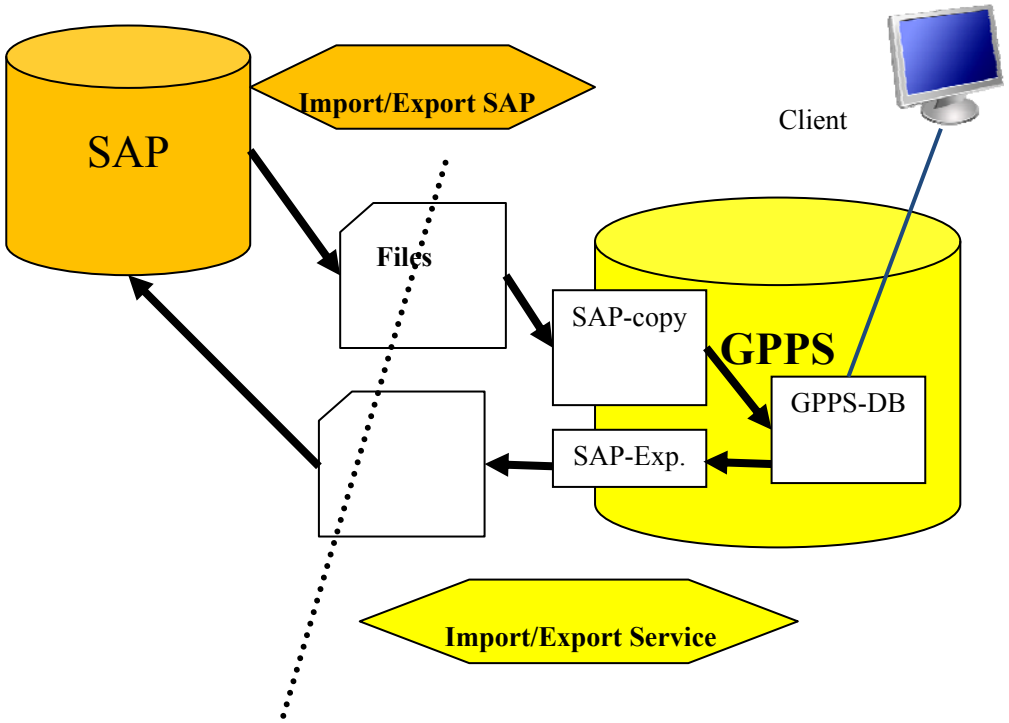

Fig. 8: System topology PPC

The **GPPS** system („Gießerei-PPS“) is on basis Microsoft SQL server 2008 / MS .NET 3.5 (=Version 2008) realized.

Master and movement data as well as some HR (humane relations)-data are taken over by SAP. Those data and/or those data attributes that are not imported by SAP can be maintained directly in the GPPS system.

The interface is via CSV (“comma separated values”)-files realized. SAP fills the

data regularly (1 time per day; possibly 1 time per hour and/or time entry dates every 5 minutes) or on user requirement (Button in SAP) into the interface files. The GPPS system polls (cycle time 5 minutes) and takes over the data first into one SAP Database snapshot, where the changes are determined - a corresponding time stamp is put - and to be transferred the changes into the actual GPPS database.

Production feedback, changes at SAP processes (duration, plan operating time, fixed final deadline, workflow status, performance data at „scrubbing in the house") will hand over to SAP (CSV files). SAP gets these data in regular distances (e.g. every 5 minutes) off

7.2 Functional departments

Here the data model as well as the corresponding user interface is described.

7.2.1 Master data (Dimensions)

7.2.1.1 Material

The article and material master data is taken over by SAP and complemented where appropriate.

⇒ Measurement (in the respective production status)

⇒ Weight (in the respective production status)

⇒ Material

⇒ Production-relevant data (Duration, temperature...)

⇒ „stackability" as support for batch size formation

In case of materials

⇒ Replenishment times

⇒ Suppliers

⇒ Costs

Those data, that already in SAP can be entered, is queued exclusively in SAP.

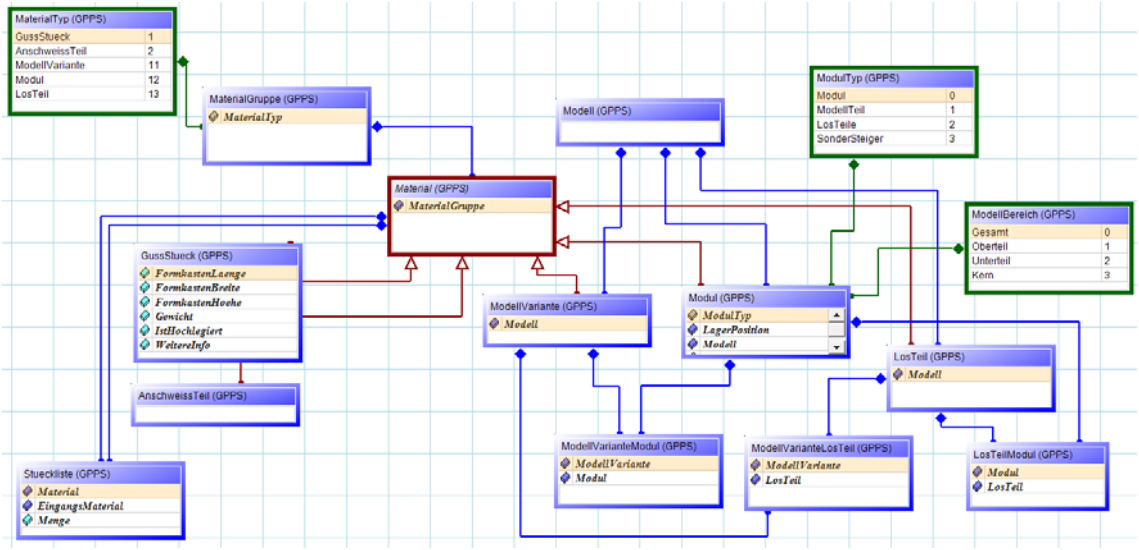

Fig. 9: Table structure „Material"

7.2.1.2 Resource

Next to employees also other resources (e.g. casting pits, stoves etc.) are modelled.

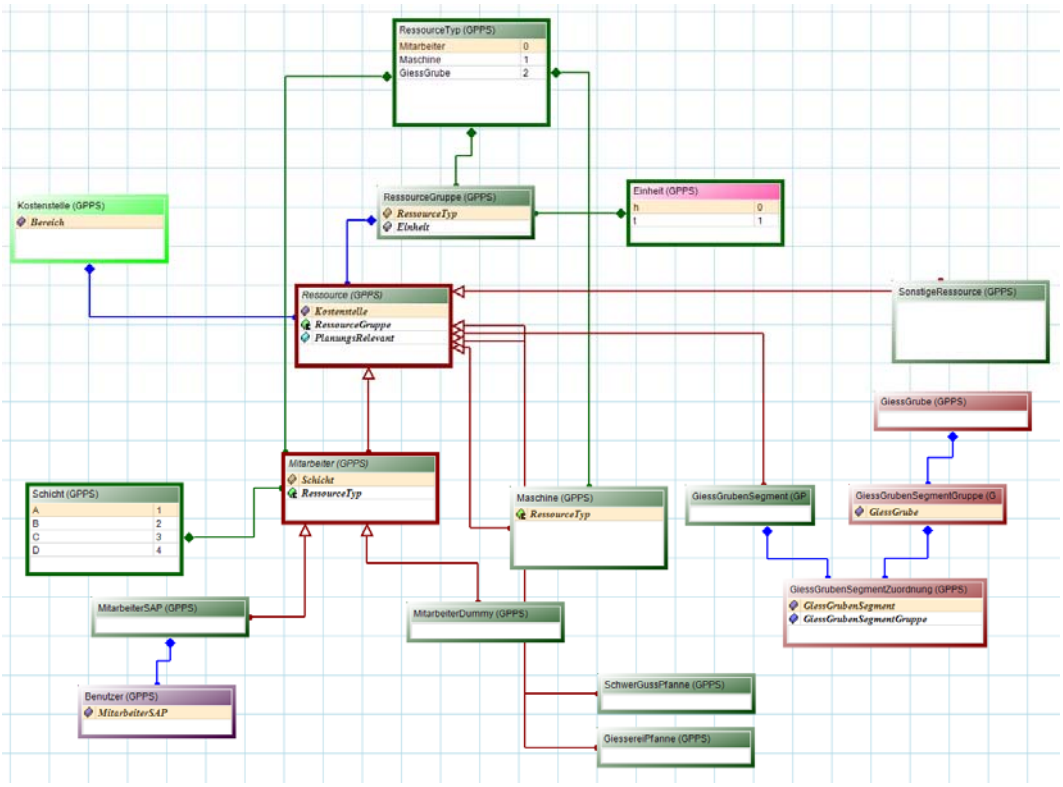

Fig. 10: Table structure „Ressource"

7.2.1.3 Work schedule

The different processes according to SAP are brought into a quick activity raster per cost section in order to facilitate an efficient acknowledging-realization.

