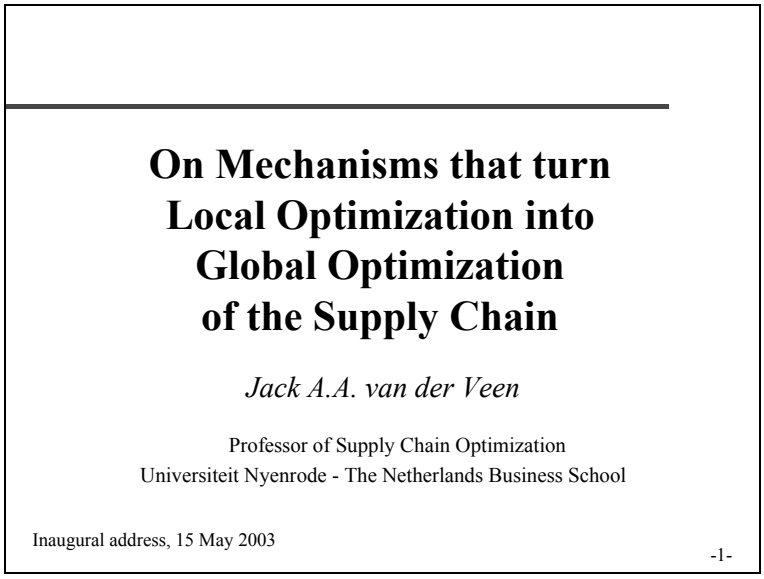
On Mechanisms that turn Local Optimization into Global Optimization of the Supply Chain[1]

Prof.dr. Jack A.A. van der Veen[2]



[SLIDE 1]
Leden van de Raad van Toezicht,
Members of the International Advisory Board,
Mijnheer de President, Mijnheer de Decaan,
Dear colleages, Dear students and alumni,
Gewaardeerde zakelijke relaties,
Familie, vrienden en Cangeroes,
En voorts u allen die door uw aanwezigheid van uw belangstelling blijk geeft,

[1] This document contains the full text and all the PowerPoint slides of the inaugural address of 15 May 2003 at Universiteit Nyenrode

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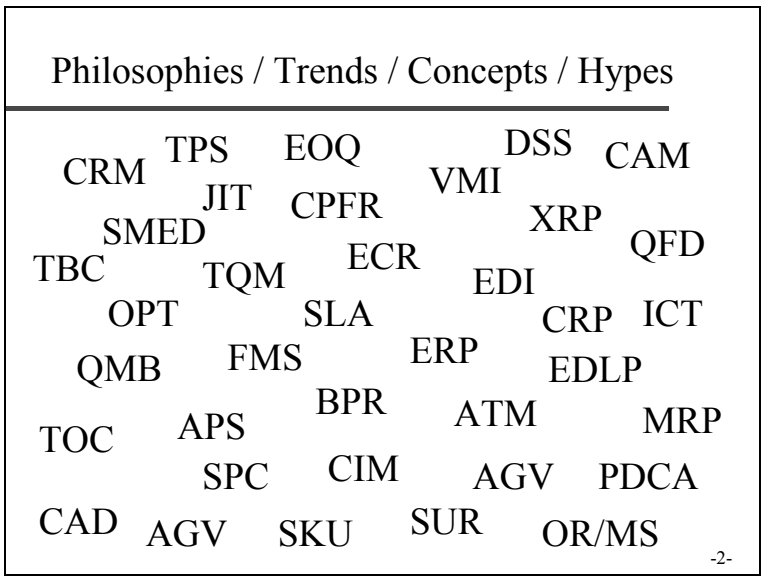
In a way this inaugural lecture marks my twelve and a half year anniversary at Universiteit Nyenrode. Over the last couple of weeks many people have asked me why it took me more than three years to give this inaugural address. Finally I found an answer. Namely that I wanted to make this particular opening statement. So, today marks my 12 ½ years anniversary at Nyenrode. It is fair to say that since I came to Nyenrode in December 1990, the world has drastically changed. Of course I do not claim any causal relation, don't blame me! But the Nyenrode world, my personal world and the Business world indeed have changed quite drastically.

