MASTER

Startrek supply chain planning : modeling, optimization and generalization

Camp, H.P.J.

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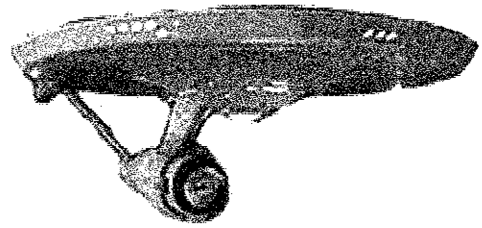

Unilever Startrek

STARTREK SUPPLY CHAIN PLANNING
Modeling, Optimization and Generalization

MASTER THESIS

Bart H.P.J. Camp
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Eindhoven University of Technology
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STARTREK SUPPLY CHAIN PLANNING
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Supervisors Unilever
First Supervisor David Grandt
Second Supervisor Claudio Bandiera

Supervisors Eindhoven University of Technology
First Supervisor Prof. Dr. Ir. A.G. de Kok
Second Supervisor Dr. Ir. C.W.G.M Dirne

Author
Bart H.P.J. Camp
Student at Eindhoven University of Technology
Faculty of Technology Management
Study: Industrial Engineering and Management Science
ID Nr.: 432567

I ABSTRACT

In 2001 the Startrek project is started in Unilever Asia. This project covers the closure of the tea factory in Australia and the transfer of teabag production to the tea factories in India and Indonesia. This research assignment analyses this supply chain with the goal of minimizing the required inventory capital, while satisfying the final customers in Australia. A quantitative modeling and optimization study has been performed, which determined significant opportunities for inventory reduction. The applied procedure is generalized, to be applicable in other supply chains. Options for integrated and collaborative supply chain planning have been evaluated and a plan for implementation of the recommendations has been developed.

II EXECUTIVE SUMMARY

II.1 Introduction

Unilever is the world's leading tea company and in value outsells its nearest competitor, Tetley, by a factor five. The World Class Supply Chain Strategy in the Unilever global "Path to Growth" program aims to create a more integrated manufacturing network and improve the leverage of scale by concentrating volume in lead manufacturing sites. Within the beverages category a Bush-to-Brand supply chain vision is developed to restructure the tea supply chain: *"Move the business from a "functional" or local supply chain to a global supply chain"* This leads to a reduction of the tea packing factories from around 40 to 20. One of the projects in this program is the Startrek project. In this project the tea-packing site in Australia, is closed and its production of teabags is moved to the tea factories in India and Indonesia. This new supply chain structure is shown in figure II.2. Previous experiences with moving production from Australia to Indonesia has shown that this can lead to significant increases in inventory and a decrease in service to the Australian customers. Therefor an analysis of the supply chain was started to determine the optimal planning policy and the required inventory levels to meet the service requirements of the Australian customers, based on the latest Supply Chain Optimization models developed at the Eindhoven University of Technology. In Unilever a global working capital reduction initiative was started. The generalization of this analysis will be positioned within this program, to achieve further benefit for the Unilever Organization. Based on these consideration the following goal for this research project was formulated:

- *Design a Supply Chain Planning policy for the Startrek Supply Chain, with the goal of minimizing the inventory value from packing site to VDC, while meeting the fill-rate target of the customers at the VDC of 97%.*
- *Generalize the modeling and optimization procedure to make it applicable for other food supply chains.*

