Operations management and financial management information systems: a designing approach for infinite and finite planning system

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Operations Management and Financial Management Information Systems

- A Design Approach for Infinite and Finite Planning Systems -

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Operations Management and Financial Management Information Systems

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Piet Vandenbossche was born in Kortrijk (Belgium) at August, 25th in 1969. He holds a Masters degree in Commercial and Financial Sciences with major in Accountancy from the Economische Hogeschool Sint-Aloysius at Brussels. He followed a post-graduation program in Financial Management at the Catholic University of Leuven and is recognized as CPIM by APICS. Currently, he is Ph. D. student at the Eindhoven University of Technology. His professional career started as controller in a middle sized company in 1992. Afterwards, he was software designer in an international software house where he is currently involved in designing a new ERP-architecture.
Operations Management and Financial Management Information Systems

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Abstract

Enterprise Resource Planning (ERP) is an integrated business information system to support Operations Management decisions. Software designers of ERP systems have to organize the information according to the business functions that are to be supported. It is possible that one business function occurs in several application domains. This paper describes the business function “planning” in both Operations and Financial Management in a two phased designing oriented way. The possibility to model generically the planning procedures for two different application areas is explored. In a first step, a model for planning against infinite planning is presented and its strengths and weaknesses are indicated. In a second step, a refined model is presented to overcome the weaknesses of infinite planning. This model is called finite capacity planning.

Keywords: Operations Management, Financial Management, Planning Systems, Modeling, ERP-information systems
1. Introduction

Enterprise Resource Planning (ERP) systems are information systems which integrate different functional areas into one integrated business information system. Their objective is to support business tasks as: administration, planning, contracting, et cetera with appropriate information. Some of the main business functions supported by ERP-systems are e.g.:

- *Manufacturing and Distribution functions*: application area of Business Logistics, Distribution Requirements Planning, Total Quality Control, Just in Time philosophy et cetera;


A business task can occur in more than one business function. Examples of ERP systems are for instance Baan, SAP, MFGPro, SSA. They all contain the following modules: Manufacturing and Process, Finance, Distribution and Transportation. They are called integrated information systems, as all modules have at least one interface, namely one to the Finance module in which financial transactions are posted and processed. A non-financial interface is for instance the link between Manufacturing and Distribution module where the Manufacturing module generates projections of sales- and purchase orders which are transferred to the Distribution module when they become real orders. In ERP-design, one can design a generic solution or a tailor-made one to support a business task. In the BAAN approach, business tasks are supported in a generic way within an application area. This means that this software can be used in whatever type of business. From the point of view of output, this is a very valuable concept as there is an infinite reuse possibility for each new customer that wants to use the ERP system.
But there are some disadvantages concerning the architecture of the system. During several years, these systems have grown from a relatively limited systems towards a quite elaborated, sophisticated ones. In the design process, one always starts from the business function in the application area itself. The integration is established afterwards. No single person is bothered with the overall architecture. The consequence is obvious: no one makes use of the possibility of functional reuse: the same functionality in different application areas occurs two, three or even more times in the overall system. Disadvantages of this approach are:

- there is much more maintenance work as the overall application is much bigger than it necessarily should be;
- the overall architecture is not clear as the same entities occur several times in slightly different form;
- users complain that they have to enter the same data several times in order to support different business processes.

These disadvantages promote the search for a different design architecture. Instead of starting the application design in the domain itself, it is apparently more beneficial to search for generic concepts which can be reused or tailorised in the application area itself. When applying this approach, all former disadvantages are converted into advantages. From this point of view, this approach can be called “a generic modeling approach”. When modeling generical solutions, object orientation is nowadays frequently applied as designing method because it provides tools to create flexible, adaptable systems and allows reuse of existing software [38]. As derived from current ERP architecture disadvantages, it is an interesting research question to investigate if a business function that occurs in several application areas can be modeled in a generic way.
In this paper, an example of the solution to the described problem is given via the generic modeling of the business task “planning” in both manufacturing and financial business functions. Two approaches to planning can be distinguished: planning against infinite and finite capacity:

- **Planning against infinite capacity**: In this type of planning, events are projected without considering potential constraints. As a consequence, it might be possible that the plan which is the output of the planning process, cannot be realised.

- **Planning against finite capacity**: This is a planning approach in which all known constraints are taken into account and optimized.

This difference in approach origins from the domain of Business Logistics but also makes sense in Financial Management as explained in later sections.

The objective of this paper is providing a generic model for both the infinite as well as the finite planning systems in the area of Business Logistics and Financial Management. It is explicitly investigated if “planning” has the same objectives in these two application areas and to what extent it can be supported in a generic way.

### 2. Literature on Management Information Systems

This section deals with the characteristics of Financial and Business Logistics literature. It is described to what extent tools are available to support the business task “planning” and in what way these tools can be helpful to design Management Information Systems.
2.1 Domain of “Finance”

The “Financial” body of knowledge is covered by two disciplines, namely Financial Accounting and Financial Management.

Financial Accounting is historically oriented and supports transaction processing, registration and consolidation. Its main objective is to provide the necessary information to support the legally obliged publication of the annual figures [45]. As a science, Financial Accounting has no contribution in supporting the planning function of a company: it can only deliver the correct starting points, namely: the historical balance sheet and the transferred period results from the income statement.

The Financial Management’s body of knowledge contains two kinds of methods: techniques for financial decision support and future-oriented financial processes [1]. Examples of techniques for financial decision support are the discounted cash flow techniques: net present value, pay back method and profitability index; the Black and Scholes option pricing method et cetera. Future-oriented financial processes are: the budgeting process, the financial planning process and treasury management processes with which some of the above mentioned techniques for financial decision support interact. Only these processes are considered in this paper. They are used as instruments that support the planning functions. For example, budgeting is not only used for supporting traditional budgeting objectives [32]. The budgeting technique is also applied as aggregated planning method which allows detailed planning in a later stage. Financial planning cannot be supported by financial sciences only: it needs input elements from other functional areas to have sufficient information to execute the task. This statement is explained further in this paper.
2.2 Domain of "Manufacturing"

In this approach, for "Manufacturing", both the internal production as well as the physical distribution are considered. The internal production is defined in Business Logistic, whereas the physical distribution is defined in Distribution Resource Planning (DRP). The common characteristic of both Business Logistics and DRP is that they are initially *planning systems*, which implies that they focus only on the future. In Business Logistics, production schedules are established on several future horizons varying from long term (Aggregated Production Plan - APP) towards detailed scheduling (Shop Floor Control - SFC scheduling) [5,7]. The mission of DRP is linking the production channel through customer connectivity, realised by EDI (Electronic Data Interchange). Planning and scheduling systems like Distribution Resource Planning (DRP) and Manufacturing Resource Planning (MRP II) generate and maintain valid plans across the entire industrial pipeline. Those plans do not only correctly reflect the needs of the company, but do so as things constantly change, and are attainable as well. Just in Time / Total Quality Control (JIT / TQC) generate quick material flow, and attack all forms of waste (i.e. inventory that sits too long, long manufacturing setups, large manufacturing lot sizes and safety stock), thus reducing costs and improving quality. Finally, electronic data interchange (EDI) and bar coding facilitate information flow and material flow. The ingredients described are all available. It's only a question of combining them in a logical and sensible sequence [14]. As opposite to Financial Management, there is a long tradition in designing and modeling Business Logistics and DRP applications.
3. Infinite planning in Business Logistics: Closed-Loop MRP

Before explaining infinite capacity planning algorithms in specific application areas, the characteristics of this planning approach are discussed first. The main characteristic of planning against infinite capacity is, that the planning is calculated by simply projecting all available data and events using known procedures without considering potential capacity or procedure constraints. If capacity is considered at all, a post-calculation capacity load profile is established which indicates the capacity needed for realising the plan. However, it is not possible to apply optimization algorithms that consider the available resource capacity.