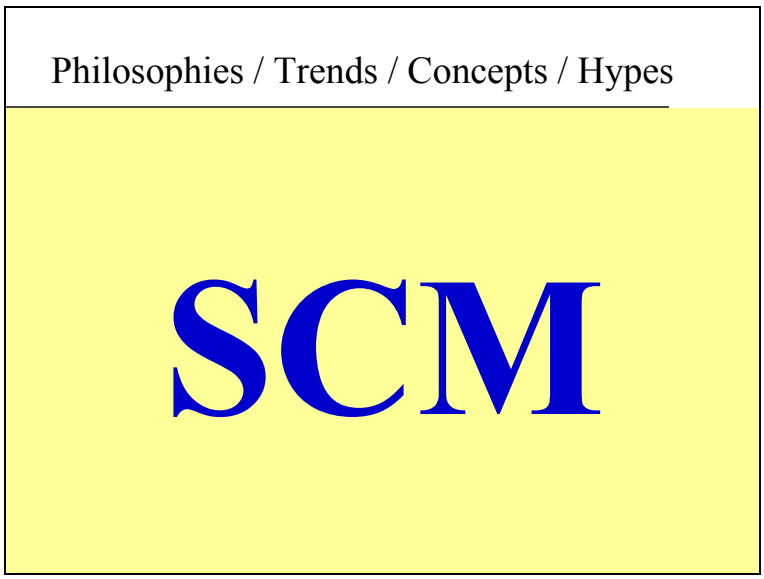
Although I am sure that some of you would find this far more interesting, I will not get into my reflections on the changes at Nyenrode. And I will also not discuss the developments in my personal life. Instead I will focus on the field of management education.

Over the last 12 ½ years the field of Business Administration has seen many new trends, ideas and concepts. Some of them were even announced as philosophies or still even better; a new paradigm! Also, many of these ideas turned into hypes. That is, they disappeared almost as fast as they became immensely popular.



[SLIDE 2] More frequently than not, a philosophy is given a tree-letter acronym. It sometimes seems like a hype is not an hype unless there is a three-letter acronym associated with it. Since nowadays fantasy is running out, also four-letter acronyms come into play. This slide shows some of the concepts that I came across in my area of expertise. The little quiz is that if you can proof that you know all of these, you are eligible for an MSc or MBA degree of your liking. In this context it is maybe worthwhile noting that MSc, PDP and MBA are three letter acronyms as well!

For a reason that I find hard to explain, my professional interest over the last 7 years has been with one of these upcoming concepts namely supply chain management. First, it is to be said that Supply Chain Management has many features of a hype. At least the necessary condition is fulfilled: it can be abbreviated to a three-letter acronym, namely "SCM".



[SLIDE 3] The term “Supply Chain Management” came up around the mid-nineties. And as typically for a hype, before we knew it, the term Supply Chain Management was adopted by virtually everybody. The purchasing people saw it as a new name for at least a subset of their activities. In Logistics there were many people who simply renamed their field as Supply Chain Management as they believed this sounded much sexier than simple Logistics. When talking about sexy, Marketeers are not far away. Also Marketing adopted Supply Chain Management as their activity. But then, of course, Marketing always has to do things differently, so they called it *Demand* Chain Management. The underlying ideas however, were exactly the same.

The result of this renaming business is a total chaos. It created an enormous confusion over terminology. The situation today is that if you ask 10 managers what they think that Supply Chain Management is, you most probably get 10 different answers.

Even more serious is the fact that the key ideas of Supply Chain Management are flooded by old and well-known ideas. This created the impression of “old wine in new bottles” or “the emperors new clothes”. The fundamental and valuable new ideas of Supply Chain Management are obscured by old ideas in such a way that many people have lost interest.

Clearly, in this situation it is the role of a business school professor, like myself, to explain the public what is really new about Supply Chain Management, to distinguish the humbug from the fundamental conceptual ideas and to put the new concepts in perspective.

Supply Chain Management

- Definition:

  Management activities focused on the coordination of several entities in the supply chain in order to optimize the entire supply chain as it were one unit, rather than optimizing each entity separately

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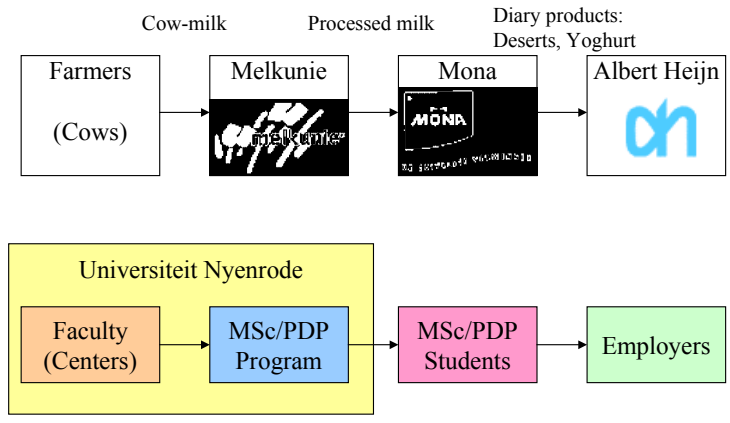
[SLIDE 4] It is with this in mind that at the start of this lecture, I will spend some time on explaining what I feel that Supply Chain Management is. So, let me start with a definition of Supply Chain Management. I can understand that to you in the audience this comes across as being a rather boring exercise. Yet another academic that has to define the obvious. But unfortunately the definition is really required to understand where I am coming from. And it is also necessary for understanding my key message. So, don't switch off now, please bear with me.