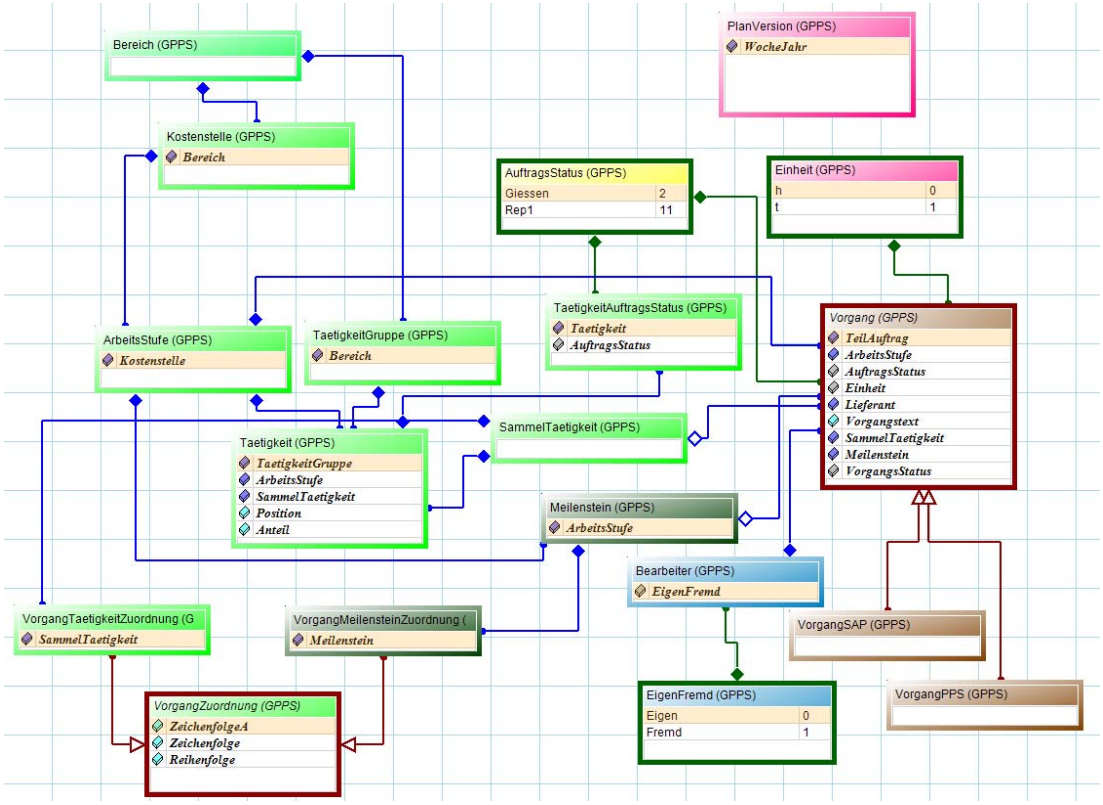

Fig. 11: Table structure „task schedule"

Activities are organized either in activity groups or organization.

The translation process➔ activity occurs by means of the translation table „activity assignment" where the assignment rules are defined.

Possibly a process is analyzed in finer activities (e.g. during the moulding or while scrubbing).

Moreover milestones are labeled separately (no hour feedback, however under circumstances event-triggering...E-Mail etc.).

After the takeover the PPC-activities can still be dealt with.

7.2.1.4 Task

Tasks contain one or several sub-jobs. Possibly also different customer orders are combined into a PPC-task (model creation, cast iron, finishing).

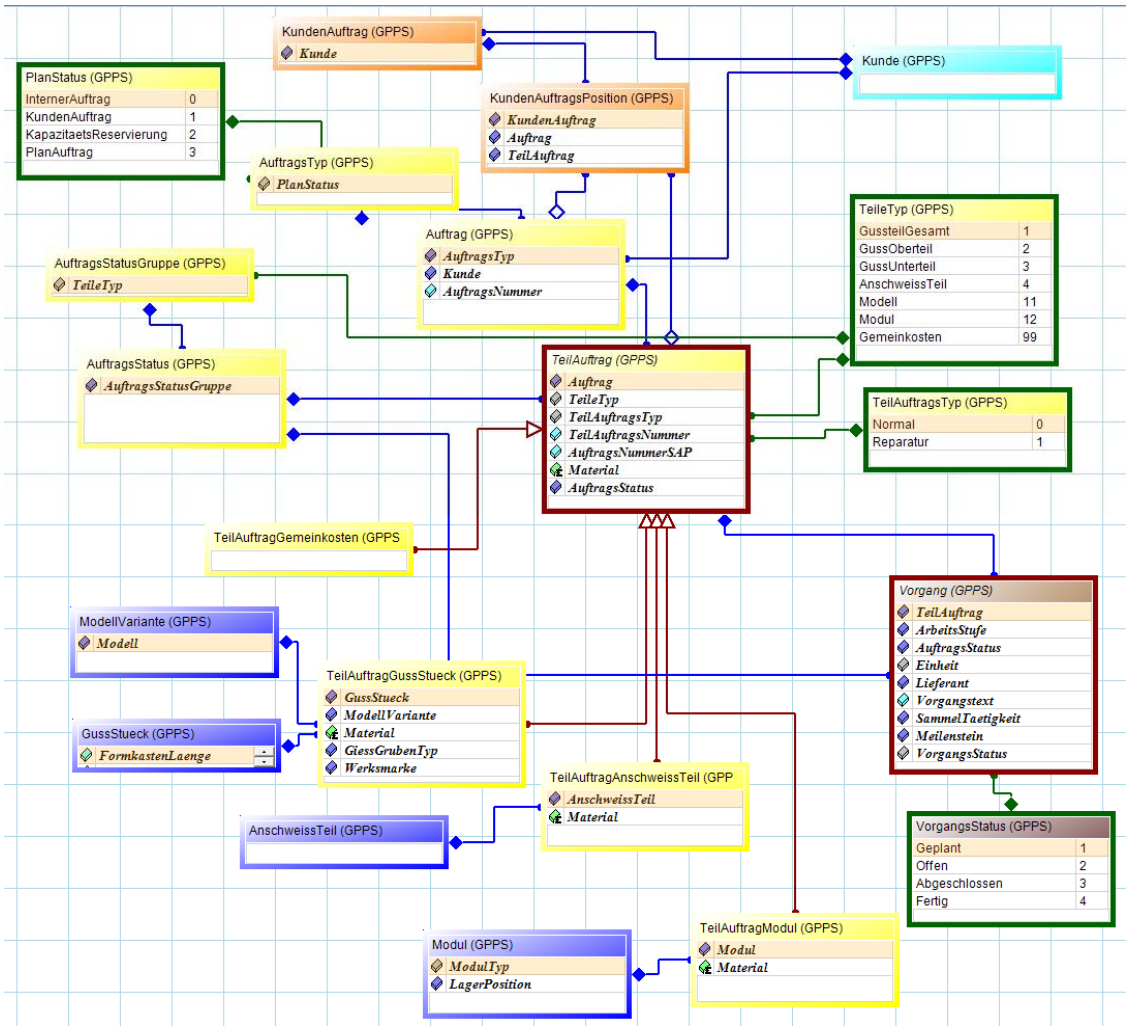

Fig. 12: Table structure „Task"

We distinguish different classes of sub-jobs:

⇒ Cast iron

⇒ Wounding part

⇒ Model

The customer order and/ or customer order item is tied to the production order (task

or sub-job).

7.2.1.5 Time

The time is represented after calendar-/fiscal year and / or month / week apart from level shift.

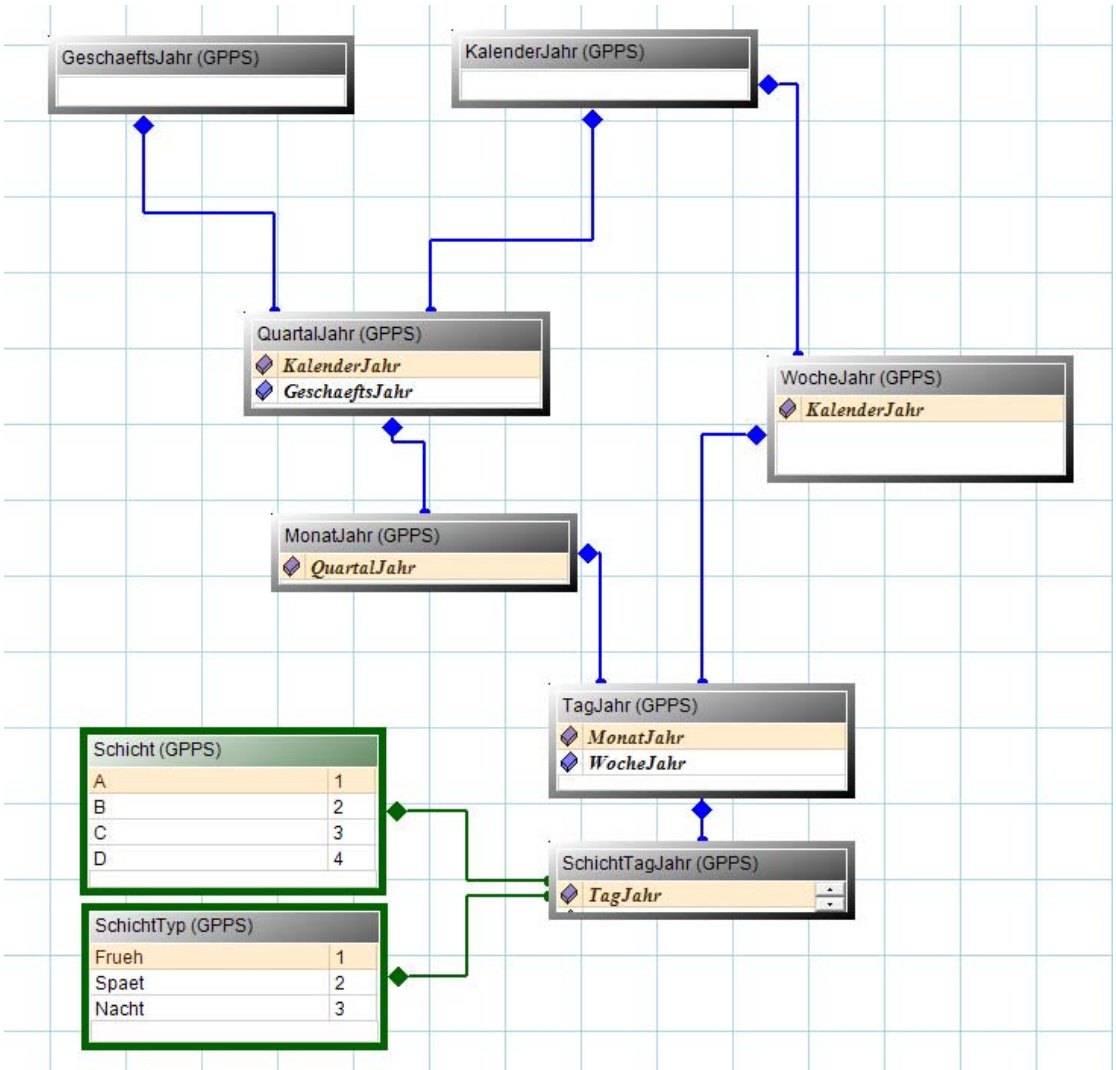

Fig. 13: Table structure „Time"

7.2.1.6 User / authorization

The restriction of the authorizations to single windows and functions occurs with the base-framework-functionality while besides a restriction to level cost section is can be defined.