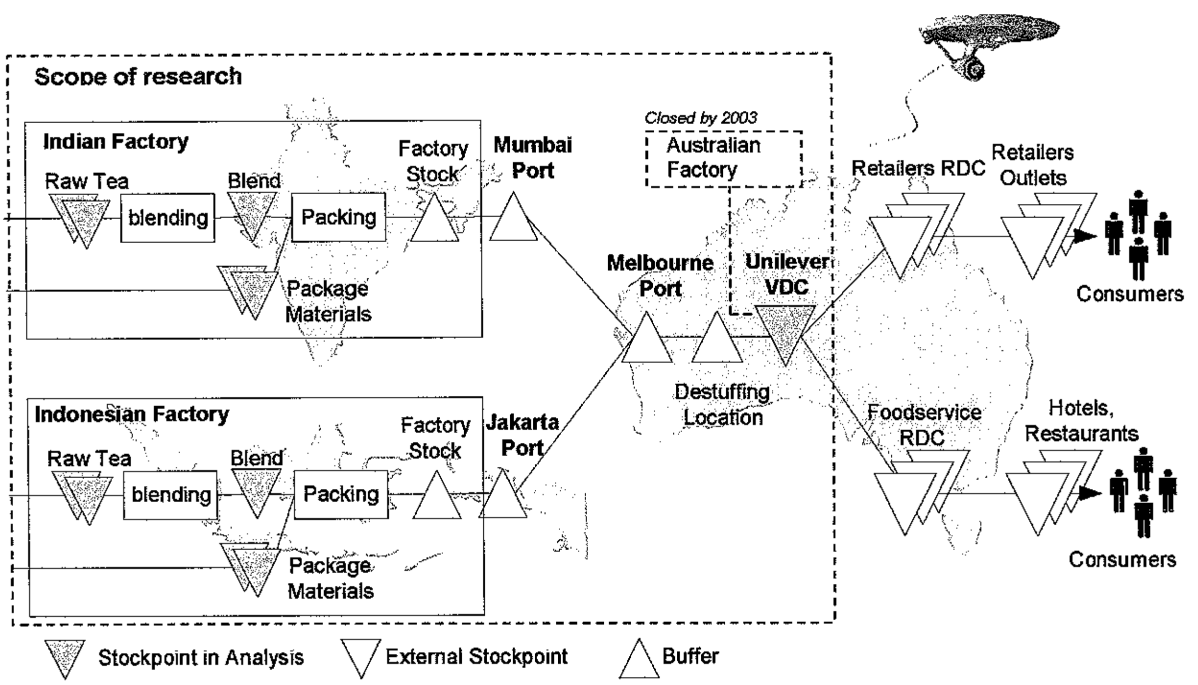
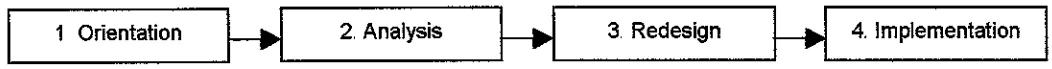


Figure II.1 The Startrek Supply Chain

The research project was performed at the Foods Supply Chain Department of the Asia Business Group and organized in the following four phases:



II.2 ORIENTATION

The purpose of the orientation is to develop a detailed understanding of the organization, product, market and business processes, as a foundation for the analysis. A detailed description of the business processes is presented along the functions of the SCOR model: Plan, Source, Make, Deliver. The Startrek Supply Chain Characteristics are summarized below:

- *Low complexity*. The number of final products is limited to 18 teabag SKUs, with consist of 68 components, with a high commonality. Each factory uses only a single machine type for its Startrek production, with a straightforward routing. All teabags are made-to-stock
- *Low uncertainty and dynamics*: The teabags are sold in a mature market, with a 3% growth in 2001. The variability of demand is low, with an average coefficient of variation of weekly demand of 0.4. The reliability of suppliers of materials and the production is expected to be good after the ramp-up. The product structure is stable, with only an occasional promotional package.
- *High flexibility*: There is a high commonality among package materials and blends. The analysis showed that the capacity is sufficient to deal with the variability of demand.

II.3 ANALYSIS

The analysis was structured along a general framework for Supply Chain Performance improvement. Within this framework, the focus of this research is on the Tactical Supply Chain Design, concentrated on optimizing the Material Coordination function, by determining the optimal inventory allocation. The Analysis concluded with the following four areas for supply chain performance improvement:

1. Reduction of the planning interval and planning lead-time

Currently the Australian planners issue purchase orders to the factories with a firm horizon of 13 weeks. Figure II.2 shows that this is 5 to 7 weeks longer than the minimum reaction time (the lead-time of production and distribution). Orders are issues in on a monthly interval. This long lead-time and planning interval lead to higher safety stock requirements. Therefor a quantitative analysis is performed to determine the effect of a reduction in planning interval and –lead-time.