On this slide a workable definition of Supply Chain Management is given. There are several words important words here. The first are "supply chain" and "several entities". To show what this means, let me give two simple examples of supply chains.

Entities in Supply chains



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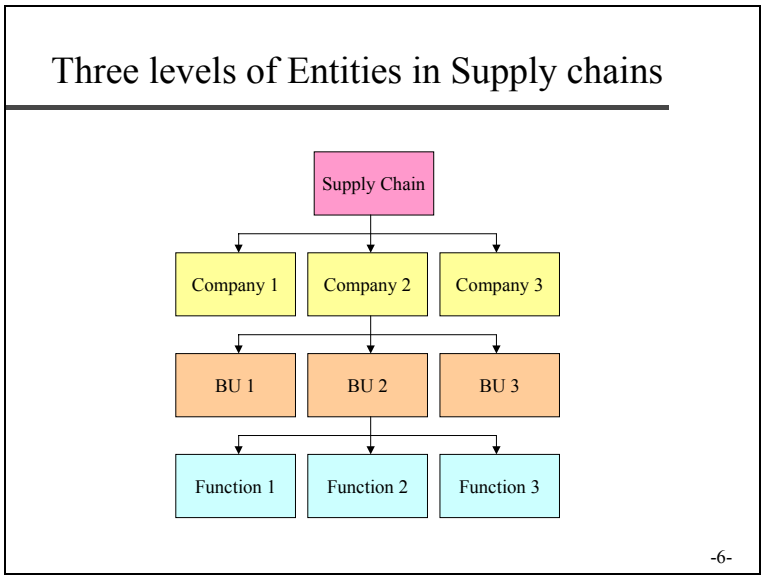
[SLIDE 5] The first example shows the supply chain of diary products up to the store of Albert Heijn. Since the opening of this wonderful Albert Heijn Building, the unwritten law at

Nyenrode is that Albert Heijn is to be mentioned at least once in each lecture. So that point is now checked.

The second example shows the supply chain of our programs at Nyenrode. The little arcs in both supply chains represent buyer-supplier relationships. So, for example Albert Heijn buys the deserts from Mona and the Nyenrode centers sell their courses to the MSc program.

It is to be noted that supply chains exist for physical products but also for services. Furthermore, the entities can be different organizations but also different units within one organization.

If we take this one step further we can sketch the following situation.



[SLIDE 6] A supply chain consists of several independent autonomous organizations like Mona en Albert Heijn. An organization may consist of various Business Units. For instance a company like Unilever has two global divisions namely Home & Personal Care and Unilever Bestfoods, each of which are divided in several Regions. Each of these Regions can be considered as a Business Unit. Within a Business Unit there usually are various departments or functions like Purchasing, Operations, Marketing and Logistics. All these companies, business units and functions are entities in supply chains.

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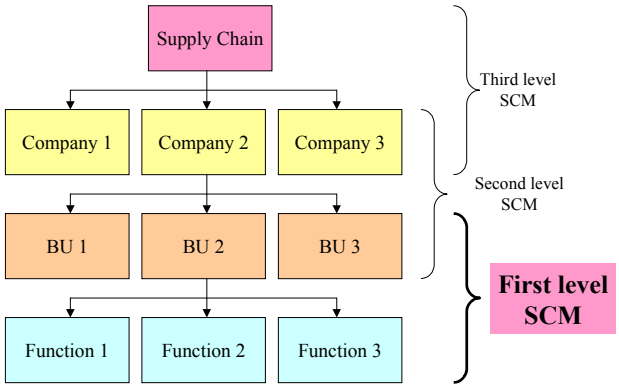
[SLIDE 7] The other words of importance in the definition are “coordination” and “one unit”. The key idea is that the several entities should work together to get to the best result for the combined entity. Depending on who the entities are, we can establish at least three levels of Supply Chain Management.