In next two main sections, infinite planning is discussed in the area of Business Logistics and Financial Management respectively.

This section describes the infinite planning approach in Business Logistics. The model that is proposed is called: Closed-Loop MRP. Closed-Loop MRP as concept is not new: its logic is already known since the beginning of the seventies. After its strengths became clear, it is applied at large scale and continuously refined. It contains three planning levels and three according capacity load profiles. Before explaining the flow which consist of interactions between planning levels and capacity load profiles, the necessary input elements for establishing the model are indicated.

3.1 Input elements

The only input element that can be mentionned for infinite planning in Buisiness Logistics is a Demand Plan (sales budget) which is needed to feed the Master Production Schedule. The Demand Plan contains a definition of the quantities at product family level that will be sold the comming year. Besides this one input element, Business Logistics can support the
planning functions on stand-alone basis as consequence of its domain characteristics as explained above.

3.2 Closed-Loop MRP - Flow

In closed-loop MRP, planning is established at three levels: at medium term, a Master Production Schedule (MPS); at short term, a Material Requirements Plan (MRP) and for the immediate period, a detailed planning (Shop Floor Control (SFC) plan) is maintained [3]. The function of these three planning levels is described in the next section. An according capacity load profile can be established at these planning levels: the Rough Cut Capacity Plan (RCCP), the Capacity Requirements Plan (CRP) and the Input / Output Control (I/O Control). The relation between the different scheduling levels and capacity load profiles is visualised in figure 1.
Fig 1: Infinite Business Logistics Planning: Closed-Loop MRP
3.2.1 Production scheduling at different levels

Closed-loop MRP works with three different planning levels: the MPS level, the MRP level and the SFC level. A general description of the functioning of closed-loop MRP is given in appendix A. The objectives and functioning of the three levels is described next [42,43].

**Master Production Schedule**

The MPS is a statement of what the company plans to manufacture in terms of items, quantities and planning periods [40]. The items can be products, assemblies or individual parts. They are the highest level items that the MRP system uses as input to determine for lower-level components and raw materials. The information elements maintained by the MPS are described in appendix B. The MPS can serve the following purposes:

- It provides a schedule for production orders for MPS items;
- It drives the MRP-system via bill of material definitions for MPS items;
- It serves as the basis for determining the capacities needed in terms of manpower, machine hours and other resources through the rough-cut capacity planning system;
- It provides the basis for making delivery promises to customers for assemble to order products.

The MPS contains two main parts: the frozen part and the unfrozen part. The frozen part is exploded at the MRP-level. Both the unfrozen as well as the frozen part can consist of forecasted data and planned customer orders. Schedule changes become more costly, difficult and disruptive as they become closer to the present time. For this reason, it is useful to divide the future into intervals with different procedures applicable in scheduling for each interval. This intervals are divided by time fences. A formal agreement between manufacturing and marketing as to what the time fences are and what procedures must be
followed when making changes is important in improving communication and co-operation in managing the MPS. One of the most important time fences is the planning time fence, which equals to the cumulative lead time for production and procurement of the product [39].

**Material Requirement Plan**

The Material Requirements Plan is a system for planning production and procurement of components and materials needed to produce items specified in a MPS. The content of the MRP is explained in appendix C. The purposes served by MRP are [7, 42]:

- To plan the orders for components and materials in terms of items, quantities and release dates;
- To set and maintain priorities by assigning due dates to orders;
- To provide the input to the capacity requirements planning system to determine the resources that will be needed to produce the MPS.

**Shop Floor Control: Operation Scheduling**

Operation Scheduling is the assignment of start and/or completion times to manufacturing operations [41]. The purposes of Operation Scheduling are:

- To determine the sequence in which operations are to be performed at a given work center, that is: to create the dispatch list;
- To estimate the completion date of orders.

The output of Operations Scheduling is a dispatch list, which indicates the priorities and sequence in which operations are to be started.
3.2.2 Capacity load profiles at different levels

There are three according capacity load profiles in closed-loop MRP: the rough cut capacity planning (RCCP), the capacity requirements planning (CRP) and the input / output control [6]. Their characteristics and function are explained next.

_Rough Cut Capacity Planning (RCCP)_

Analysis of the resources required by the MPS is carried out by Rough-Cut Capacity Planning (RCCP). Under RCCP, a set of load profiles is maintained for each item scheduled in the MPS. The profiles show the amount of a number of critical resources required to make one unit of the product [44]. The critical resources may be, for example, manpower, machine hours, or floor space in certain departments or work centers. These resource requirements are spread by time period over standard lead times. Once a tentative MPS is developed, it is input to RCCP to determine whether it is compatible with available planned capacity. The RCCP is approximate in that it is only concerned with critical resources and does not take into account changes in work in process or component inventories. However, normally RCCP is sufficient to avoid major inconsistencies between the MPS and available capacity, and remaining problems can be handled at the MRP or Operation Scheduling levels.

_Capacity Requirements Planning (CRP)_

Capacity Requirements Planning (CRP) is the capacity planning system corresponding to MRP. CRP makes use of backwards scheduling. It starts with the due date for an MRP order and works backward determining the time at which each operation will be completed using the same standard leadtime elements used in determining release dates in MRP [5,44].
The workload associated with each of these operations is assigned to a time bucket for a particular work center. This may involve standard manhours, standard machine hours or both. These workloads are then summed over all orders to determine the total workload at each center. This is done without regard to the capacity available at a center and is called infinite loading.

*Input / Output Control (I/O Control)*

The capacity system at the operation scheduling (SFC) level is input/output control. This system monitors the flow of work into work centers, the amount of work completed and the size of the queue. Significant cumulative deviations between actual and planned input or output indicate the need for investigation and corrective action [5,44]. This also aids in controlling the size of the queues. Planned inputs and outputs for each work center by time bucket are obtained from the CRP system. Actual inputs, outputs and queues are obtained from the shop floor reporting system.

**3.2.3 Conclusion**

Closed-loop MRP arranges infinite planning in Business Logistics at three planning levels: MPS, MRP and SFC horizon. There are three according capacity load profiles: respectively RCCP, CRP and Shop Floor Control which give an indication of the capacity needed when executing the plan. They are created batch-wise after the calculation of the plan. Infinite logistics planning can be generated without input elements from other disciplines, except for the input of the Demand Plan.
4. Infinite planning in Financial Management: Infinite Financial Capacity Planning

In this section, the infinite planning approach in the Financial Management area is described. The proposed concept is called: Infinite Financial Capacity Planning (IFCP) and is entirely new. Compared to infinite planning in Business Logistics, planning concepts in this area are quite new and not widely accepted or used. Attempts to define concepts that cover the financial domain can be found in literature. An example of such a concept is the Money Resource Planning concept defined by Schollaert [46]. Reasons for the absence of tradition in financial planning can be due to the fact that there is no legal obligation to do so. Compared to planning in Business Logistics which is necessary to manage the production and physical distribution department, financial planning provides additional information which is not vital to the day to day fulfilling of financial obligations. Its strengths and relevancy lay in the fact that this information provides the tools to prevent liquidity shortages and it makes it possible to prepare decisions and negotiations in a professional way. Financial planning information is in this case used as financial marketing instrument as negotiations for banking loans, use of venture capital for entering new markets et cetera are prepared and illustrated on the basis of this information. The necessary input elements for establishing the model are discussed first. Afterwards, the model flow is explained in six consecutive steps.