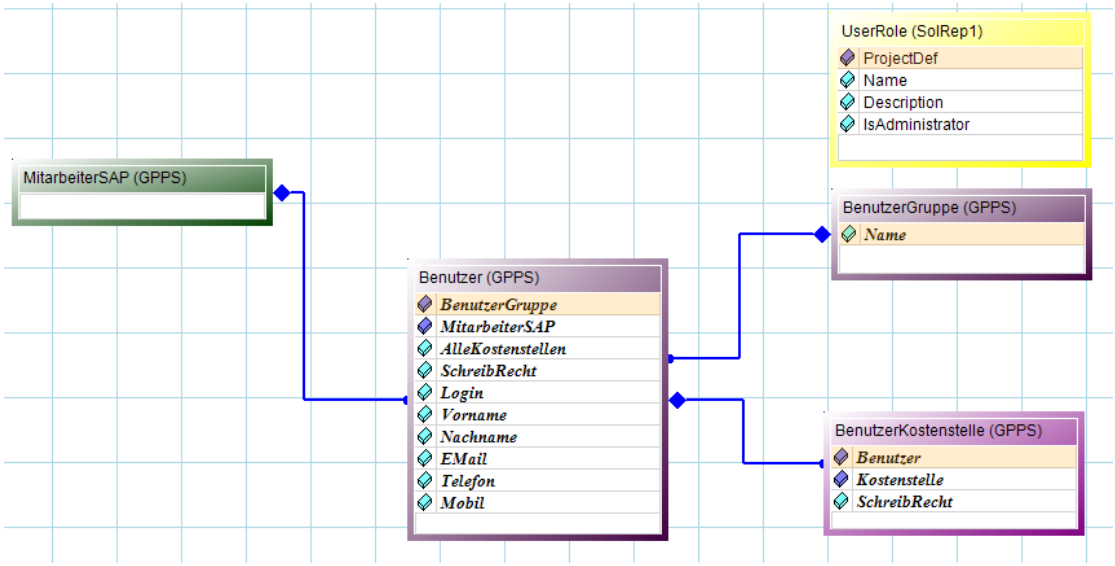

Fig. 14: Table structure „User / authorization"

Per user group the functional authorizations and/or the start menu are quickly defined.

7.2.2 Data collection

The employee data are imported by the PPC from the SAP and put aside as master data. It is also known to which shift an employee belongs. Normally the master craftsman at the end of the shift enters the data for his employees.

The data collection-mask is a raster in which task processes and employees are registered. The cells contain the man-hours that an employee worked on a task process.

After the opening of the data collection mask only the employees that belong to the current shift are registered by standard. The user can still make, however, additional employees be registered; the screen is increased by that.

The cells of the data collection mask which the employees worked on last time are marked as regards in colour. Since the processing of a process normally uses several days, the customer can enter quickly the current data in the correct cells. Through a double click into a cell 8 hours are given.

The working time for every employee must be eight hours. The master craftsman

must divide up the eight hours for every employee onto the corresponding processes (also absence processes and / or direction hour processes). Employees with whom this criterion is not yet fulfilled are characterized separately.

If the data from the time detection system are already available at shift end, validity checks can be carried out. So the user gets a notice if e.g. he inputs that an employee worked on a task process although this is absent according to attendance list or if he captures vacation for an employee being present according to attendance list.

During the gathering of the work expenditures the PPC-system calculates immediately how much amount of work will still be necessary up to the finishing. The user can declare how long they will still last and how much amount of work will still be necessary now besides to the gathering of the work expenditures for the single processes.

Processes must be finished manually.

Working cycles with negative remaining amount of work are characterized in particular.

The data for the scrubbing are not entered over the surface, but they come over an interface of POT directly into the system.

Moreover it is possible, to look at the bookings in tabular form for an employee in a certain period or also for a process. This view is also printable.

For the input of the hour collection the corresponding cost section as well as the shift must be selected.

The input usually occurs per task with which a gathering per employee is also possible.

Feedback of the scrubbing is understood normal, sent, however, onto the SAP charging for services.

7.2.2.1 OLAP data model

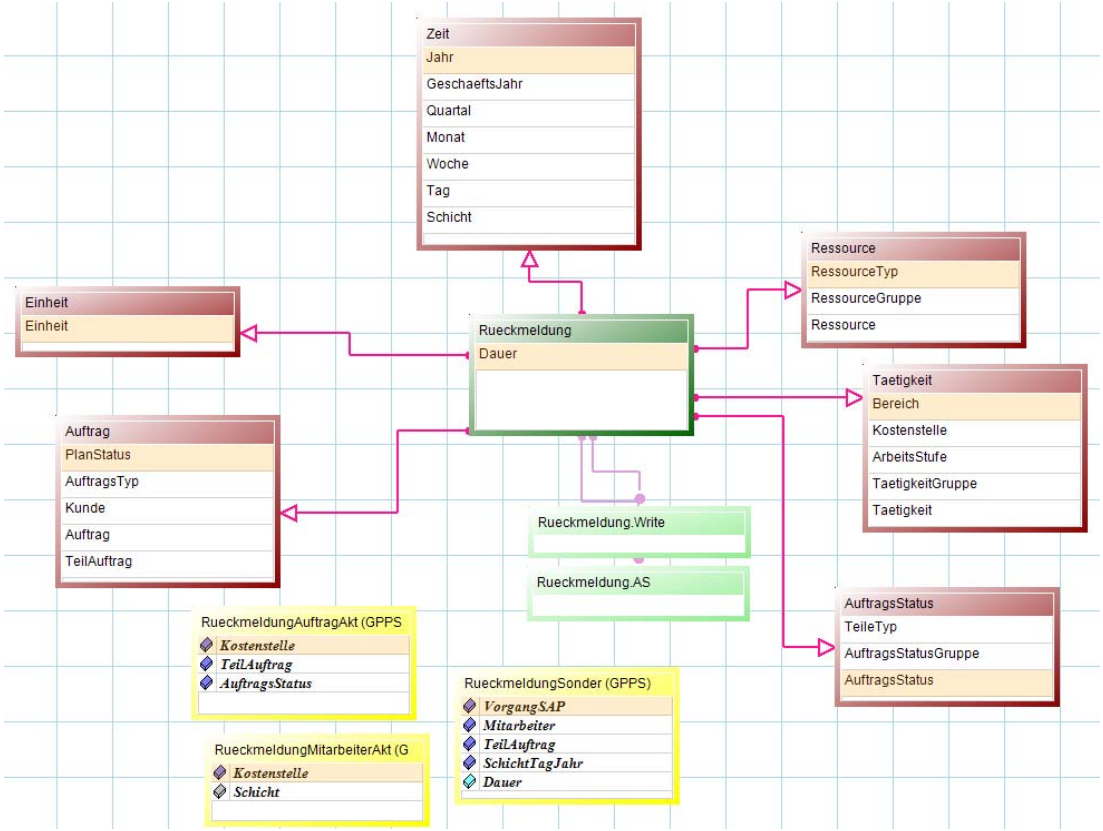

Fig. 15: Table structure „Data collection"

Standard data collection (activity and order status could be identified) occurs according to the dimensions:

⇒ Time

⇒ Resource

⇒ Task

⇒ Task status

⇒ Activity

⇒ Unit

Special data collection occurs with regard to process / employees.

The employees belonging to the shift and/or the task status are also stored.

7.2.2.2 Data collection according to task

Hour billing finishing

Thursday, 15th October 2009

Early

Tasks	MS	HS	ARC	S	∑
EEMSHAVEN 2 903134			1,0		1,0
Admission case 903247 R1		3,0		8,0	11,0
Inside case 903428 R2					0,0
Pot case 903323 R1		4,0			4,0
…					
…					
…					
…					
Sum					16,0

Name	MS	HS	ARC	S	∑
Berger Franz				4,0	4,0
Huber Karl		2,0		3,0	5,0
Mayr Josef		1,0		1,0	2,0
…					
…					
…					
…					
…					
Sum					11,0

Not assignable

Task xyz	Berger Franz	4,0
…		

Fig. 16: Example mask „Hour data collection by order"

First the respective task must be clicked on in the left table (Whose status - „repair-cycle" is indicated). *Comment*: If a task is active in two repair-cycles (because of adoption in shift), two lines are indicated so. Not assignable processes are captured separately.

The collection of the hour data per employee and cost section specific activity occur to the right of. In this case the fields are dyed different:

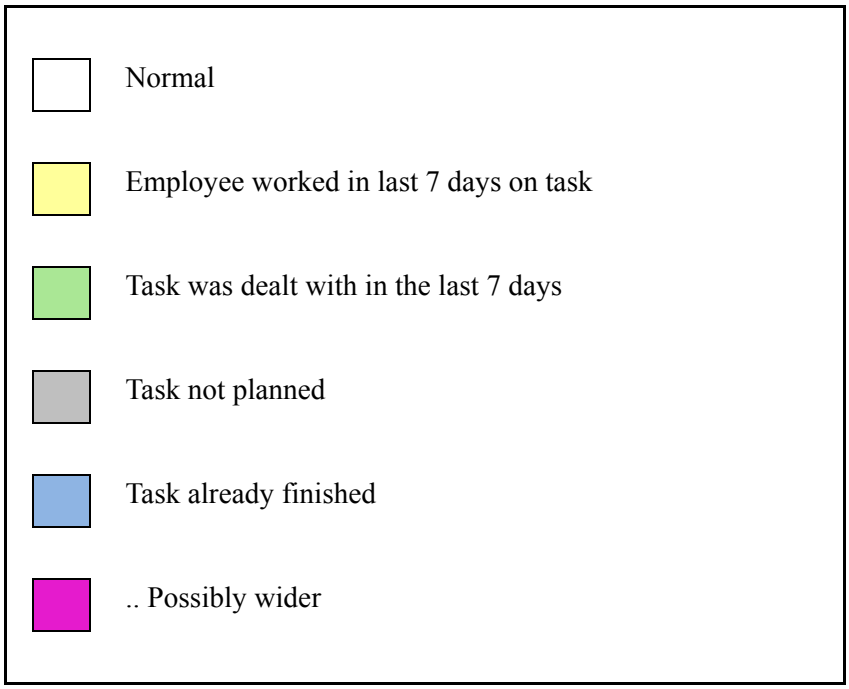

Fig. 17: Markings „Statuses tasks"

Comment: If besides to the main task there are still additional tasks (repair, welding...), those ones are represented directly under the main order.

If in addition to hours also a weight must be captured, the corresponding resource (e.g. machine raying) is indicated under the employee-table.