Three levels of SCM



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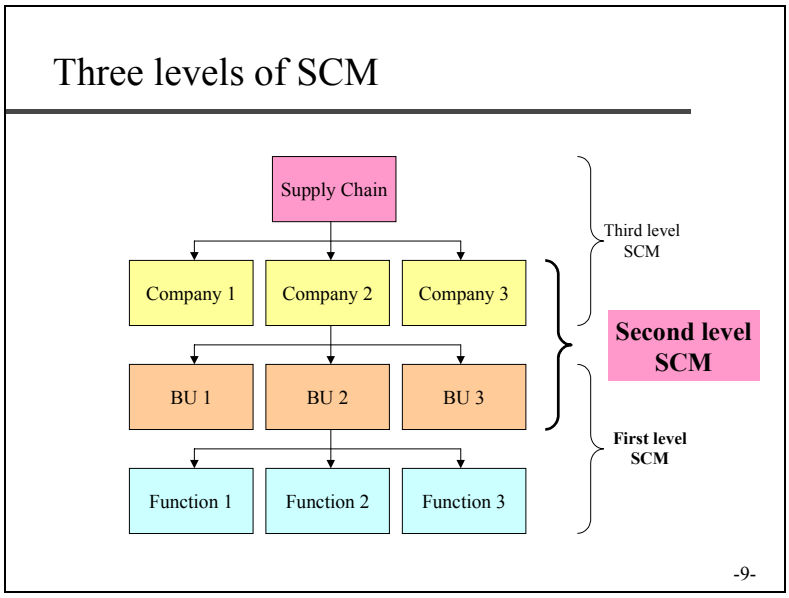
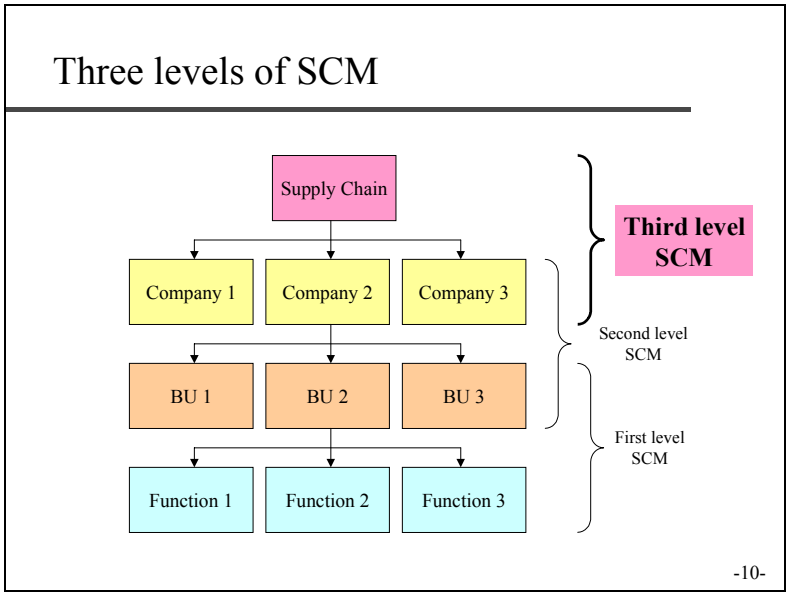
[SLIDE 8] At the first and lowest level, the various functions in the organization should work together to get to the best results for the Business Unit as a whole. My colleague Ad van Goor always says that this has little to do with Supply Chain Management. He feels that such coordination issues between the various functions relate to general management rather than to supply chain management. To him this is old wine in new bottles. A typical case of renaming old ideas. Although I fully agree, it is to be mentioned that when we set up the Center for Supply Chain Management at Nyenrode back in late 1996, we felt that the professors in

Marketing, Purchasing, Operations, Logistics and Information Management all should be put together in one integrated Center. In other words, we were using this level of Supply Chain Management as the key reason for creating the center the way it was created.



[SLIDE 9] At the second level of Supply Chain Management, it are the various Business Units that should be working together to get to the best result for the Corporation. Typical issues at this level are joint purchasing, account management and the integration of operations and logistics. The term Supply Chain Software in fact relates to this level of Supply Chain Management.



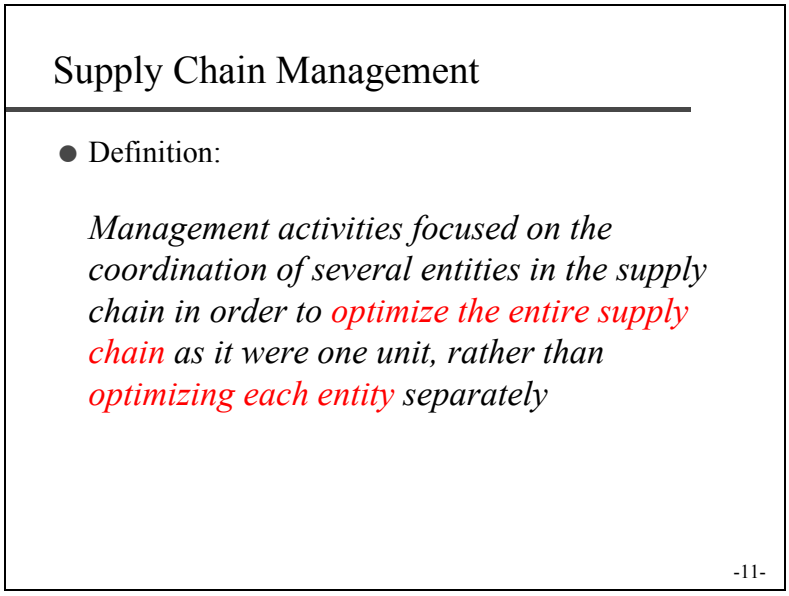
[SLIDE 10] At the third and highest level of Supply Chain Management, it are the various companies that are to work together to get to the best situation for the supply chain as a whole. Compared to the previous two levels there is a fundamental difference here. The difference is that the supply chain does not have an owner. There is no one in charge of the entire supply chain. This may seem to be obvious. Nobody is surprised. However, the consequences turn out to be quite considerable.