4.1 Input Elements

As a projecting tool, Financial Management has only a limited scope. A lot of input elements are needed in order to establish a financial projection with appropriate detail and correctness. Three elements are needed in order to complete the IFCP: financial administration data, the time phased financial commitment information system and the
Business Logistics information system. They are visualised using figure 2. Their contribution and relevancy are explained next.

- **The Financial Administration.** This information system contains the open sales and purchase invoices. Open invoices are invoices that are sent or received but from which money is not yet collected or paid. The information is known with all possible detail: the due date, the amount due, the currency used and tax implications are fixed. In the very short run, most input comes from this information system.

- **The Time Phased Financial Commitment Information System.** Invoices are the formal external document of delivered or received goods on which cash collections or payments must follow. As long as goods are not received or delivered, they are registered in form of an open sales or purchase order. Projection of exact collection and disbursement of money is possible with this information. The only difference with the previous element is, that the due date is not really fixed. The order delivery date is considered as the future invoice date on which terms of payment data are calculated to obtain the due date. As a consequence, if there is a delay in delivery, the due date will move to a later point in time. Besides this information, the mentioned information system also contains information pertaining to financial implications of insurance, currency contracts, commissions for representatives and all other kinds of commitments in which money is involved. If one goes further into the future, on first sight no projected financial data is available any longer. One can think the ultimate financial projection horizon is reached. But this is not true.
• **The Business Logistics Information System.** In an ERP system, there is a part which almost entirely focuses on future projection, namely Business Logistics. One of the main objectives in this functional area is making a production planning for the coming period, task executed by the closed loop-MRP logic [7]. In this information system, projected time phased production and purchase advice orders are generated. This system only generates projected quantities in a certain time bucket. No financial data is present. The objective now is to relate financial data to the planning output of the Business Logistics information system in order to obtain relevant financial projection data. Only if the Business Logistics planning information is included, financial projection on a longer future horizon becomes possible. The integration of Business Logistics for future-oriented Financial Management modeling objectives is not only logic, but even vital as input in order to be able to execute the planning on a longer horizon. The Business Logistics information system is therefore the third necessary input element.

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![Diagram](https://via.placeholder.com/150)

**Fig. 2**: Necessary Input Elements for Infinite and Finite Financial Capacity Planning
All three input elements have a specific planning horizon that serves as important input factor. In the short run, the Financial Administration plays the most important role. In the longer run, the Time Phased Financial Commitment Information System becomes important and in the long run the Business Logistics Information System. This is visualized using figure 3.

![Diagram of Level of detail vs. Horizon per Input Element]

Fig. 3: Level of detail vs. Horizon per Input Element
4.2 Proposed Concept : Infinite Financial Capacity Planning (IFCP) - Flow

In this section, the functioning of IFCP is explained at full extend. IFCP embodies an entire financial projection concept, and is therefore not the same as financial planning. IFCP is both input element of and prerequisite for the FFCP concept. The flow is explained using figure 4. The concept supposes that an Business Logistics closed-loop MRP system with three planning levels is present and actively used. At the highest level a Master Production Schedule (MPS), in the middle a Material Requirements Planning (MRP) level and at the bottom a Shop Floor Control (SFC) level should be available [5]. The detail of closed-loop MRP - processing is explained in the part of Infinite Planning in Business Logistics. As the focus of this section is on the Financial Management side, no further detail is given on Business Logistics processes apart from links towards and necessary data for Financial Management objectives. The IFCP cycle contains six consecutive steps:

1. Strategy Definition
2. Annual budgeting cycle
3. Rough financial MPS evaluation
4. Currency Hedging
5. Detailed financial business projection
6. Short term treasury management activities

Each of these steps is explained in detail in function of the integration objective.
OPERATIONS MANAGEMENT

BUSINESS PLAN

- LT CAP. BUDGET
- LT MARKETING BUDGET

Definition Year Budgets

DEFINITION MT AGGREGATED ACTIVITY BUDGETS

- Personel Budget
- Investment Budget
- Aggr. PROD PLAN

Input Sales Data

FROM

DEMAND PLAN

CURRENCY

INPUT

Financial Evaluation MPS

MPS

MRP - Explosion + Routing Data

LOGICS planning under (in)finite production capacity

MRP

FINANCIAL BUSINESS PROJECTION

ROUGH FINANCIAL BUSINESS PROJECTION

Input for

Personel Cost Budget

Cost Budgets

General Costs Budgets

Derived

Derived from

FINANCIAL MANAGEMENT

Indication Financial Immplication

AGGR. LT CASH BUDGET

AGGR. YEAR CASH BUDGET

Personel Cost Budget

Investment Budget

General Cost Budgets
Receipt + Process of purchase invoices

SFC → SUBCONTRACTING → PERSONNEL BUDGET

Invoicing Sales Orders

FINANCIAL ADMINISTRATION

input for
Payment Purchase Invoices

ST TREASURY MANAGEMENT

input for
Receipt Sales Invoices

FINANCIAL ADMINISTRATION

Input historical start situation

Fig. 4: Infinite Financial Capacity Planning
4.2.1 Strategy Definition

The 3 to 5 years strategy is defined in the business plan in a descriptive way. The business plan contains the product-market combination selected by the company and the major steps that must be followed in order to reach the targets. From the business plan, both a long term capacity budget and a long term marketing budget are derived. The long term capacity budget contains the necessary number of people and the necessary machine per plant capacity for the execution of the targets that are described in the marketing budget. The marketing budget contains a definition of the product families concerned, the eventual costs of product research, and the projected sales. Both the capacity and the marketing budget need a certain amount of long term and short term money for their execution. An aggregated projection of this need is expressed in the aggregated long term cash budget. The result serves as indication of the money needed.

4.2.2 Annual Budgeting Cycle

The long term capacity and marketing budgets at 3 to 5 years are translated to aggregated activity budgets for the coming year. From the strategic capacity budgets, the personnel and the investment budget are derived and serve as input for the aggregated production plan. From the marketing budget, the sales and sales cost budgets are derived. The sales budget serves as input for the demand plan which serves as input for the Master Production Schedule (MPS). Budget data must be time phased to a certain extend for IFCP purposes. The sales budget must be defined as an activity budget (quantities per end item, multiplied by a sales price, both elements stored separately) [5,17].
4.2.3 Rough Financial MPS Evaluation