7.2.2.3 Data collection by employee

This occurs in analog mode to the input according to task:

Hour billing Adjustage

Thursday, 15th October 2009

Early

Name	MS	HS	ARC	S	∑	GK
Berger Franz	4,0		3,0	1,0	7,0	
Huber Karl		7,0	1,0		8,0	
Mayr Josef	6,0				8,0	2,0
…						
…						
…						
…						
…						
Sum						

Tasks	MS	HS	ARC	S	∑
EEMSHAVEN 2 903134			1,0		1,0
Admission case 903247 R1		3,0			3,0
Inside case 903428 R2					0,0
Pot case 903323 R1		4,0			4,0
…					
…					
…					
…					
Sum					8,0

Not assignable

Admission case 903247	Task xyz	Berger Franz	4,0
…			

Fig. 18: Example mask „Data collection by employees"

If in addition to hours also a weight must be captured, the corresponding resource (e.g. machine raying) is indicated under the employee-table. The tasks all will divide up - except the permissible - „greyed"

For every employee also additional overhead cost hours can be captured.

7.2.2.4 Capturing the resource reservations

In a specific mask start and final reservations can be captured for resources. The user announces e.g. that the heat treatment began for the stove 1.

7.2.2.5 Data collection still open per task / task status

Next to the current-data collection the planned finishing time if necessary is adapted:

Hour billing finishing

Thursday, 15th October 2009

Tasks		Σ sum	Σ week	open	finished	Weight [kg]	Status
EEMSHAVEN 2 903134	R1	333,0	38,0	251,0	01.12.2009	55.472	begun
MS		140,0	23,0	20,0	28.11.2009	55.000	begun
HS		110,0	5,0	120,0	23.11.2009	55.472	begun
ARC		60,0	9,0	80,0	01.12.2009	55.000	begun
S		23,0	1,0	31,0	17.10.2009	55.000	begun
Admission case 903247	R2						planned
MS							….
HS							
ARC							
S							

Fig. 19: Example mask „Data collection open hours of tasks"

The still open capacity demand as well as the planned completion date can be overwritten. This leads to a SAP process change.

Moreover weight and status can be defined.

At milestones a status change can lead to further actions as e.g. sending of e-mails (realized in step 2).

7.2.2.6 Overview personnel hours

For the manual feedback into the HR-module the following evaluation is provided:

Month distribution finishing

October 2009

Name	Day	MS	HS	ARC	S	∑
Berger Franz	1	2,0		3,0	3,0	8,0
	2					
	…					
	31					
	∑					
Huber Karl	1	2,0		3,0	3,0	8,0
	2					
	…					
	31					
	∑					
…						
…						
…						
Sum						

Fig. 20: Example mask „Overview personnel hours"

This list can also be printed.

7.2.3 Shift book

The shift book is shown inside as the fault detection/complaint (over the setting “importance” it is determined that it is a question of a shift book entry).

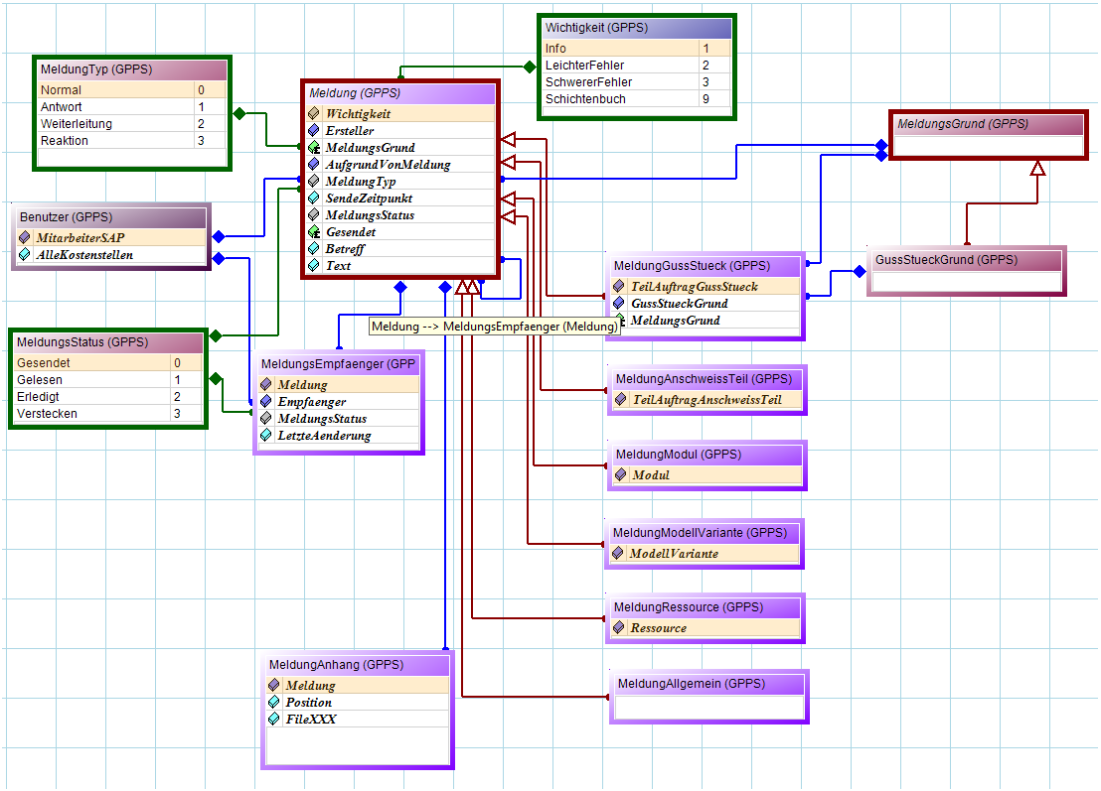

Fig. 21: Table structure „Shift book"

7.2.4 Detailed planning

The following SAP work schedule („IP Inner Casting 1000 MW LWR") stands exemplary for all cast irons:

KSTL_k	ARBPL	KTEXT_UP	VorgangsText	BEARZ	BEAZE
	6102-01		Schmelzen Induktionstiegel Ofen	91	MIN
	6105-01		Schmelzen Ofen 4	216	MIN
	5708-01		Strom auf Auftrag	0	
	162,00		Schmelzenanalyse	0	
	170,00		Gießdaten	0	
	6150-01		Stahltransport	0	
6582	6582	STEIGERMONTAGE	Steigermontage	113	H
6581	6581	MODELLBAU	Modellbauleistungen	0	
6550	6550	FORMEREI	Formen	120	H
	ABGU?		Gießen	0	
6556	ALLGEM	ALLGEMEINER ARBEITSPLATZ SAHLGUß	Ausschlagen	0	
6561	6561	VORADJUSTAGE	Vorputzen	9	H
6591	6591A	ANLASSGLÜHUNG	Unwandlungsglühen v. Steigerbrennen "N"	0	

6561	6561	VORADJUSTAGE	Steigerbrennen	62	H
6591	6591C	UMWANDLUNGSGLÜHUNG	Unwandlungsglühen "HRL"	0	
6591	6591A	ANLASSGLÜHUNG	Anlassen "ANL"	0	
6562	6562A	ARC-AIR	Arc-Air Brennen n .d. Verguten	151	H
6562	6562B/1	SCHLEIFEN	Schleifen n .d. Vergüten	450	H
6563	6563	GUßSTRAHLANLAGE	Maschinenstrahlen	0	
6562	6562C	HANDSTRAHLEN	Handstrahlen	229	H
6595	6595	MAßKONTROLLE	Maßkontrolle v. d. Vorschruppen	0	
1558	FREMD	FREMDBEARBEITUNG	Vorschruppen	14	TAG
6595	6595	MAßKONTROLLE	Maßkontrolle n. d. Vorschruppen	10	H
6562	6562A	ARC-AIR	Arc-Air Brennen n. d. Vorschruppen	137	H
6562	6562B/1	SCHLEIFEN	Pruffähig Schleifen	694	H
6563	6563	GUßSTRAHLANLAGE	Maschinenstrahlen	0	
6562	6562C	HANDSTRAHLEN	Handstrahlen	287	H
6593	6593	ZFP	ZFP Erstprüfung	330	H
6562	6562A	ARC-AIR	Arc- Air / Fehleröffnen 1. Rep	417	H
6562	6562B/1	SCHLEIFEN	Schleifen / Fehleröffnen 1. Rep.	167	H
6569	6569A	FERTIGUNGSSCHWEISSEN	Fehlerschweißen 1. Rep.	159	H
6591	6591A	ANLASSGLÜHUNG	1.Spannungsarmglühen "E"	0	
6562	6562A	ARC-AIR	Arc-Air Brennen 1. Rep.	94	H
6562	6562B/1	SCHLEIFEN	Schleifen 1. Rep.	201	H
6563	6563	GUßSTRAHLANLAGE	Maschinenstrahlen	0	
6562	6562C	HANDSTRAHLEN	Handstrahlen	99	H
6593	6593	ZFP	ZFP 2. Rep.	103	H
6562	6562A	ARC-AIR	Arc- Air / Fehleröffnen 2. Rep.	0	
6562	6562B/1	SCHLEIFEN	Schleifen / Fehleröffnen 2. Rep.	0	
6569	6569A	FERTIGUNGSSCHWEISSEN	Fehlerschweißen 2. Rep.	17	H
6591	6591A	ANLASSGLÜHUNG	2.Spannungsarmglühen "E"	0	
6562	6562A	ARC-AIR	Arc-Air Brennen 2. Rep.	0	
6562	6562B/1	SCHLEIFEN	Schleifen 2. Rep.	0	
6563	6563	GUßSTRAHLANLAGE	Maschinenstrahlen	0	
6562	6562C	HANDSTRAHLEN	Handstrahlen	0	
6593	6593	ZFP	ZFP 3. Rep.	810	H
6562	6562A	ARC-AIR	Arc- Air / Fehleröffnen 3. Rep.	0	
6562	6562B/1	SCHLEIFEN	Schleifen / Fehleröffnen 3. Rep.	0	
1558	FREMD	FREMDBEARBEITUNG	2. Vorschruppen "Kernlochdeckel einpassen“	5	TAG
6569	6569B	KONSTRUKTIONSSCHWEISSEN	KS Kernlochdeckel	0	
6569	6569A	FERTIGUNGSSCHWEISSEN	Fehlerschweißen 3. Rep.	0	

6591	6591A	ANLASSGLÜHUNG	3.Spannungsarmglühen "E"	0	
6562	6562A	ARC-AIR	Arc-Air Brennen 3. Rep.	182	H
6562	6562B/1	SCHLEIFEN	Schleifen 3. Rep.	167	H
6562	6562B/2	SCHLEIFEN KS	Verschleifen der KS	0	
6563	6563	GUßSTRAHLANLAGE	Maschinenstrahlen	0	
6562	6562C	HANDSTRAHLEN	Handstrahlen	154	H
6593	6593	ZFP	ZFP Endprüfung	0	
6595	6595	MAßKONTROLLE	Endkontrolle	0	
6562	6562B/1	SCHLEIFEN	Rest Schleifen	108	H
6569	6569A	FERTIGUNGSSCHWEISSEN	Rest Schweißen	0	
6563	6563	GUßSTRAHLANLAGE	Maschinenstrahlen	0	
6562	6562C	HANDSTRAHLEN	Handstrahlen	0	
6593	6593	ZFP	ZFP Abnahme	0	

Fig. 22: Reference work schedule

7.2.4.1 Task linking

The production tasks next to the casting-task (e.g. finishing) and/or the assignment to the model version occurs in the PPC-system. A total task contains in general of model creation, cast iron and finishing. These sub-jobs are worked off behind each other - a later final deadline of a sub-job involves also a later start deadline of the following one.