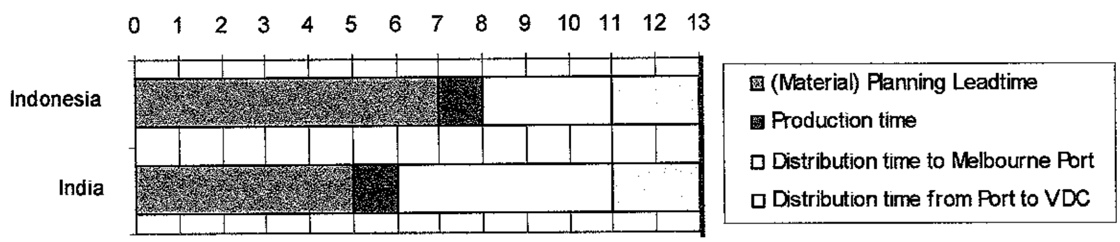


Figure II.2 Lead-times in weeks, from arrival of order at factory to available for sales in VDC

2. Optimization of the safety stock parameters

Safety stock parameters are currently determined based on a "rule of thumb" (where safety stock is set close to the time it takes to produce and deliver the teabags), or based on past experiences (to avoid past stock-outs due to unannounced promotions, production problems, or sudden changes in forecast). These parameters were expected to be to high. Therefor a quantitative analysis is performed to determine the optimal safety stock parameters

3. Supply Chain Planning: Factory-based Replenishments

Supply Chain Planning is performed by three isolated planning units: The Australian Third Party Planners, Factory Planners and Tea Buyers. The communication that takes place is in the form of firm orders, or requirements. As a result each party "optimizes" their section of the supply chain, by setting their local safety stock targets to satisfy their downstream customer. This leads directly to excess upstream stock-building that does not add any value to the final customer ("dead stock"). The most apparent decomposition is the fact that the Australian planners determine the teabag purchase orders. Afterwards these orders are adjusted to the capacity and material restrictions at the factories, which replenish the stock. This effectively means that two parties are controlling a single stockpoint. Therefor the alternative of factory based replenishments is evaluated, where the factory planners receive sales forecast and inventory status information directly, which would be enable them to optimize the required stock replenishments, while taking the material and capacity restrictions into account.

4. Integral Supply Chain Planning

The planning units plan their purchase orders and production, based on MRP logic. This is a top-down calculation, without any check on material, or capacity constrains, which often results in infeasible plans. A material shortage is reported as an exception message that has to be manually solved. No support is given to optimize the allocation of the shortage (a bottom-up procedure). The inflexible and little user-friendly interfaces of the BPCS and MFG/Pro further complicate this matter. For these reasons, the planning is performed in spreadsheets, where the requirements are manually adjusted to the available materials and capacity. Orders are generated based on the safety stock parameters. These parameters are required to run the system, but no structured approach is available to link these parameters with the service performance to the final customer. Combined with the discussed lack of information sharing, this leads to excess stock in the supply chain. To avoid this local sub-optimization of the inventory, an integral supply chain planning policy is required. An integral Supply Chain Planning policy, determines its control parameters, material and resource releases, based on the requested service to the final customer, its demand and the material and capacity situation across all units in the supply chain. Currently two fundamentally different types of systems are available, who implement two different view on Supply Chain Planning:

- Advanced Planning and Scheduling Systems, based on a deterministic view of Supply Chain Planning
- Material Availability Planning, based on a stochastic view of Supply Chain Planning

II.5 REDESIGN - CONCLUSIONS

Redesign describes the quantitative and qualitative analysis that is performed along the four areas of performance improvement. The potential for performance improvement, the effect on business processes and the required organizational change and IT systems is discussed. The conclusions are presented in this summary.

1. Reduction of Planning Lead-time and Interval, leading to a more reactive supply chain

To evaluate the effects of planning lead-time and interval, different scenarios of the Startrek Supply Chain have been modeled in the Supply Chain Optimizer, based on the modified base stock (MBS) policy. The evaluation of alternative policies is presented in table II.1.