The rough financial MPS evaluation phase fulfills a Business Logistics objective: its medium term decision making is enlarged with a profitability evaluation of the MPS. In Business Logistics, the MPS plan is an aggregated plan of the coming medium term production. It normally contains one whole business production cycle. This plan can be longer than a calendar year or much shorter depending on the characteristics of the branch of the company for which it is established. A lot of medium term financial decisions are taken for one financial year [29]. In order to be able to make a sound financial projection on this planning length, enough projected logistic data must be available. This can impose that more than one business cycle has to be defined in the MPS until it has a projected length of at least one year. For Business Logistics planning purposes, it is not necessary that all end items are forecasted by the MPS: if they are not critical or material, they can be planned on lower planning levels (e.g. MRP or even SFC level). However, IFCP supposes that all end items are planned at MPS level. Financial projections derived from MPS data are, like the MPS, defined in aggregated terms. Business Logistics decisions (in this case: the profitability evaluation of the MPS planning) must be supported by the relevant costs technique, which has a short term and a long term variant [15,34]. As the profitability evaluation of the MPS is not a daily decision, the appropriate relevant costs technique is the long term variant which equals to the management accounting contribution margin calculation method. The full explanation and justification of this technique is beyond the scope of this paper. The technique makes use of the following calculation scheme [37]:

\[
\text{Profit Margin} = \frac{\text{Turnover} - \text{Costs of Goods Sold} - \text{Material Costs} - \text{Production Costs}}{\text{Turnover}}
\]
In Appendix D, the constituting elements of the contribution margin is explained in depth. Because this scheme is calculated in a time phased way using the time bucket definitions of the MPS, the processing of results of each element of the contribution margin can be seen as an application of financial budgeting. If this reasoning holds, it implies that all possible budgeting applications (e.g. difference calculation between alternate MPS plans) are possible [19,32]. Financial budgets are a very suitable reporting format at this level. It is not wishful and even wrong to report in form of a projected financial master budget, because data is only available with a too low level of detail, which is required by and inherent to this method. It is however possible that projected statements are wanted by users. In this case, this output format is not wanted as answer to the real question at this level, namely “how much money can be earned with the MPS in question”. The real reason is, that users want to enlarge the reporting generated at the MRP level (which equals the frozen part of the MPS) with the information available from the unfrozen part of the MPS in order to have consistent information on a longer horizon: it is then possible to have a one years’ projection in form of a projected master budget.

4.2.4 Currency Hedging

The Financial Management objective that is solved at this level is a contribution to the solution of the currency hedging problem [10]. When dealing with currency hedging, one quickly refers to Markowitz’ modern portfolio theory [3]. But as correlation coefficients between risk currencies cannot be defined in a correct way, this method is not applied here. Currency hedging is here proposed as an annual exercise for which appropriate information (which is not available in current financial information systems) is required. In this approach, the question that is solved is: how big are volumes in currencies used [21].
Questions as: how riskfull are currencies, how do they correlate, how is the currency rate likely to evolve, what are the appropriate hedging instruments in the underlying situations, et cetera are beyond the scope. At MPS level, rough logistic projection information is available. It is obvious that from rough logistic projection data, no detailed financial projection can be derived. Target as solution for currency hedging therefore are time phased indications of volumes per currency used. These indications can be derived from the rough One can solve this objective by adding a currency distribution scheme to each element of the contribution calculation scheme. An example of a currency distribution scheme can be:

Turnover:

50% USD
20% CAD
15% FRF
10% BEF
5% DFL

100% (Total Turnover)

4.2.5 Detailed Financial Business Projection

Objective in this phase is to define a detailed financial business projection in form of a financial master budget [21,22]. A financial master budget consists of three linked statements, namely the projected balance sheet, the projected income statement and the projected cash budget. An example of each statements' layout is presented in appendix F.
4.2.6 Short Term Treasury Management Activities

In short time treasury management, the actual disbursement and collection of money is
arranged. The systems used here works on a quite low level basis: it is only the execution
of financial duties at the due date without sophisticated optimization [9,10,11,13]. The
cashflows as result of a financial business projection serve as indicators of cashflow volumes.
As stated above, these in- and outflows are the aggregated time phased projection of the
underlying Financial Administration, Time Phased Financial Commitment and Business
Logistics projections. No attention is paid to the fact if money can be available at the time
necessary or not.

4.2.7 Conclusion

IFPC is a financial projection technique which uses Business Logistics, Time Phased
Financial Commitment information and the Financial Administration as input. Concepts for
infinite planning in Financial management are rare. The proposed concept works with six
consecutive steps. Projected results are valuable for a lot of applications which are described
in Appendix E. Note that the applications for FFCP are the same. The only difference is,
that the same application objectives are reached in a more refined way with FFCP.
5. Shortcomings and comparison between Business Logistics and Financial Management Infinite Planning

Although closed-loop MRP and IFCP seem to be very valuable projecting techniques, they also contain some major drawbacks and shortcomings. The main disadvantage is, that they only project events, without considering if they can be executed at their respective starting moment or not.

In closed-loop MRP, a time phased projection of the materials needed for production is generated using the “offset for lead time” technique. Production planning is generated on the basis of routing data. The system never checks if the production capacity is really available at the moment it is needed. In other words, it never checks if the production planning can be executed.

In IFCP, incoming and outgoing cashflows, costs and revenues are generated simultaneously. Cashflows are generated using projected due dates, terms of payments, tax and currency policies. Costs and revenues are generated using correct cost and revenue moments. The problem here is situated mainly for cashflows. IFCP generates projected incoming and outgoing cashflows without considering if money (= financial capacity) is available in the projected currency.

It can be stated that IFCP and closed-loop MRP have the following common characteristics:

- both concepts are future oriented and project data in a time phased way;
- both concepts solve the same underlying problem, namely requirements planning, which is “material requirements planning” in closed-loop MRP and “money requirements planning” in IFCP.
• both concepts cope with the same problem: possible unavailability of capacity, which is “production capacity” in closed-loop MRP and “financial capacity” in IFCP.

6. Recent Developments in Finite Capacity Planning for Business Logistics

The previous section indicated the need for more refine planning concepts. Infinite planning solves a lot of the planning problem but cannot assure that the plan can be executed. The same statement is true in both the Business Logistics as well as the Financial Management domain. Planning concepts in both application areas need an extension where the availability of capacity is taken into account [6]. If capacity is limited, capacity constraints and optimisation objective become important when generating the plan.

Recently, a number of logistics trends have come up: shorter throughput time, shorter delivery time, cost reduction, just in time production et cetera. The underlying objectives in all these new trends must be reached via a more focused attention on planning. Solution must be found via capacity oriented resource scheduling. Finite planning is generating logistics plans while considering the constraint availability of material and capacity. In the remainder of this part, first an investigation is made if this planning approach needs input elements from other functional areas. Afterwards, the difference in constraints at different planning levels are explained.
6.1 Input elements

Because finite logistics capacity planning is a refined form of closed-loop MRP, finite planning in Business Logistics also doesn't need input elements from other disciplines in order to establish the plan.

6.2 Different constraints at different levels

As in infinite planning, finite logistics capacity planning is possible at three planning levels: at MPS level, at MRP level and at SFC level. These levels are visualised in figure 5. Literature and software packages often only deal with the SFC level. The reason behind this phenomenon is, that drawbacks of infinite planning only become visible and real at the SFC level. Failing finite capacity planning at other levels is ignored. As finite plans are generated automatically, the according capacity load profiles: rough cut capacity planning, capacity requirements planning and input / output control are generated simultaneously with the plan instead of in a batch-oriented way as in closed-loop MRP.
The planning systems' model differs by planning level. The primary process model is more aggregated on higher levels and more detailed on lower planning levels [47]. It is also very important to note that lower planning levels have to plan within constraints set by higher levels. The same applies to optimization goals. On higher planning levels, cashflow and inventory goals are important. At lower planning levels, on-time delivery is more important. Constraints are also more aggregated on higher planning levels. It does for example often not make sense to consider very detailed waiting time constraints at MPS level.

**Fig 5: Finite Business Logistics Planning**
6.2.1 Constraint planning at MPS level

The function of constraint planning at MPS level is determining a feasible production and sales plan which result e.g. in an optimal cashflow. Capacity in an MPS plan is expressed in a volume (number) of end items. The planning is calculated with rough and aggregated constraints. It is important to know that the MPS determines the output and load of the whole factory over a long planning horizon. Critical work centers and materials are considered. Business simulation and scenario planning and analysis is therefore often done at this level. The schedule must be arranged as such that the planning at MRP and SFC level can be optimized.