In the SAP such dependence is not possible, the sub-jobs are handled independently by each other. If in the PPC necessary shifts are indicated, the deadlines must be adapted in the SAP manually.

7.2.4.2 Capacity planning

The capacity / week available for every cost section are planned:

As a basis for the planning (from SAP) following sizes are used:

⇒ Company calendar according to SAP

⇒ Shift calendar

⇒ Persons per shift

⇒ Usage- / performance level

Individual adaptation:

+/-hours in % (Shift prolongation, Saturday work..)

7.2.4.3 Week planning general

7.2.4.3.1 Resource utilization planning (e.g. for stoves, casting pits...)

This occurs at a point of time-referred (means reservation from:to), at which an input simplification (only day) is planned.

An activity can occupy possibly several resources (e.g. casting pit segments) and/or several activities can occupy together a resource (e.g. stove).

With the resource planning (see corresponding chapters) the activities and the resources are associated with each other. With the data collection the PPC is informed of the start and /or the end of the resource reservation then.

7.2.4.3.2 Week planning

This occurs for personnel resources.

In every department there are one or several activity groups. These contain one or several activities. Activity groups or activities can be planned. This property is set at the activity groups.

Normally there is for every department exactly an activity group.

In the moulding department activities are planned, that means this particular activity group has the attitude „planning towards activities". In the finishing department the entire activity group is planned, means this particular activity group has the attitude „planning towards activity group".

We distinguish two kinds from planning:

⇒ Week planning (currently only for model creation workshop)

⇒ Time scheduling (Input of start and final deadline

During the week planning an activity and/or activity group is analyzed in single individual week blocks. For every week block it is indicated how many hours that is supposed to be worked on.

During the time scheduling the start and final deadline respectively the number of hours for an activity group and/or activity is indicated. Within such a block the hours are equal distributed. If one wants to distribute the intensity of the job differently, e.g. in the first week 30 hours, in the remaining two weeks in total 100 hours, so one must divide the block after a week. Through the change of start-final deadline or the number of hours all following activities and/or activity group are adapted.

Activities outside of the SAP work schedule precedence can also be defined. Moreover the different activities possibly are prioritized.

The SAP fining-stage (1-4) for the total task as well as its planned delivery date are indicated in this case.

A comparison with the week capacity offer occurs.

Activities must be put manually on statuses readily.

No scheduling occurs in the PPC. They are put only in the case of certain actions within a task automatically.

7.2.4.3.3 Week planning in the Gantt

In the Gantt chart it is selectable for which department one wants to do the planning. Only such tasks which are relevant for the selected department are indicated by that in a list.

A task can be shifted by means of drag & drop into the Gantt. In this way the start week is fixed. The final week is calculated automatically from the duration. Moreover a distribution into single weeks in the planning horizon and the rest as a total block occurs. Thus there are several plan objects after the inserting for the task.

The plan objects can not be moved. If one changes the hours for a plan object, the

hours of the following plan objects are adapted.

If the hours are increased, the corresponding hours are deducted from the last plan object. No hours anymore are available, it is deleted and the remaining hours are deducted from the penultimate plan object and so forth.

The hours are reduced, the corresponding hours are added the last plan object. This can lead to an extreme over-planning of the last plan object. The user must attach in this case further plan objects behind.

If the job is suspended a week, the hours must be reduced for the corresponding plan object to zero.

Through the above described actions the specification hours stay the same. Changing the specification hours, the hours of the plan objects are adapted.

The specification hours are increased, the corresponding hours are added the last plan object. This can lead to an extreme over-planning of the last plan object. The user must attach in this case further plan objects behind.

If the specification hours are reduced, the corresponding hours are deducted from the last plan object. No hours anymore are available, it is deleted and the remaining hours are deducted from the penultimate plan object and so forth.

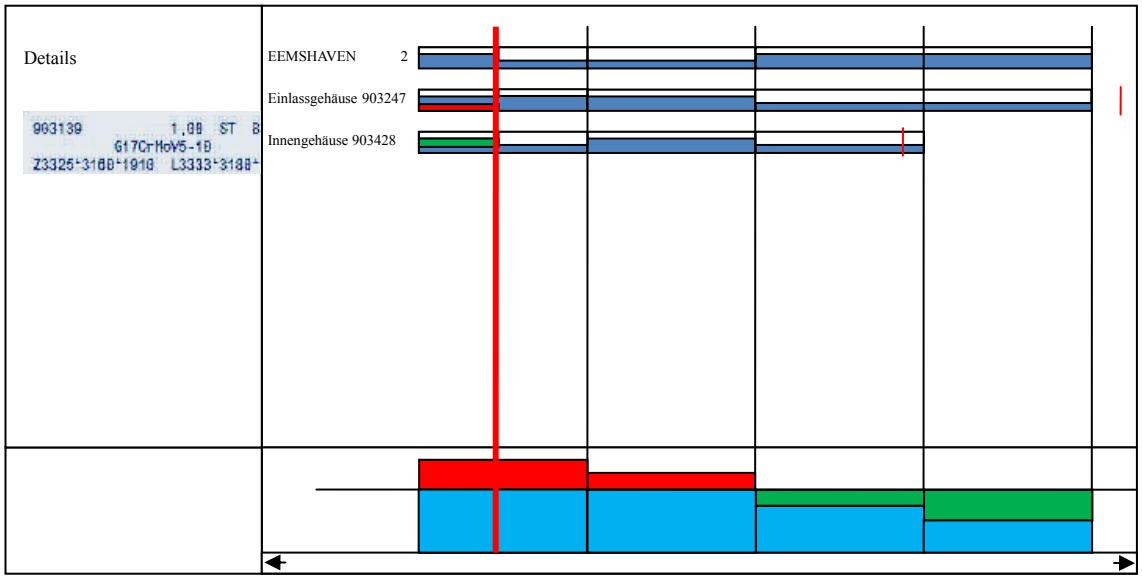

Fig. 23: Example mask week planning in the Gantt

The single lines in the Gantt correspond to the tasks. Every girder represents a planning object. The height of the allochromatic area within a girder symbolizes the intensity of the job. A small perpendicular red line indicates the delivery date.

In the bar chart - that is the lower area of the mask - the use workload is represented for a before selected department (e.g. model creation workshop). The units are in this case percent, the horizontal line indicates the 100%-level.

If one goes above a girder with the mouse, all relevant data for this task are indicated in an info-box.

The time scale can be stopped. For the model construction workshop it is in weeks.

For the past (to the left of the red perpendicular line) also girders are represented. Within the girders the data are represented in a bar chart from the feedback. When it was more worked then was planned, the colour is green - if less was worked the colour is red. By means of alpha blending also the planning is still visible (in the example no alpha blending is represented).

7.2.4.3.4 Tabular week planning

Alternative to the level one in the Gantt the planning can occur also in a table.

	Priorität	geleistet	noch offen	KW37.2009	KW38.2009	KW39.2009	KW40.2009	KW41.2009	zu verplanen	Endtermin	wichtig	Red-Stufe	Liefertermin
EEMSHAVEN 2 903134	●	150	100	40	52					16.09.2009	●	●	27.11.2009
Einlassgehäuse 903247	o	56	200	25		31	54	8	82	15.10.2009			15.12.2009
Innengehäuse 903428		12	70		25	36				22.09.2009			20.01.2010
Topfgehäuse 903323	●	0	74		20		54			01.10.2009			22.01.2010
Reparatur M3134/1				8									
Stunden/Arbeitstag				14,6	19,4	13,4	21,6	1,6					
Summe				73	97	67	108	8					
Kapazität				90	90	90	90	90					

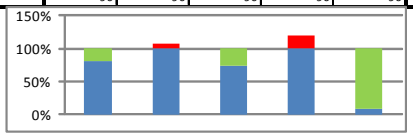

Fig. 24: Example mask „Tabular week planning"

Every cell in the week area in the table corresponds to a planning object in the Gantt.

With the above example all tasks are indicated very to the left for the model creation workshop. This list can be sorted and filtered. As a default it is sorted according to

delivery date. A specific filter is that one that only such activities that have a plan entry in the observation period are indicated.

Below the activity list the workload is indicated for every week graphically. In this way one sees immediately an overloading or also free capacities.

7.2.4.3.5 Time scheduling in the Gantt

In the Gantt it is selectable for which department one wants to do the planning. Only such tasks which are relevant for the selected department are indicated by that in a list.

By click onto a task all planable objects are indicated. - Therefore activities and / or activity groups. Such a plan object can be shifted with drag & drop into the Gantt. In this way the starting time is fixed. The final deadline is calculated automatically from the duration. Are already plan objects behind the again inserted plan object, these are postponed automatically.

If one changes the duration of a plan object, the deadlines of all linked plan objects are adapted. The duration is prolonged, all linked plan objects are postponed for so long on until the final deadline of a plan object lies before the commencement date of its successor. Up to now available buffers will shrink in this case. The duration is reduced, all linked plan objects are shifted for so long to the left on until the commencement date of a plan object reaches its defined earliest commencement date. New buffers arise through that.

The user wants to interrupt a planned plan object, so he can split up the plan object and can give a new final deadline for the left part and/or a new commencement date for the right part. The PPC calculates then the final deadline for the right part and fits the deadlines of the linked plan objects described as above at.

The user can do, however, a part again also from two parts of a divided plan object. The PPC calculates then the final deadline and fits the deadlines linked plan objects' described as above.