In business and in other aspects of life, it is a well-known phenomenon that sometimes one person needs to step back from his personal goals and facilitate others to achieve their goals to the benefit of all. If, in sports, all team-members want to make the winning score the team is likely to loose because the defense is neglected. In a bicycle race the lesser gods hustle their tail of to get their best teammate in a good position towards the end of the race. At the end of an inaugural lecture it is customary for professors to thank their partner for baring with them while they had to prepare for the lecture. So, sometimes you have to sacrifice your own targets to elevate the performance of the total.

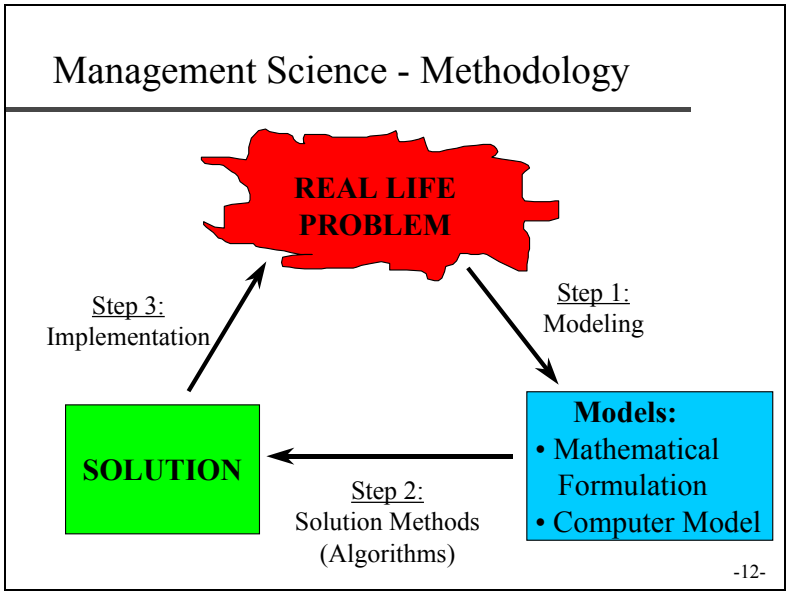
Now, let's take this idea to the three levels of Supply Chain Management. It is easy to see that the concept of relaxing the goals of the individual entities to achieve the goals of the higher organizational unit works, at least to some extent, on the first two levels of Supply Chain Management.

Such trade-offs between entities however is simply not feasible at the third level of Supply Chain Management. There are two simple reasons for this. Firstly, the entities at this level are autonomous companies. Each company has its own responsibilities and goals that are largely independent of the responsibilities of the other companies in the supply chain. Secondly, there is no owner of the supply chain, so in general no one is able to enforce a non-optimal strategy to another company in the supply chain.

For me the third level of Supply Chain Management is the only new thing about Supply Chain Management. The other two levels largely fall into the category of old wine in new bottles. Not much new there.



[SLIDE 11] Back to the definition. The final words I would like mention relate to "optimization". Like terms as Quality and Flexibility, Optimization is frequently used without being defined properly. Surely, optimal is good. Nobody is against it. But when is a supply chain optimized? With my background in Econometrics it make sense to use optimization like it is used in the area of Mathematical Programming which is part of Operations Research or Management Science.



[SLIDE 12] In Management Science there are basically three important steps. The first step is to make a model from the complex, messy, real life problem at hand. Modeling is the art of including the most important aspects of the real life situation and to leave out the less relevant parts. At step two the optimal solution is found within the model. This is the area of mathematical methods and computer algorithms. The optimal solution is found within the well-defined model. In step 3 the optimal solution is translated back to the real life situation. In my work I intend to apply these steps to research supply chain decision making.

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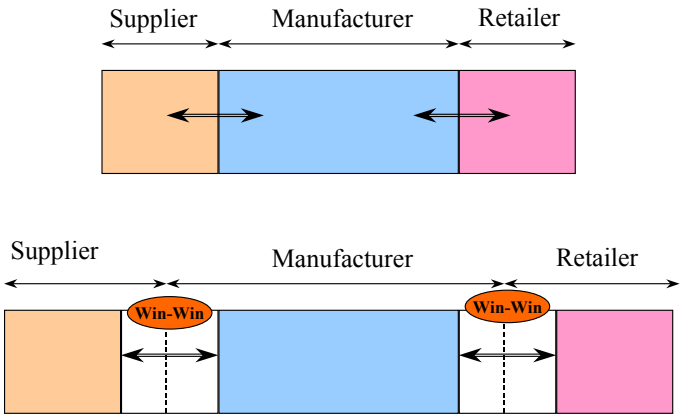
[SLIDE 13] In the definition of Supply Chain Management two types of optimization are mentioned. The first one is optimization of the entire supply chain. This will be referred to as "Global optimization". The whole, the global is to be optimized. The second one is optimization of each entity separately. This will be referred to as "local optimization".