6.2.2 Constraint planning at MRP level

The function of the MRP is to determine the timing of the start with production and the resulting time phased material requirement. The goal of constraint planning is to generate production orders with feasible start and finish times. This results in a feasible goods flow or material requirement. The MRP constraint planning works within the constraints defined at MPS level. Order acceptance is often supported with constraint planning at this level.

6.2.3 Constraint planning at SFC level

The main function of the SFC is to carry out the logistical plans and targets set on higher planning levels. The goal of SFC constraint scheduling is therefore to generate an optimized plan given a set of orders priority rules and the ability to react in a dynamic way: the SFC plan is frequently rescheduled. The SFC plans within their start and end times. Constraints are defined with hour and minute detail. SFC constraint planning is defined within the constraints defined at MRP level.
6.3 Conclusion

Finite planning in Business Logistics makes use of the same planning levels as closed-loop MRP: the MPS, the MRP and the SFC level. Opposite to infinite planning, according capacity load profiles (RCCP, CRP and Input-Output Control) are generated simultaneously with the planning. The described model is more aggregated on higher levels and more detailed on lower planning levels. It is important to know that lower planning levels have to plan within constraints set by higher planning levels. Compared to closed-loop MRP, the characteristics of the production system are important and must be taken into account.

7. Finite Planning in Financial Management: Finite Financial Capacity Planning (FFCP)

In this section, a similar finite planning system is designed for the support of the financial planning task. The name given to the new financial concept is: Finite Financial Capacity Planning (FFCP). Compared to infinite financial planning, there are no known concept examples of this approach in literature or practise. As a comparison between closed-loop MRP and IFCP exists to a large extend, it is obvious that a solution for the availability optimization of financial capacity is searched for via the solution found in Business Logistics.

In Business Logistics, one tries to plan production orders in an optimized way, given the available production capacity and constraints. There are different constraints and optimization objectives at each planning level. The characteristics of the production system determine the optimization possibilities. Each production order has a specific due date and consumes a certain amount of production capacity (= one or more resources), defined via the routing. The general objective is to plan production orders in such a way that all orders are
realised in time with at least capacity fluctuations as possible (e.g. working overtime, outsourcing, use of inefficient alternate routings, et cetera). If alternate resources can be used, possibilities of production rescheduling are evaluated.

If these objectives are applied in Financial Management, this should mean that all available financial capacity is equal in first instance and is only planned against payment due dates. This reasoning is not correct: long term and short term money (= financial capacity) are essentially different. These two types can be subdivided into different products, each with their own possible applications and cost. The characteristics of the production system are of no importance for finite planning in Financial Management.

The following temporarily conclusion can be made. Business Logistics finite planning solutions are not really suitable for Financial Management optimization. Resources of FFCP differ depending of the time horizon and the application. Before indicating the relevant time horizons and both objectives and flow of FFCP, it is first investigated which input elements are necessary to establish a finite financial capacity plan.

7.1 Input Elements

FFCP can be seen as a refined model of IFCP. The same input elements must be available to execute the plan. The IFCP input elements are:

- The Financial administration;
- The Time Phased Financial Commitments Information System;
- The Business Logistics Information System (closed-loop MRP).
7.2 Time horizons of FFCP

FFCP works with four different planning horizons. These horizons are entirely based on the financial objectives that are to be reached. The planning horizons are:

**Strategic Time Fence**

The Strategic Time Fence typically has a length of 3 to 5 years. The data defined in this time horizon is characterized by aggregation. This time fence mainly serves for strategy definition.

**Medium Term Time Fence**

The length of this time fence falls together with the length at which the MPS is defined. As the period of one year is appropriate for some financial decisions, it is advisable to maintain an MPS using a one-year's planning length. The MPS consists of an unfrozen and a frozen part. The frozen period equals the cumulative lead time (which is the sum of procurement and manufacturing lead time). It represents quantities of end items committed to, and started in manufacture. The unfrozen period is a period for which a manufacturing forecast is defined and translated into “available to promise” (ATP) quantities. Customer orders which consume ATP can be defined at this length but can still be rescheduled. The Medium Term Time Fence contains the strategy for the coming year and is defined at unfrozen MPS length. The Medium Term Time Fence, together with the Execution Time Fence are visualised using figure 6.
Execution Time Fence

The Execution Time Fence starts the moment that is chosen for a MPS. As explained in the previous part, the MPS consists of an unfrozen and a frozen part. In the Execution Time Fence, the "current year's strategy" is executed. This time fence falls together with the frozen part of the MPS. The Execution Time Fence, together with the Medium Time Fence are visualised using figure 6.

![Diagram of MPS Time Fences for FFCP](image)

Fig. 6: MPS Time Fences for FFCP

Short Term Financial Time Fence

This time fence starts the moment that goods of purchase or sales orders are received or delivered and converted into invoices. Purchase advice orders are generated during the MRP explosion. Receipt can be situated some time later but in any case before or at the moment of the SFC planning. Delivery of sales orders always comes after the SFC planning as the items are finished in the shop floor. Short term treasury management objectives are optimized at this time fence.
7.3 Objectives of FFCP per time horizon - Flow description

In the next subsections, the objectives per FFCP time fence and the FFCP flow are explained in depth using figure 7.
MRP

Logistics Planning under
(in)finite logistic capacity

Release Production Orders

MRP-Explosion + Routing

Financial planning under infinite
financial capacity

Receipt + Process
Purchase Invoices

SFC

SUBCONTRACT.

PERS.BUDG.

Invoicing Sales Orders

FIN. ADMINISTRATION

Payment investment
invoices

MT TREASURY MANAGEMENT

FINANCIAL BUSINESS
PROJECTION

Input history
for compose of
start situation

FIN. ADMINISTRATION

Input for
Payment
Purchase Invoices

SHORT TERM TREASURY MANAGEMENT

Input for
Cash receipt
Sales invoices

FINANCIAL ADMINISTRATION

Fig. 7: Finite Financial Capacity Planning
7.3.1 Strategic Time Fence: three to five years for strategy definition

The long term strategy is fixed in the business plan. The strategy defines the product-market combination chosen and the steps and options that will be followed to reach these targets. The business plan is stated in a descriptive way. It must be translated into a long term capacity budget and a long term marketing budget. The long term capacity budget contains the necessary number of people (subdivided into functions and skills) and the necessary machine per plant capacity for the execution of targets described in the marketing budget. In the long term marketing budget, a definition of the products concerned and the eventual costs of product research are given. Besides these, the market segments, their costs and the potential risks involved are defined [35].