Table II.1 Stock Control Policies and Optimization

	MRP	LP	SCO (MBS)	SO (R,s,nQ)
Material Feasible Plans	No	Yes	Yes	No*
Capacity Feasible Plans	No	Yes	No	No
Lotsizing	Yes	Yes	No	Yes
Lead-time	Constant	Constant	Constant	Variable
Safety Stock Setting	None	End Items	Supply Chain	Local
Optimization	No	LP and DE**	Analytical	Analytical
Optimization Results	--	+ ***	++ ***	+/-

* Can be "forced" by high internal fillrates
** Linear Programming Model + Discrete Event Simulation
*** Based on [De Kok, 2002b]

The benefits of this policy are the following:

- MBS avoids dead stock, by not ordering more of a component than the final product cover of components with a longer lead-time, which are used in the same end product
- MBS allocates shortages in balanced way.
- MBS calculates the minimum safety stocks, required to satisfy the customer service target and avoids access safety stock downstream that doesn't add value to the customer.

A reduction in planning lead-time and interval leads to a decrease in the stock teabags and an increase in package materials and teabag stock. The net result is a decrease in the overall safety stock value in the supply chain. Planning in a weekly interval under minimum firm horizon (planning lead-time = 0), results in a decrease of safety stock value of 10%, compared to the extreme case where planning is done on a monthly basis under a firm horizon equal to the maximum cumulative lead-time. This relatively small decrease is a result from the low variability in demand. A further benefit is the fact that the supply chain is now able to react faster to unexpected changes in demand (a reaction time of 6 weeks for Indonesia and 8 weeks for India, instead of the current 13 weeks, plus the one-month planning interval).

2. New Safety stock targets
The current safety stock targets were not determined by an explicit procedure, but by a "rule of thumb". The results of the best MBS scenario showed a great savings potential for the safety stock of teabags, filter paper and package material, which were further investigated.

Teabag safety stock working capital savings: 55%
One of the motivations for the high current targets was the effect of the Australian Aqis department, who randomly checks containers of teabags. This effect has been modeled in a specific discrete event simulation. Combining the results from this simulation with the "worst case scenario" of the MBS policy leads to safety stock targets between 2 and 6.1 for the individual teabag SKUs. Comparing these targets with the generic target of 8 weeks leads to a saving of 55% of the safety stock value.

Filter Paper safety stock working capital savings: 59%
Filter paper, is a common component for all Startrek teabags and is ordered in a large lotsize of a 20ft container. In the Indonesian Factory this filter paper is also shared with the teabags for the local market, produced on the same machines. To model this (shared) lotsize an additional optimization is performed in the Stockpoint Optimizer Module of the SCO tool, which models a single stockpoint system. Material Feasibility is ensured by a high local service target of 98%, which is similar to the current, locally optimized and controlled situation. The resulting safety stock targets, closely matched the MBS results and have been used for the new recommended target of one week safety stock. This leads to a saving of 59%, compared to the current targets.

Raw tea safety stock working capital savings: 65%
Like Filter Paper, raw tea is also ordered in large lotsizes of a single 40ft container per tea type. The optimization was set up in the same way as for filter paper in the Stockpoint Optimizer module and concentrated on the non-seasonal common teas. The resulting safety stock targets lead to a saving of 65% for the raw teas in the Indonesian factory, as the Indian factory already minimized their safety stock. It was also concluded that replacement of slow-moving tea types with faster moving similar teas could significantly reduce their cycle stock, resulting from the large order quantities: blend harmonization (figure 5.6). All LTS tea buyers use the ITS/TPS, which contains a standard safety stock target of 3 weeks for these common teas. The analysis showed that for all teas, besides the extremely slow-moving ones, a safety stock of one weeks would be sufficient to deliver a fillrate above 98% to the factory. Reducing this target in other secondary tea buying units as well, will results in further savings. The MBS optimization also showed that is was preferred to move the tea stock closer to the customer by blending the blends when the raw tea is available, instead of keeping raw tea stock and blending based on the firm production schedule.

Development of Supply Chain Optimizer tool for rapid supply chain optimization
The SCO tool enables the modeling of a generic supply chain and uses the MBS policy in the SCO module to determine the safety stock requirements from a supply chain perspective. The Stockpoint Optimizer (SO) module, offers the functionality to include lotsizes and lead-time variability (in locally optimized stockpoints). This tool has been further developed during this project and has proven its usefulness in efficiently determining working capital savings. A user-friendly interface and documentation has been developed in cooperation with Asia Supply Chain Department to apply this modeling and optimization procedure in other Unilever supply chains.