The premises is that global optimization is better, or as least as good as, local optimization. If all the entities optimize their own situation this does not necessarily lead to an optimal situation for the total group of entities.

Pie-sharing Vs. Pie-growing



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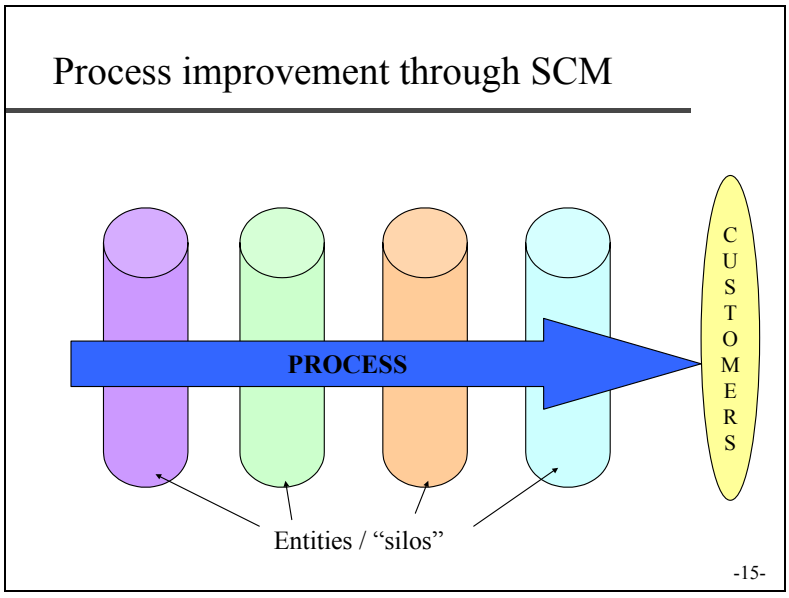
[SLIDE 14] If we take this one step further, we arrive at the following picture. In this slide we distinguish between pie-sharing and pie-growing. In the analogy the size of the pie reflects the overall profit in the supply chain and the size of the slice that each entity gets reflects the profits for that entity. Although pie-sharing might seem like a friendly activity, in the supply

chain pie-sharing is equal to ruthless warfare. That is, all entities involved will fight to get a larger part of the pie. Obviously, this is not possible unless at the expense of the other entities in the supply chain. In this zero-sum game, power is an important issue. If you are strong enough, if you are big enough, if you have enough power you can force the other parties to accept a lower price. Or you can force them to improve their service at the same price. As a consequence, your share of the pie will be larger since you take away a piece from the other entity. If you want to see how this powerplay works in practice, just pick up the newspapers of this and last week and read about the current warfare in the Pharmaceutics supply chain.

The other option on this slide is pie-growing. Here the idea is that the several entities work together, collaborate and coordinate. The result will be an increase in the profit of the total supply chain. The pie will become larger. And if the pie is larger, there is a larger slice available for everybody. In order words, all entities will benefit from working together, there will be a win-win situation. This idea is the fundamental concept underlying Supply Chain Management. If you do not believe in pie-growing, you do not believe in Supply Chain Management. And only if the pie grows, there can be a win-win situation. And a win-win situation is a necessary condition for Supply Chain Management on the third level.

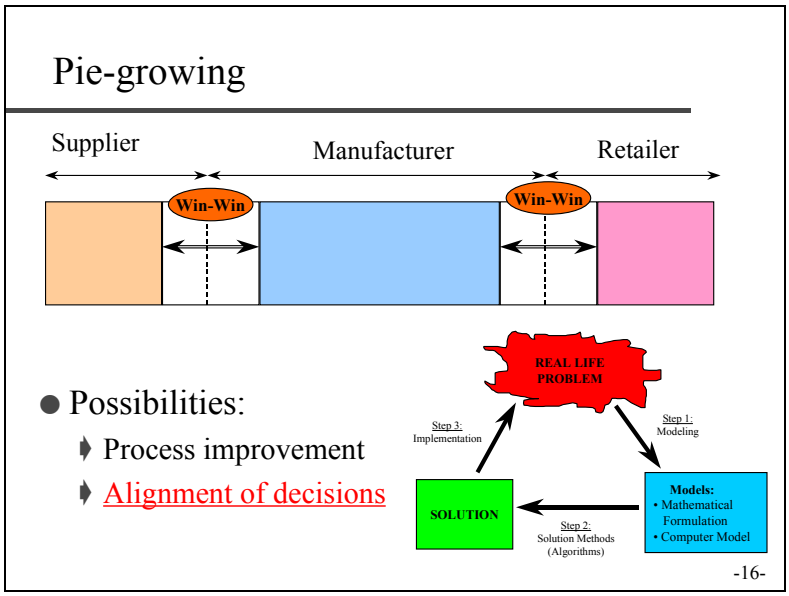
When first confronted with this pie-growing concept, your likely initial reaction is: Well, very nice but, sorry, … How is it possible that the pie gets larger through Supply Chain Management? How does this little piece of magic happen?