For long term treasury management objectives, the financial capacity necessary for the realization of the long term budgets will be determined [20]. It is the explicit task of the treasurer to have certainty that the necessary financial capacity becomes available at the right moment in form of credit lines, capital raise et cetera. Strategic plans must be realistic from the financial point of view. Shortages in the long term cannot be solved and a make a redesign of the strategic plans necessary.
7.3.2 Medium Term Time Fence: purpose is one year, practically: frozen MPS length for rough financial projecting purposes

Long term strategic budgets for 3 to 5 years are translated to aggregated activity budgets for the coming year. With "budgets", the personnel budget, the investment budget, the sales- and sales cost budget, and the organization cost budgets are meant [18]. Purchase cost budgets and production cost budgets are especially not mentioned as they can be derived directly from Business Logistics output. The necessary short term and medium term financial capacity is derived from the aggregated activity budgets at this time fence. The necessary financial capacity is compared with the long term available capacity. This comparison will indicate a surplus or a shortage on medium term. Surpluses pose no problem at all: available financial capacity will not be used and remains available over a longer period of time. Shortages can be considered as differences from the long term budget. If the long term exercise is done well, these differences are not that material that they cannot be solved via negotiation. In this case, long term capacity is consumed prematurely, in an implicit way. The aggregated medium term capacity budgets (personnel budget and investment budget) are the input for the Aggregated Production Plan (APP) [26]. In this way the available logistic capacity becomes visible. The sales budget serves as input for the demand plan. Together with the APP, it is the input for the MPS.

It is possible that more than one alternate scenario is considered when translating the marketing strategy into a sales budget. These alternate possibilities result in more than one possible MPS with a given logistic capacity. Finally, one must choose for one MPS. Therefore, a financial evaluation of the MPS is made in rough form via a rough financial business projection, which processing is explained in the part of IFCP. The treasury management objective that is solved at this level (namely: currency hedging) is also
explained in the part of IFCP. The rough financial business projection is translated into a sales, costs, and investment operational task budgets. Operational task budgets contain information about events that are scheduled to appear [11]. In this time fence, the events of the investment budget are executed: investment invoices are received which are processed afterwards in the financial administration. Financial administration's processing is defined in the financial accounting's body of knowledge. Payment of investment invoices, together with the fulfillment of existing medium term obligations are optimized in medium term treasury management

The new part in FFCP is the target of financial capacity control. This objective is reached via two consecutive steps. In the first step, the necessary financial capacity is derived from the aggregated activity budgets on year basis (which is explained above). Financial requirements are described in aggregated terms (certainly not in terms of specific bank products or applications as this definition is made at an aggregated level, and consistency must be maintained) in a time phased way. There must be a separation between medium term and short term money. The scheme can look like this:

<table>
<thead>
<tr>
<th>Type of Requirement</th>
<th>Type of Money</th>
<th>Total (in m. USD)</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Credit Line</td>
<td>Medium Term</td>
<td>40</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Short Term</td>
<td>25</td>
<td>3</td>
<td>5</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>Capital Raise</td>
<td>Medium Term</td>
<td>120</td>
<td>40</td>
<td>60</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Short Term</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loan</td>
<td>Medium Term</td>
<td>50</td>
<td>10</td>
<td>15</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Short Term</td>
<td>80</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
</tbody>
</table>

Table 1: Time Phased Aggregated Financial Requirements

In the second step, the general scheme is further detailed. Purpose is that one makes here a time phased classification among the strategy of use. These budgets are therefore called "financing task budgets". One will always chose for the cheapest possible financing
strategy, given the knowledge that each financing form has a different cost and can only be used for a limited set of purposes. If for a certain financing form a capacity shortage occurs in a certain period, it is always possible to use a more "general" (= more expensive) form.

An example of the time phased financing task budget classification can be:

<table>
<thead>
<tr>
<th>Type</th>
<th>Detail</th>
<th>Use</th>
<th>Total Amount</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Credit Line (Short Term)</td>
<td>JP Morgan</td>
<td>Trade Notes</td>
<td>20</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Barclays</td>
<td>Temporary</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Shortages</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capital Raise (Medium Term)</td>
<td>ING Bank</td>
<td>Investments A</td>
<td>60</td>
<td>15</td>
<td>25</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>RABO Bank</td>
<td>Investments B</td>
<td>60</td>
<td>10</td>
<td>30</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Loans (Medium Term)</td>
<td>ING Bank</td>
<td>Investments C</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Loans (Short Term)</td>
<td>JP Morgan</td>
<td>Short Term A/P</td>
<td>30</td>
<td>10</td>
<td>5</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Barclays</td>
<td>Refunding Existing</td>
<td>0</td>
<td>30</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 2: Time Phased Financial Task Budgets

7.3.3 Execution Time Fence: unfrozen MPS horizon for detailed projecting purposes

In the Execution Time Fence, the "current year's strategy" is executed. Projections are made with more detail. The necessary detail only becomes available using an MRP explosion. In this time fence, the detailed financial budget projection is executed, which is explained in the part of IFCP. The objective of FFCP in the Execution Time Fence is now twofold. On one side, one tries to project the financial capacity consumption per financing form. This is executed via a dynamic financing activity budget projection. All other elements of the scheme are described in the part of IFCP and serve as input for this projection objective, with one exception: the projected cash budget. In FFCP, one needs not only a cash budget per currency (output of IFCP), a detail per currency per country is needed for the optimization of
payments and collections (see: FFCP objectives in the Short Term Financial Time Fence).

On the other side, purpose is to make a difference calculation between the dynamic financing activity budget projection and the time phased financing task budgets. The time phased financing task budgets contain the available financial capacity on medium and short term basis and the application (use) of the money which is agreed upon at the beginning of the year. The dynamic financing activity budgets on the other hand contain a projection of the use of the money on the basis of the assumptions defined in the time phased financing task budget. The difference calculation between capacity and agreements and projection with this data indicates if a capacity problem will occur. Note that both surpluses as shortages can be considered as “problems”. If a shortage occurs, one is inescapably forced to use a more inefficient financing form. The added value of this system exists in the ability to predict these financing capacity problems a long term in advance. If this is possible, there is maybe enough time left to evaluate all alternatives and chose for the most profitable one.

7.3.4 Short Term Financial Time Fence: two weeks, purpose is financial optimization

In the Short Term Financial Time Fence, disbursements and collections are made. Compared to IFCP, purpose here is to execute these financial transactions an optimized way. Both production and material cost invoices and sales invoices are processed by the financial administration. Cashflows are processed by short term treasury management. In the Execution Medium Term Time Fence, a cash budget per currency per country is available. These cash budgets give the necessary input for optimization in the short term. Main objective is to minimize bank costs related to international money flows and the eventual purchase or sale of foreign currencies. This can be reached when the following data elements are present:
• **Detail of available money per currency per country per time bucket**: this detail is available in separate cash budgets.

• **Detail of the lead time of national and international payments and cash collections.** A payment routing, together with a worldwide network of bank relations must be available to be able to reach this objective.

In Business Logistics, a routing is defined as: “*A set of information detailing the method of manufacture of a particular item. It includes the operations to be performed, their sequence, the various work centers involved, and standards for setup and run...*”[23]. The same idea can be used in Financial Management applications. One must know per payment instrument per bank per destination country how long it takes to execute the payment and the detail of costs involved. Both elements can be found via an appropriate routing definition indicating the sequence of, and lead time (including costs) between parties involved. If payment routing information is filled, it is possible to use optimization algorithms as linear programming (e.g. Simplex method) to minimize bank costs and consequentially to maximize available money [36]. This optimization is only possible if one uses a world wide network of bank accounts when operating in an international distribution environment. Funding on another bank account can be seen as a DRP (Distribution Requirements Planning)-order on the company’s in-house bank [8,14].

These statements make clear that Business Logistics techniques seem very useful to reach FFCP objectives in the short run. The application of Business Logistics techniques in Financial Management is called “Financial Logistics”.