3. Factory Based Replenishments. leading to flexible and effective teabag replenishments
Currently the teabag stock at the VDC is controlled by the Australian third party planners, who issue firm purchase orders to the factories on a monthly basis, based on the available inventory and the forecast, with a firm horizon of 13 weeks. The factories plan their production plan based on this input. In the situation of factory replenishments the factories plan their production and deliveries directly, based on the available inventory, forecast, resource and material availability. In this way all constraints can be taken into account in the replenishment decision and the plan can be adjusted to the most actual situation up to the actual production. This enables the implementation of a weekly planning interval, with a minimum firm horizon (production plus distribution). The redesign showed that this process can be supported, without considerable investments, by inventory and forecast information, available in the SAP/APO business warehouse. Australia can still control its stocklevels, by setting the safety stock targets for the teabag stock.

4. Collaborative Supply Chain Planning, using Material Availability Planning software

Currently teabag, package material and raw tea stock is managed by a different party, which bases its replenishment and purchase decisions on local information, processed in a standard MRP system. This leads to local sub-optimization of the inventory and little supply chain coordination. After evaluating the current MRP system, supply chain planning in Advanced Planning and Scheduling (APS) systems and Material Availability Planning (MAP), MAP has been chosen as the optimal solution for introducing integral supply chain planning in the Startrek Supply Chain (table II.2). The MAP tool generates material feasible plans in minutes in a collaborative planning environment. In this environment the third party planners, factory planners and tea-buyers hold a NetMeeting on a weekly basis to determine the optimal supply chain planning. The MAP tool provides support for solving bottlenecks in the supply chain and facilitates interactive planning. This means that the planners can adjust the generated plan to lotsize-, capacity restrictions and other considerations and receive an alternative plan material feasible plan in minutes. This can lead to a further decrease of inventory and lead-time and an increase in resource usage, supply chain visibility, trust and knowledge.

Table II.2 Supply Chain Planning Policies

	MRP	APS*	MAP
Material Feasible Plans	Manual	Yes**	Yes
Capacity Feasible Plans	Manual	Yes	Manual
Lotsizing	Yes	Yes	Manual
Safety Stock setting	Manual	Manual	Manual
Calculation Speed	Instant	Hours	Minutes
Feedback** (pegging)	Forward	**	Forward and Backward (Bottlenecks)
Feedback Support**	None	None	Bottlenecks
Decision Making	(De)central	Central	Collaborative

*Master Planning
**MPS-level, but BOM explosion done by MRP
***Besides re-planning

II.6 IMPLEMENTATION

This paragraph presents a general time-phased planning for the implementation of the recommendations.

Currently in progress: Implementation of the SCO modeling tool in Unilever

The Supply Chain Leadership Team has decided to integrate this tool with the current Foods Benchmarking program. The goal of the SCO tool is to analyze the results of manufacturing decisions on the inventory management and determine the required safety stock targets, for the related stockpoints. This is in line with the global working capital reduction program. The Tea Technology Institute is responsible for this benchmarking program and is currently evaluating the SCO tool.

First Quarter 2003 – Implementation of reduced safety stock targets

A first requirement for the implementation of the new safety stock targets is the finalization of the production transfer from Australia to Indonesia and India and a stabilization of the production and delivery process. This is planned to be achieved by the end of 2002. The new safety stock targets can be implemented, without any changes to the current organization or systems.

Fourth Quarter 2003 – Factory Based Replenishments

Before Factory Based replenishments can be implemented, the safety stock targets for the teabags have to be well defined and the required IT infrastructure must be available. This is expected to be achieved after the first implementation phase in the fourth quarter of 2003.

Fourth Quarter 2005 - Collaborative Supply Chain Planning, using MAP

The Factory Replenishments were the first step towards supply chain integration. The next step towards collaborative supply chain planning, using MAP will involve all planners in the Startrek Supply Chain, a structural change of planning methods (from local MRP to collaborative MAP) and significant changes to the IT infrastructure.