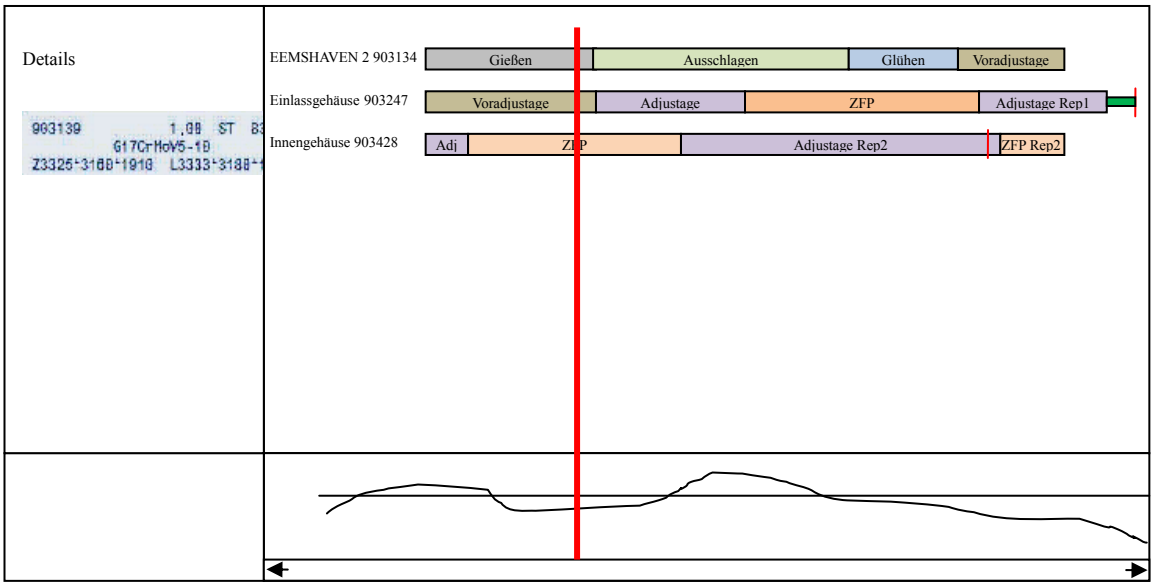

Fig. 25: Example mask „Time scheduling in the Gantt"

The single lines in the Gantt correspond to the tasks. Every girder represents a planning object. The girder colour symbolizes the department, e.g. non destructable examination is in orange represented. A perpendicular red line indicates the delivery date. A small green at the end indicates the buffer.

In the line graphics - that is the lower area of the mask - the workload] is represented for a before selected department (e.g. finishing). The units are in this case percent, the horizontal line indicates the 100%-level.

If one goes above a girder with the mouse, all relevant data for this task are indicated in an info box.

The planning objects can be moved by drag & drop. The duration can be changed also by drag & drop.

The time scale can be adjusted. For the finishing it is in weeks, for the moulding department in shifts.

Arbitrary can be defined for the Gantt. In this case can both the planning for the personnel, than also for the resources are indicated.

7.2.4.4 Tabular view of the time scheduling

The planning which occurred in the Gantt can be indicated also in tabular form. A restricted input is also here possible. It can be changed only deadlines, priorities etc. however not the week capacity demand since this is calculated by the PPC.

Analogous is valid for the moulding department that in a stratified way plans.

Intermittent tasks are represented in a multi-line way.

	Priorität	geleistet	noch offen	KW37.2009	KW38.2009	KW39.2009	KW40.2009	KW41.2009	zu verplanen	Sollendtermin	Abweichung	wichtig	Red-Stufe	Liefertermin
EEMSHAVEN 2 903134 Rep1	●	150	100	48	52					16.09.2009	+3 W	●	●	27.11.2009
Einlassgehäuse 903247 Rep2	o	56	200	25		31	54	8	82	15.10.2009	-5 W			15.12.2009
Innengehäuse 903428 Rep1		12	70		25	36				22.09.2009	-3 W			20.01.2010
Topfgehäuse 903323	●	0	74		20		54			01.10.2009	-2 W			22.01.2010
Stunden/Arbeitstag				14,6	19,4	13,4	21,6	1,6						
Summe				73	97	67	108	8						
Kapazität				90	90	90	90	90						

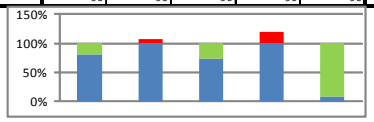

Fig. 26: Example mask „ Tabular view of the time scheduling"

7.2.4.4.1 Development of a task

Every week the current plan is stored automatically to a certain time (e.g. every Monday at 10:00) as a reference plan. The user can store, however, a reference plan also to every arbitrary time and look at it again later to every arbitrary time as Gantt or table.

These reference plans can be indicated for a task in a graphic. In this way relevant planning changes become visible. The user can look for more precise considerations at the corresponding reference plan. There he sees also the other tasks.

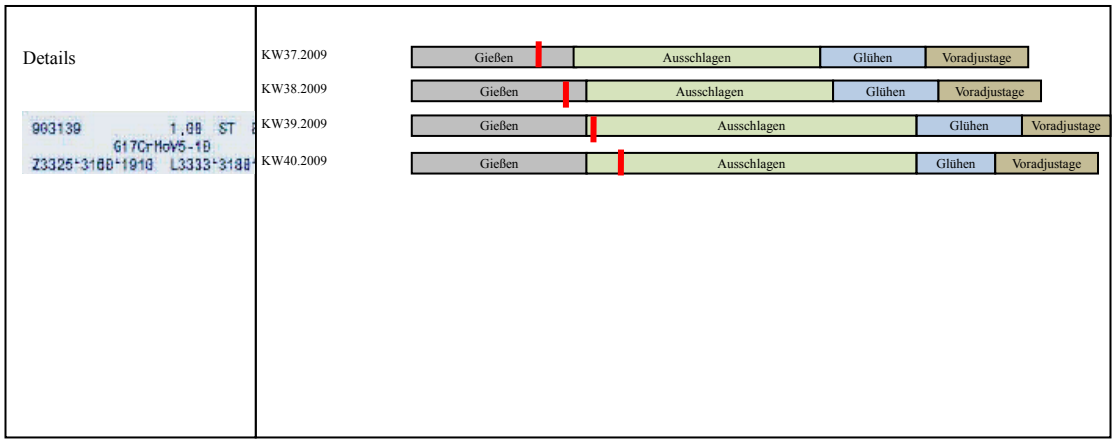

Fig. 27: Example mask „Development of a task"

7.2.4.5 Model construction workshop

7.2.4.5.1 Model parts list

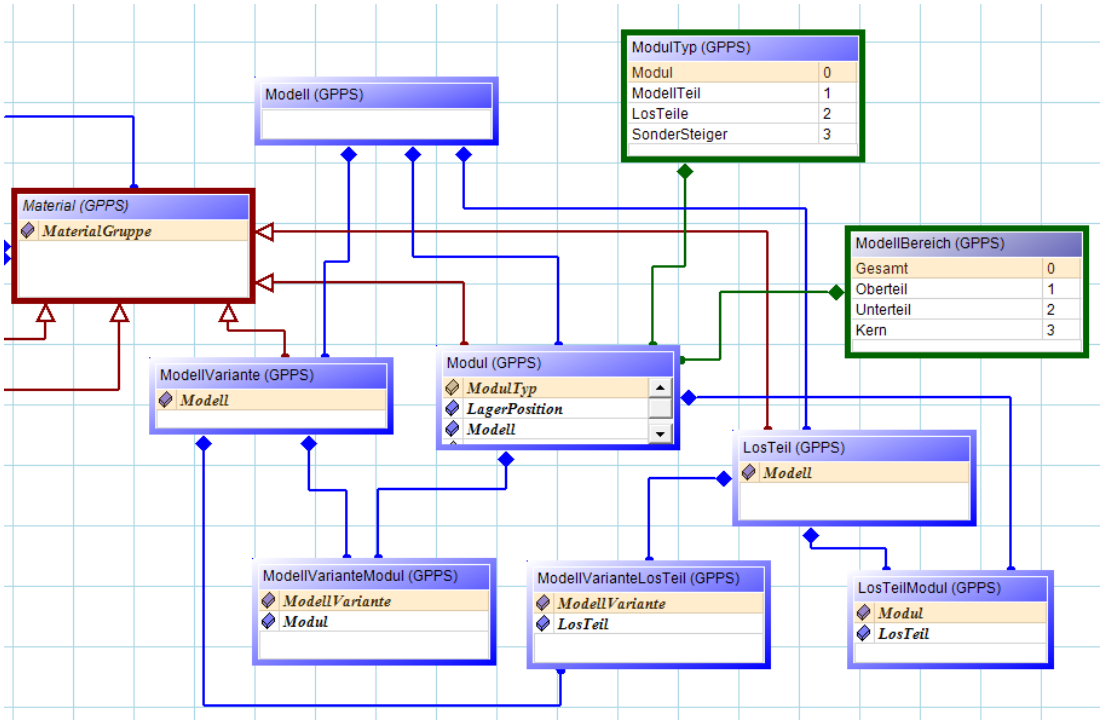

Fig. 28: Table structure „Model parts list"

There can be a model in several variants. Exactly a variant is used with a cast task.

A model is divided into model positions which can have following markedness:

⇒ Module

⇒ Model part

⇒ Lot parts

⇒ Special tools („Steiger“)

Of every model position it can give as many as desired, also none. If a model is produced in modular design, a model position is laid down for every module. Also lot parts can be created more then one time, if one wants to subdivide the lot parts into lot parts for lower part, lot parts for upper part etc.

The smallest transportable unit is a model position and is used for transport jobs.

The model position lot parts can still be subdivided through a parts list. In this case an entry is fed for every lot part. Moreover it is also determined with which model versions the lot part is used.

7.2.4.5.2 Model creation

A model creation task is laid down in SAP and withstands model and “Steiger”-technique/lettering from the two processes.

This task is split up in the PPC manually into the following processes:

⇒ CAD, drawing (→model)

⇒ CRM (→model)

⇒ Bond (→model)

⇒ CNC (milling machines) (→model)

⇒ Glue together and to put together (→model)

⇒ “Steiger”- technique (→”steiger”-technique/lettering)

⇒ Lettering /control (→”Steiger”-technique/lettering)

The PPC-processes are used in further consequence with the data collection.

During the model creation itself also the parts list is constructed for the lot parts. Moreover can be announced, when a model position and/or a lot part is ready.