In this time fence it is possible to make a difference calculation between the defined financing task budgets and the actual consumption, in other words: post audit financial capacity control. This output can be useful as learning element when defining next year’s financing task budgets.
7.4 Added value of FFCP

The added value of FFCP is explained using figure 8. The added value must be situated in an integrated planning approach where both financial and logistic plans are optimized. It is only relevant to consider situations where a form of financial planning (infinite or finite) is present. The figure makes clear that it is possible to generate financial planning starting from both an optimized (Finite Logistic Capacity Planning) as well as a non-optimized logistic planning situation (closed-loop MRP planning).

FFCP has little added value when generated from infinite logistic capacity planning results (closed-loop MRP planning). Most added value is obtained when FFCP is calculated immediately after finite logistic capacity planning: in this case one has a financial optimization besides a logistic optimization. Only in this case, one can speak of integral “Enterprise Resource Planning”.

7.5 Conclusion

Finite planning in Financial Management is entirely new. The described concept is called FFCP and is defined at four different time fences: the Strategic Time Fence, the Medium Term Time Fence, the Execution Time Fence and the Short Term Financial Time Fence. Each time fence has its own optimization objectives. FFCP works with the same three input elements as IFCP. They are: the Financial Administration, the Financial Commitments Information System and the Business Logistics Information System (closed-loop MRP). The added value of FFCP is reached mostly when generated on the basis of finite logistics capacity planning results.
8. General conclusion

In this paper, an attempt is made to provide a generic design solution for the business task “planning” in both Business Logistics and Financial Management in a two phased way.

First, a model is presented for infinite planning in this two application areas. For Business Logistics, the existing concept of closed-loop MRP is described, for Financial Management, the new concept of Infinite Financial Capacity Planning (IFCP) is introduced. As infinite planning is coping with mayor drawbacks concerning capacity management, further designing research is necessary. A second model for finite planning in each application area is therefore described. In Business Logistics, the known theory of finite capacity planning is used; whereas for Financial Management, again a new model is presented: Finite Financial Capacity Planning (IFCP).

The ultimate research question of this paper is: do business task that occurs in several application domains have the same objectives and can they be modeled in a generic way. For the business task “planning”, the following conclusions can now be made. When dealing with infinite planning, in both application areas, the objective of requirements planning is reached (see section 6). In closed-loop MRP requirements planning is material requirements planning. In IFCP, requirements planning means money requirements planning. It is described that infinite planning in both areas have the same drawbacks. Sofar, it can be concluded that the business task “planning” has the same objective in both Business Logistics as well as Financial Management. When researching the same phenomenon for finite planning, it is clear that essential differences exist. It is concluded that both constraints as well as resources are quite unique to the application area.
It can be concluded that generic objectives and modeling of the business task “planning” in different application areas is possible in a basic, not-optimized model (infinite planning). When the objectives become complex (finite planning), a solution specific to the application area is to be provided.
Appendix A: Operation of closed-loop MRP

The basic operations of a closed-loop MRP system are carried out by a level-by-level process as follows [42]:

1. The MPS orders are exploded using their bills of material to determine the quantities of first level components needed. The period in which they will be needed is obtained by offsetting the completion dates for the MPS items by their lead times. For components common to more than one end item, these quantities are summed up by need period. For components which also have independent demand as service parts, a forecast of this demand is added. These totals are called gross requirements.

2. The available balance is projected by period. Receipt of an MRP order is planned in the first period in which the available balance is projected to be negative, or less than a safety stock if there is independent demand.

3. A lot size is determined for the MRP order using one of the lot sizing techniques. This increased to adjust for possible scrap.

4. Steps (2) and (3) are repeated until all requirements through the planning horizon are covered by planned MRP orders.

5. A release date is determined for each order by offsetting the due date by the leadtime.

6. Steps (1) to (5) are repeated for level 2 components, then level 3 components, etc. until orders are planned for all components and raw materials controlled by MRP.
Appendix B: Content of the MPS

The MPS typically contains the following information [42]:

*Forecast*: independent demand
If the item is a final product, this will be the forecast of total demand. If it is a component of appearing in the second level of a two level MPS, this will be service demand.

*Production forecast*: calculated dependent demand
Only applicable when the item is a component.

*Actual demand*: promised customer orders
Promised customer orders can be seen as consumption of demand forecast.

*MPS*: the scheduled receipts of released and firm planned orders

*Projected available balance*: projection of the on-hand inventory.
The projected available balance is calculated by adding the starting on hand plus cumulative MPS minus cumulative demand.
Appendix C : Content of the MRP

For each component or raw material, the MRP shows the following information by time bucket [7] :

1. The gross requirement
2. The scheduled receipts of released orders
3. The current on hand balance and projected available balance
4. The scheduled receipts of planned orders
5. The scheduled releases of planned orders

Appendix D : Content of the Contribution Margin Method

The contribution margin method is a management account method which contains the following elements [37] :

\[
\text{Turnover} \\
\quad \text{Costs of Goods Sold} \\
\quad \text{Material Costs} \\
\quad \underline{\text{Production Costs}}
\]

\[
\text{Profit Margin}
\]

The content of each element is explained next :
**Turnover**

The single site MPS contains amounts for both the demand forecast and customer orders (consumed forecast) [26]. Turnover is therefore defined by two parts: a detailed part (customer orders) and a general one (unconsumed forecast), both in the unfrozen as well as in the frozen part of the MPS. Even in the unfrozen part, unconsumed forecast can occur: this is production capacity which remains available in the short run [6]. The detailed part refers to actual sales orders. Actual sales orders contain the exact number of units sold at customized sales prices, terms of payment, taxes and currencies used. All units defined in consumed demand forecast are processed with this level of detail. The general part refers to the non-consumed demand forecast (demand forecast minus consumed demand forecast). These units must be processed with a default sales price and prefilled assumptions concerning currencies used, taxes and terms of payment. Correct detail only becomes available at the moment of real consumption via sales orders.

Note that terms of payment and taxes data are fully redundant for the calculation of the contribution margin scheme. The reason they are mentioned here is, that the detailed financial business projection in form of a projected financial masterplan is required for some applications on a one year's horizon. This projection can only be realized in a correct way with detailed data that becomes available via the bill of materials (BOM) explosion and the application of routing data.
Costs of Goods Sold

Costs of goods sold are all sales’ effort costs involved when selling the product. For projected purposes, one has to make estimations of these costs. This estimate is reflected in the sales costs’ budget.

Material Costs

The frozen part of the MPS is exploded and generates a time phased material requirements plan in form of purchase advise orders (considering inventory on hand) and production advice orders [7].

The driver which generates the plan is the bill of material. Advice orders are generated on a default supplier, which contains all necessary financial detail information: terms of payment, currency and tax percentage to be used. Detailed financial planning can be established with this data.

Production Costs

The production planning is generated via a quantity dependent routing during the BOM explosion run. A routing is a sequence of operations per work center used [23]. Operations only contain data concerning the planned lead time per production lot size. This information must be enlarged with financial information for completing the projected income statement and the projected cash budget.
Appendix E: Infinite and Finite Financial Capacity Planning:

Possible Applications

Treasurer's insight in the liquidity status of all currencies used

With the availability of projected cash budgets in different currencies, the treasurer has an overview of the position in different currencies over different time periods. With these statements, the treasurer is aware of shortages a long period in advance and can negotiate the appropriate loan for it. Besides this, he has detailed information concerning the volume in currencies, which he can eventually hedge.