Well, if we rule out God and Harry Potter there are basically two possibilities to indeed increase the size of the supply chain pie.

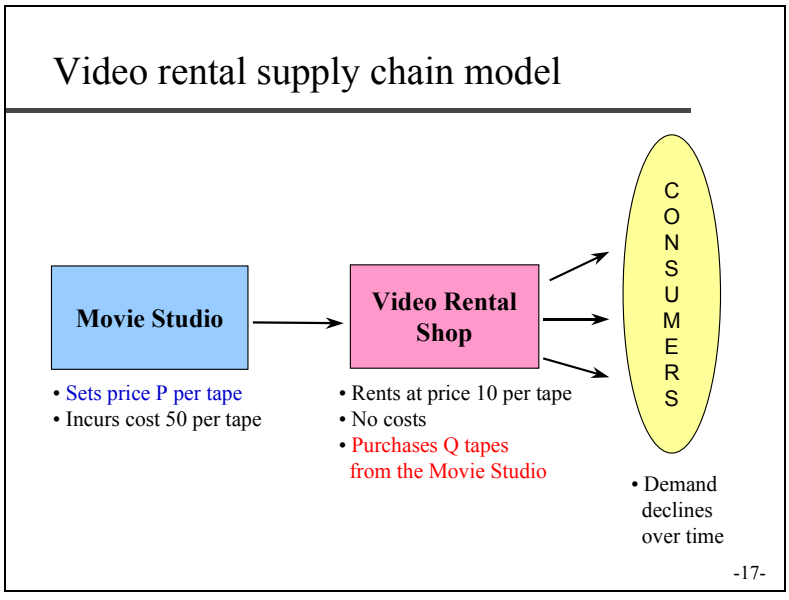


[SLIDE 15] The first possibility to make the pie larger is to improve on the process between the various entities. Nowadays it is well-understood that the Customer is all important when running your business. The problem however is that frequently the organizational structure is around entities and not around customer processes. Like TQM, JIT and BPR, Supply Chain Management focuses on the processes to improve customer service and on removing inefficiencies between the silos. Many examples of substantial improvements created by

process improvements are reported in the literature. Usually such improvements are described in terms of lower stocks, increased availability or fresher products.



[SLIDE 16] The other method to make the pie larger is trough an alignment of decisions of the several entities. In the remainder of this lecture I will focus on this specific aspect. So, I will focus on how to make decisions such that the pie gets larger and win-win is made possible. As mentioned before, I will use the Management Science methodology to explore this territory.



[SLIDE 17] As an introduction to this field I will take you to a very simple example. Let us look at the supply chain of rental videos. Frequently, I take Nils, our 7 year old son, to the

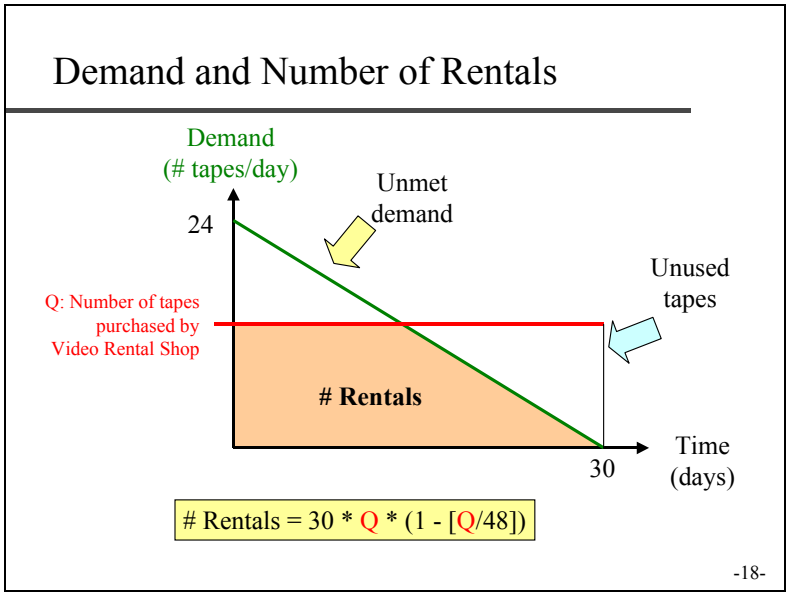
local video rental shop to rent films like the “De Leeuwenkoning”, “Platvoet en zijn vriendjes” or “Pokemon”. Children seem to like to see the same film at least 25 times, but for grown-ups this is quite different. They are always looking for the newest video releases. When looking at the assortment of the day-rentals, one can observe that nowadays the available number of copies of the newest films is very large compared to some years ago. In the old days you had to make a reservation for a new video weeks in advance, now they are readily available on the shelves, you can just pick them up. This increased availability is the result of Supply Chain optimization and I would like to show you how this works.