7.2.4.5.3 Model repair

According to the removal from the mould it can be that model positions or single lot parts are damaged. To every affected model position and/or lot part it is understood that there is harm. Moreover textual error descriptions, photos etc. can be set aside. After the gathering of the harm every individual position gets the status „to estimate".

The model repair is activated about specific PPC-tasks which are tied to a model position (Modules, model parts and lot parts).

In the case of repairs to be valued the expenditure must still be estimated by the model creation workshop. The status is changed on „closed level".

Model repairs are selectable also in the week planning. If in fact now a repair is planned, the status is changed on „planned". During the done setting of the process the repair receives the status „done".

Since in the PPC is known , which cast iron which model in which model version needs, it can be indicated when a model position to be repaired is required next time. There is not any cast task, can be set aside, with which probability the model will be needed again. The user is supported in the week planning by that.

If free capacities are available, the user can plan corresponding repairs.

7.2.4.5.4 Model transportation (Model position transportation)

The model transportation is not activated by the PPC-system. Only the transportation of the model position from A to B is acknowledged in the system. Very presumably can the information set aside in the system as moulding deadlines etc. to be inspected in order to avoid unnecessary or unnecessarily wide transportation.

The warehouse positions (A, B) are to be laid down in the PPC-system as master data.

The access from outside / abolition of models" is shown "as a special stock location („NEW”, “GONE”).

7.2.4.5.5 Cost allocation

For every model a task that gathers the summarized repair costs (On these is acknowledged!) is laid down. Reversed every casting-task relieves the corresponding model with the estimated costs (10-50 hours).

Own model repair orders (onto these also acknowledge!) are also possible.

A simple releasing workflow is implemented, where greater repairs have to be released by the sales department before starting the casting process.

7.2.4.5.6 Requirementsof SAP

The model / model variants must be laid down as materials in SAP.

The cost collection task must be created per model.

Casting-tasks must refer to their model version.

Possible model repairs greater charged by the customer must refer to the model.

7.2.4.6 Moulding department / foundry

7.2.4.6.1 Moulding department

In the moulding department the individual activities are planned by the day. In the SAP there is for that only one process - in the PPC several activities are made out of this which then shift-wisely are planned and also acknowledged.

The planning occurs as a time scheduling. Moulding upper part, moulding lower part etc. become plan objects for the tasks. Since the planning shift-wisely occurs, the beginning of the shift in which the drop-time lies is taken after the drag & drop into the Gantt.

7.2.4.6.2 Casting pit reservation

The individual casting pits are disassembled into one meter-segments; each of these segments is considered as an own resource in the PPC.

With every cast task the flask size (L x W x D) must be put manually in the PPC since there are not the information in the SAP in structured form.

In the same way the total weight and the casting-weight must be set manually in the PPC.

The casting-tasks are assigned to the necessary casting pit segments (manual). In this case an inspection of the admissibility and/or a support during the assignment (marking of the possible pit segments in colour) occurs. Moreover the user announces, for how long the casting pit will be occupied.

If the cast iron is not too heavy along with flask size, it can be lifted out after 2 to 3 days from the casting pit and to cool off outside. Through the PPC knowing the total weight this circumstance can be pointed out to the user.

If it the cast iron consists of a special alloy material, it must be turned over - means, the cast iron is knocked out after 2 to 3 days and comes then immediately into the stove, where it keeps on cooling down. Thus also the stove capacity flows into the planning. Such cast irons are labeled in particular.

Limited-lot productions, means cast irons with the same model, can be shaped only sequentially since there is a model only once physically.

The casting pit reservation and/or the casting pit segment reservation for the next 4 to 6 weeks are represented in the Gantt.

A line is indicated for every casting pit. The length of the casting pit reflects the height of the line. Within the line one sees the cast irons. The extension along the x-axis corresponds to the period in which the cast iron is in the casting pit, the extension along the y-axis corresponds to the length of the cast iron.

The cast irons of a casting pit can be moved into another by drag & drop or also

within a casting pit onto another busy time. Through that it can result in overlapping. These areas are indicated in the Gantt in particular.

The cast deadlines are indicated in the girders. Cast irons which are poured together (from heavy casting and/or partial tap) are labeled as regards colour.

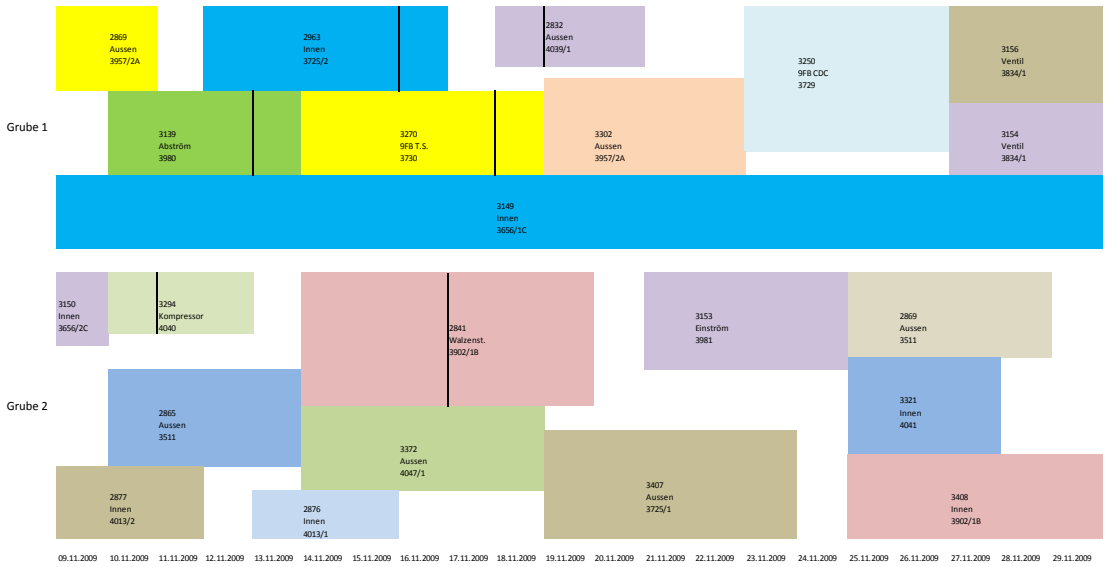

Fig. 29: Example mask „Overview casting pit reservation"

A white face indicates an unused place. In our example an unused place with a length of 2.5 m is in the casting pit 2 of the 21.11.2009 up to the 23.11.2009.

If one fixes a time n the Gantt, one can look at the casting pit segment reservation at this time.

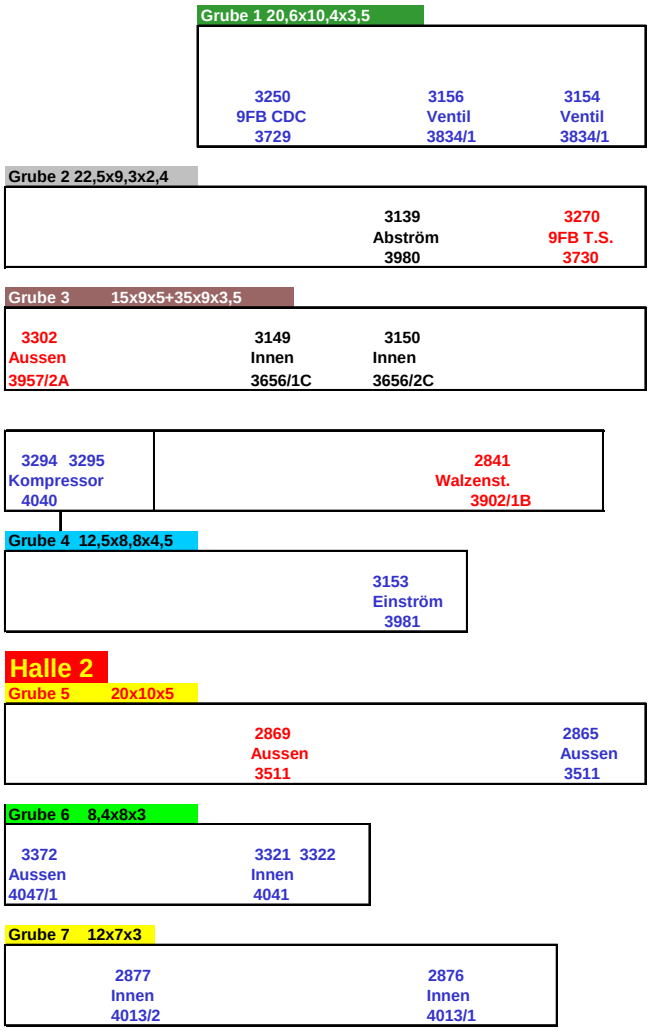

Fig. 30: Example mask „Casting pit reservation at a particular time"

7.2.4.6.3 Liquid steel

Liquid steel which is described in the following subsections is needed for the casting. In the QS-system is known, which kind of liquid steel for which task can be taken.

In the PPC it is indicated in the job list which kind can be taken from liquid steel.

Heavy casting

With a heavy casting several tasks can be casted. A heavy casting has a weight between 120 t and 150 t. Such tasks with a heavy casting which have the same work brand stamp and have the same cast deadline can be casted.

In order to support the heavy casting planning, the PPC offers the possibility to filter

such in the list of all tasks not casted yet that the same work stamp how one before have selected. The filtered list can be sorted now according to cast deadline and / or according to weight. The user selects the tasks which are casted with a common heavy casting from that now.

Partial tap

A partial tap has a maximum weight of 48 t. For a cast iron several partial taps can be necessary, one can cast also several small cast irons, however, with a partial tap.

Induction furnace

In the induction furnace scrap can be melted, the maximum weight for that is 37t. The further procedure is similar as with the partial tap.

7.2.4.7 Heat treatment / stove utilization planning

In the field of the heat treatment there are 5 stoves and a preheating-bonnet for the glow. Moreover 2 preheating-bonnets are available for the cooling of the special alloy cast irons. The preheating-bonnets can be used also as parking place.

After the oscillation and cleaning (pre finishing)→ the cast iron comes into the stove. Also after every welding must the cast iron for the stress-relieving annealing into the stove.

Several cast irons are given simultaneously into the stove and also simultaneously again taken. During the stove reservation it is to be noticed that the cast irons which simultaneously are in the stove have heat treatment rules which match. These data come of the QS-system. The preheating-bonnets can be loaded, similar to the casting pits, separately.

The stove reservation occurs on daily basis.