Financial Director's and General Manager's insight in the company's overall liquidity situation

All cash budgets per currency aggregated and converted to home currency give the consolidated cash budget per company. This statement contains the overall financial status of the company. This "general" cash budget, together with the projected income statement gives information concerning the liquidity and the profitability of the company to Financial Directors and General Managers.
Financial or General Manager’s simulation tool for evaluating future reality and consequences of alternatives

IFCP can be used to project the future in financial terms by defining assumptions concerning the future. Scenario analysis, difference and consolidation calculation are possible. A great variety of financial simulation can be done: e.g. the simulation of alternate marketing plans, financial consequences of manufacturing projects, and so on. The great benefit is, that consequences are presented on both cost as well as liquidity side.

Treasurer’s insight in consequences of financing options

The treasurer can see consequences of fluctuations in interest rates, variations in terms of payment, taxes and corporate tax. He can also use this output to prepare the discussions with third parties. He can see if the loan he will negotiate with banks really solves the financial problem without creating another one.

Appendix F: Financial Master Budget

The Financial Master Budget consist of three linked financial statements:

- The Projected Balance Sheet
- The Projected Income Statement
- The Projected Cash Budget
A standard layout of these three statements is given next:

**The projected Balance Sheet**

<table>
<thead>
<tr>
<th>ASSETS</th>
<th>LIABILITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Assets</td>
<td>Current Liabilities</td>
</tr>
<tr>
<td>Cash and Short term Investments</td>
<td>Notes Payable</td>
</tr>
<tr>
<td>Accounts Receivable</td>
<td>Accounts Payable</td>
</tr>
<tr>
<td>Inventories</td>
<td>Income Tax Payable</td>
</tr>
<tr>
<td>Prepaid Expenses</td>
<td>Accrued Liabilities</td>
</tr>
<tr>
<td>Investments</td>
<td>Current portion of Long Term Debt</td>
</tr>
<tr>
<td>Property, Plant and Equipment</td>
<td>Long Term Debt</td>
</tr>
<tr>
<td>Less: Accumulated Depreciations</td>
<td>Deferred Credits and Other Liabilities</td>
</tr>
<tr>
<td>Intangible and Miscellaneous Assets</td>
<td>Stockholders’ Equity</td>
</tr>
</tbody>
</table>

**The projected Income Statement**

Sales (Turnover)

- Cost and Operating Expenses
  - Cost of sales
  - General and Administrative Expenses
  - Selling and Delivery Expenses
- Other Expenses
  - Gain on Sale of Property
  - Interest Expense
  - Interest Income

Total Cost and Operating Expenses

Income Before Income Taxes

- Income Taxes

Net Income

To: Shareholders
  - Bonusses
  - Reserves
  - Transferred Profit
The Cash Budget (according FASB 95 regulations)

OPERATIONAL CASHFLOW
- Cash Inflows Receipt Sales
- Cash Outflows Payment Materials
- Cash Outflows Payment Salaries
- Cash Outflows Payment Other Operations Costs
- Cash Outflows Payment Sales Tax Balance

Operational Cashflow

NON-OPERATIONAL CASHFLOW
- Cash Inflows New Loans
- Cash Inflows Grants
- Cash Inflows Capital Raise
- Cash Outflow Capital and Interest Payment Existing Loans
- Cash Outflow Payment Corporate Tax
- Cash Outflow Payment Bonusses and Dividends

Non-Operational Cashflow

TOTAL CASHFLOW
**Glossary** [23,48,49]

**Budgeting**: The orderly presentation of the anticipated results of a plan, project or strategy.

**Bill of Material**: A listing of all the subassemblies, intermediates, parts, and raw materials that go into a parent assembly showing the quantity of each required to make an assembly. It is used in conjunction with the master production schedule to determine the items for which purchase requisition and production orders must be released. There is a variety of display formats.

**Black and Scholes Option Pricing Model**: The notion that the price of a call option should be such that the rate of return on a fully hedged portfolio is equal to the risk-free rate of interest has been used by Black and Scholes (1973) to derive a more generally applicable procedure for valuing an option.

**Capacity Requirements Planning (CRP)**: The function of establishing, measuring, and adjusting limits or levels of capacity. The term "capacity requirements planning" in this context is the process of determining in detail how much labor and machine resources are required to accomplish the tasks of production. Open shop orders and planned orders in the MRP system are input to CRP, which "translates" these orders into hours of work by work center by time period.

**Closed-Loop MRP**: A system built around material requirements planning that includes the additional planning functions of sales and operations (production planning, master production scheduling, and capacity requirements planning). Once this planning phase is complete and the plans have been accepted as realistic and attainable, the execution functions come into play. These include the manufacturing control functions of input-output.
(capacity) measurement, detailed scheduling and dispatching as well as anticipated delay reports form both the plant and suppliers, supplier scheduling, etc. The term “closed loop” implies not only is each of these elements included in the overall system, but also that feedback is provided by the execution functions that the planning can be kept valid at all times.

**Consolidation**: For a variety of reasons, a single economic entity may exist in the form of a parent and several legally separate subsidiaries. A consolidation of the financial statements of the parent and each of its subsidiaries results if it operates, financial positions and changes in cashflows of an affiliated group of companies under the control of a parent, essentially as if the group of were a single entity.

**Discounted Cashflow Methods**: Capital budgeting methods that discount cashflows to account for the time value of money: internal rate of return, net present value and profitability index.

**Financial Master Budget**: Three linked financial statements together: the projected balance sheet, the projected income statement and the projected cash budget.

**Hedge**: Take equal but opposite financial positions so that gains on one position offset loses on the other. Method to avoid currency risks.

**Internal Rate of Return**: Discount rate that causes equity between the present value of cash inflows and the net investment cash outflow.

**Net Present Value**: Present value of cash inflows less net investment cash outflows
**Offset for leadtime**: A technique used in MRP where a planned order receipt in one time period will require the release of that order in an earlier time period based on the lead time for the item.

**Payback Period (Method)**: Time required to recover a project net investment cash outflows through incremental cash inflows.

**Projected Balance Sheet**: The projected balance sheet can be seen as the synthesis statement where the projected result (calculated in the projected income statement) and the projected cash balances (calculated in the projected cash budgets) are embedded. The historical balance sheet is used as starting point.

**Portfolio Analysis (Theory)**: A portfolio is any combination of assets or investments. Portfolio analysis is used to determine the return and risk characteristics for any combination of assets. It involves the identification of specific characteristics that enable a manager or investor to systematically reduce risk through diversification; that is, holding more than a single asset in a portfolio. Note that in the context here: an asset is a volume in a certain currency.

**Projected Income Statement**: The projected income statement is the statement in which the projected results are derived in full detail (revenues minus costs). There is a separation between the economic result, the financial result and the exceptional result. Company tax and profit distribution at the end of the year must be considered. During the projected financial year, intermediate results per period are transferred to the next period.
Projected Cash Budget: In the projected cash budget, detail is given in form of operational and non-operational cash in- and outflows as described in the FASB-95 regulation. In IFCP, a cash budget is defined per currency. In this way, balances of bank accounts in the same currency are aggregated independent if the location of the bank is in the home country or abroad. This will be different in FFCP.

Rough Cut Capacity Planning: The process of converting the production plan and/or the master production schedule into capacity needs for key resources: work force, machinery, warehouse space, suppliers’ capabilities, and in some cases, money. Bills of resources are often used to accomplish this. Comparison of capacity required of items in the MPS to available capacity is usually done for each key resource. RCCP assists the master scheduler in establishing a feasible master production schedule.

Routing: A set of information detailing the method of manufacture of a particular item. It includes the operations to be performed, their sequence, the various work centers to be involved, and the standards for setup and run.
References


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