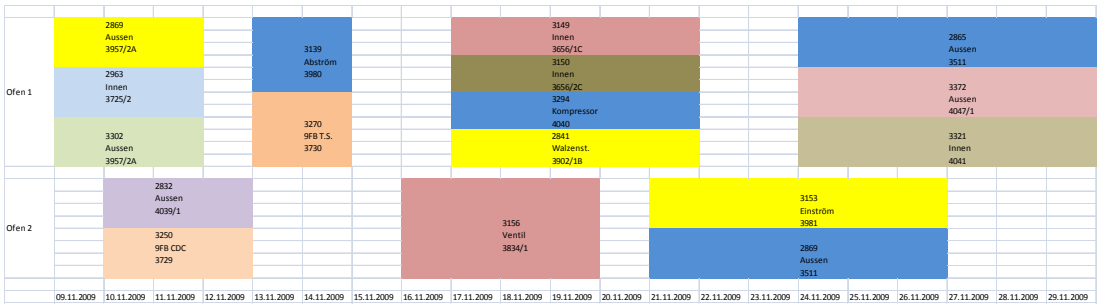

Fig. 31: Example mask „Stove reservation"

A line is indicated for every and / or preheating-bonnet. The height of the line is steady. Within the line one sees the cast irons. The extension along the x-axis corresponds to the period in which the cast iron is in the stove and / or preheating-bonnet, the extension along the y-axis corresponds to the reciprocal of the number of the cast irons in the stove simultaneously contained.

Through drag & drop the cast irons can be moved from a stove and / or preheating-bonnet into one other. If a heat treatment is supposed to be postponed, the entire stove reservation is postponed, because the cast irons are given simultaneously into the stove and also again to be removed. The user must declare whether he wants to postpone the heat treatment of a cast iron or the entire heat treatment.

If one goes above a girder with the mouse, all relevant data for this task are indicated in an info-box, in particular the heat treatment regulation that can be entered in the PPC.

The user can mark single girders in particular in the stove reservation. This is a notice for the quality department, to have a look at these again. If the quality department has controlled and reworked everything, she puts the markings again back.

7.2.4.8 Pre-finishing

The activities in the pre-finishing are planned on weekly basis. The user declares for every activity how many hours of that are to be finished in the corresponding week. Normally also a PPC-activity corresponds to a SAP-activity.

Due to the available capacity offer the PPC can compare, whether an over- or lower

planning is actual. This is indicated to the user.

7.2.4.9 Scrubbing

Normally the scrubbing away occurs. In this case no hours are acknowledged, but only the fact, that the cast iron goes after external and/or that it came back again. In the planning these two deadlines are planned.

It is, however, also possible that the scrubbing is carried out in the house. Since this is not planned in the SAP, the activities must be laid down in the PPC. The data collection occurs as usually in the PPC, but PPC can not acknowledge any hours onto SAP.

The activities for the scrubbing in the house are planned on weekly basis. The user declares for every activity how many hours of that are to be finished in the corresponding week.

Due to the available capacity offer the PPC can compare, whether an over- or lower planning is actual. This is indicated to the user.

Example: Flowchart (Excel form) for limited company data collection per shift and machine / job:

Flowchart Scrubbing		
Task		**Should**
10	Preparing processing - Programming - tool	
20	1. Mounting - To arrange piece	
30	Working on piece	
40	2. Mounting - To arrange piece	

50	Working on piece	
60	Measuring piece and deburring piece	
70	Control and announcement hall 4	

Fig. 32: Scrubbing flowchart

7.2.4.10 Finishing

The cast iron comes after an stove treatment into the finishing. After all activities were carried out, the cast iron for the measure control and then for the scrubbing comes.

After which the cast iron of the scrubbing is back, further activities occur in the finishing. Are all activities carried out, the cast iron comes into the NDE for the first examination.

If at the NDE errors are found, the user must start a repair cycle. In this case all standard activities of the finishing are copied into a new created repair cycle.

Within a repair cycle the cast iron comes into an stove for the tension glow (after the welding).

Repair cycles are created for so long until at the NDE no non-tolerable errors are found anymore.

The activities in the finishing are planned on weekly basis. The user declares for every activity how many hours of that are to be finished in the corresponding week. Normally also a PPC-activity corresponds to a SAP-activity.

Due to the available capacity offer the PPC can compare, whether an over- or lower planning is actual. This is indicated to the user.

It can be also that all activities of the finishing are assigned externally (Cluj / Romania). In this case no hours are acknowledged, but only the fact, that the cast

iron goes after external and/or that it came back again. In the planning these two deadlines are planned.

7.2.4.11 NDE (non destructable examination)

A NDE finishes the first treatment and/or a repair cycle.

The activities in the NDE are planned on weekly basis. The user declares for every activity how many hours of that are to be finished in the corresponding week. Normally only a SAP-activity which falls apart into several PPC-activities (UP, RP, MTP...) is available.

Due to the available capacity offer the PPC can compare, whether an over- or lower planning is actual. This is indicated to the user.

The X-ray examination can occur also externally (Czech Rep.). In this case no hours are acknowledged, but only the fact, that the cast iron goes after external and/or that it came back again. In the planning these two deadlines are planned.

7.2.4.12 Final finishing

If at the NDE no non-tolerable errors anymore are found, it is stated as the final test of the NDE. The cast iron is ready for the final finishing away.

For that there is a finishing task which exists also in the SAP, but does not have any connection with the cast task. This connection exists in the PPC, however.

In this case no hours are acknowledged, but only the fact, that the cast iron goes after external and/or that it came back again. In the planning these two deadlines are planned.

7.2.5 Gathering quality errors and complaints

If errors or shortcomings of a cast iron have struck a user, he can enter these into the PPC-system.

In this case he can add also photos or also documents of all kind next to error code and structured textual descriptions to his gathering. The documents are stored during

the booting up in the system at the server in a certain folder, in the database only the path is stored. That has the advantage that the documents are still accessible over the traditional way.

For every error (Error code) an own workflow is activated. It becomes between internal, supplier and customer error codes distinguished.

In order to activate a workflow, the user enters one or several responsible ones. He can select these from a list since it is a question of employees of the voestalpine-Gießerei. During the closing of the entry E-Mails are sent automatically to the responsible entered ones.

When now the receiver of this E-Mails that E-Mail opens, can reach through a click onto the sent link for the announcement of the sender.

Technically following happens with the click:

With the link it is a question in truth of a file with a certain filename extension in which information about the error and/or shortcomings entry are available. The filename extension the program „PPC-system" is assigned - this must be established unique on all PCs that use the PPC. Through that with the click the application “PPC-system” is opened and given it the announcement description file. If already an authority of the PPC-system runs, this of the restarted PPC-system will hand over the file, the restarted PPC-system is ended again.

The PPC-system reads now the necessary information from the announcement description file and opens the mask with the corresponding announcement.

The responsible person can process the announcement now, he can enter again new responsibles, those during the closing receive an E-Mail again.

The workflow organizes in:

⇒ Fault detection

⇒ Immediate measure

⇒ Bending measure

It is possible to search after

⇒ similar tasks

⇒ Error code

⇒ …

7.3 Data import from SAP

7.3.1 General one

Since it is not for license-legal reasons possible to access directly the Oracle-tables, the data exchange occurs via flat-files.

7.3.1.1 Format of a flat-file

A flat-file is a text file without column headers. Every line contains a data record. The columns within a data record are separated with the separator TAB. The flat file is produced independent of the respective country setting of the respective server.

The decimal separator is the point. A date becomes in the form YYYYMMDD, the time in the form hh24mmss produces and it is in UTC.

7.3.2 Order dates

SAP produces cyclically (e.g. once on the day at 20:00) a number of flat files. These contain the order dates. Every order flat file corresponds both in the structure and in the contained data of a SAP Oracle table. Always the entire relevant database is exported for the voestalpine-Gießerei Linz.

If all flat-files were produced, they are transmitted to the PPC-server by the SAP-server over VACOMS/FTSE (voestalpine data exchange).

At the PPC-server a polling-job runs which imports the data as soon as new flat-files are available from the flat-files into the PPC-database.

Since always the entire database is transferred, the import job must import only the recent flat-file-group.

Over a control file it can be guaranteed that the entire flat-file-group was completely transferred. The import job may not import before, when there is completely the flat-file-group.

It is supposed to be also possible to export only a single order. For this purpose the user must kick the export at the SAP. The produced flat-file-group is characterized as a single order group.

8 SUMMARY AND OUTLOOK

Currently (April 2010 stood) the first module of the new PPC-system goes just into the test operation.

It is about the collection of the man-working--hours at shift-end of the first captured departments pre-finishing and finishing. These departments were selected due to the open-mindedness of the responsible master craftsmen opposite innovations.

How presumed the - very distinct in some fields – scepticism about changes of the working methods represents the greatest risk factor during the current introduction. For that an integration of the company internal „Opinion Leaders" as early as possible to the design process of the user interface (screen forms etc.) becomes "very consciously" carried out.

Another, especially in the steel branch important, actuating variable represents the labour union. Various discussions about any gathering of personal data currently occur. Also here it is necessary to lay a cautious procedure on the day and to weaken budding, negative tendencies as early as possible.

It is planned to switch into production mode with middle May and to tie further departments then to the PPC system in a two-week-cycle tact.

A further hurdle represents the quality and complexity to the data supplied by SAP. On the one hand this is based on the very strongly integrated SAP database and on the other hand on lapses from the past, to carry out data maintenance measures.

The entire IT landscape / organization became / becomes unfortunately rather “stepmotherly” treated. Also in this field a certain thinking is to be recognized, however. So also staff considerations on these topics are started for the first time. IT is current a „appendage" of the maintenance department - an approach not very up-to-date.

Further, currently being developed (final phase), modules are the areas „error

treatment" (old EDFS system), “model administration" and „linking of suppliers with regard to deadlines". These fields represent from the view of data availability absolute grey zones - for the process of manufacture, however, they are very significant. The availability of the most important data from these fields leads, among other things, to a basis for the first possibilities of the use of the **core of the PPC-system**, the **rough-/detailed planning**. A field, that in the examined company, for the most part is covered by subjective assessment on basis of vast quantities of Excel tables covered.

The development / implementation of the PPC-system is carried out very professionally since the responsible internal and external persons responsible have broad technical and business background as well as long-standing project experience. The system represents a good middle course in its planned markedness between controllability as high as possible and necessary flexibility due to the dynamic processes.

This enterprise of the „very old economy" can through that generate a considerable competitive advantage opposite its, also for the majority very conservative, competitors - just in times of the strengthening of the Asiatic industry an important, probably almost „vital" step.

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