In the model we look at only three entities, namely the consumers, the Video rental shop and the Movie studio.

The Movie studio produces the videotapes. The variable production costs are set at 50 per tape. Obviously there are also fixed costs, but as these are to be considered as sunk cost, we do not include these in the model. The Movie studio sells the tapes to the video rental shop at price P per videotape. As they are a monopolist, the Movie studio can set this price P as they choose to. So, the value of P is the decision of the Movie studio.

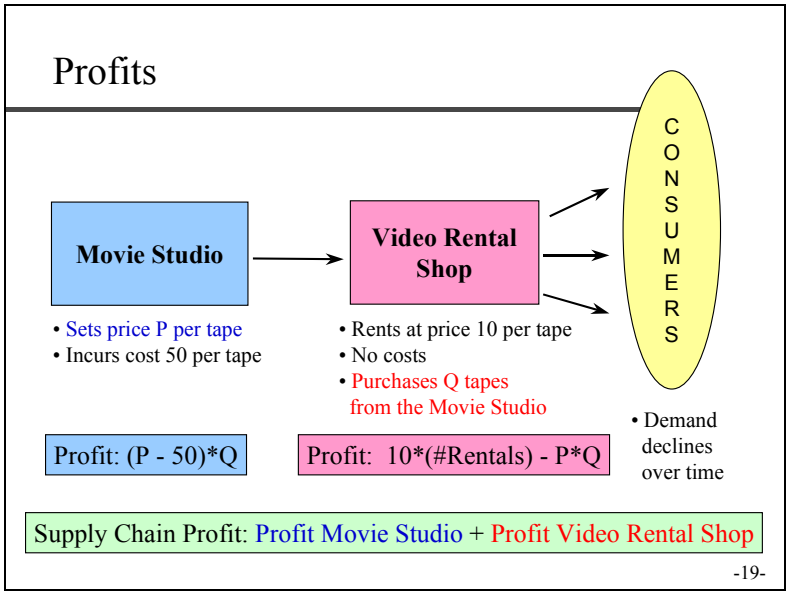
The Video rental shop purchases the tapes from the Movie studio. It is assumed that they do not have any other costs. Obviously, this is not very realistic. However, including operational cost in the model would only complicate matters without having any impact on the final insights and results. The purchasing quantity, denoted by Q, is a decision that is to be taken by the Video rental shop. The price for renting out videos to consumers is set at the market price of 10 per rental.

Finally we have the consumers, that is you and me. And of course sometimes my son Nils if there is a new Pokemon movie.



[SLIDE 18] The demand for the new released video is shown on this slide. Initially the demand will be as high as 24 tapes per day. But then over time the demand will decline. After 30 days there is no more demand for the tape as most people have already seen the film or because new films have been released taking away the interest. The Video rental shop is likely to choose their purchased number of tapes somewhere between the maximum demand

and zero. They are trading of the cost of the tape versus the number of rentals they can achieve. Clearly this will lead to a certain degree of unfilled demand and also a certain degree of unused tapes. The number of rentals resulting from an order quantity Q can be determined as the shaded area in this graph and is given in the formula on the bottom of this slide.



[SLIDE 19] In this model the Video rental shop is facing purchasing price P on the one hand and the demand of the customers for the tapes on the other hand. In optimizing their own situation they would like to choose the order quantity Q such to optimize their own profit.

The situation for the Movie studio is that they like to set the price P to maximize their own profit. This profit is determined by the revenue created through selling Q tapes to the Video rental shop minus the costs of 50 for making each tape.

The supply chain profit is simply defined by the profit of the Movie studio plus the profit of the Video rental shop.

We will study this model under two scenarios. In the first scenario each of the entities will optimize their own situation. This scenario will be called Solitaire. In the second scenario, called Partnership, the two entities sit together and jointly decide about the number of tapes that should be made available. Here the objective is to maximize the supply chain profit.

Solitaire

P: price for video-tape set by Movie Studio

Q: number of video-tapes purchased by Video Rental Shop

Supplier: (P-50)Q Buyer: 10(#Rentals)-PQ #Rentals: 30Q(1-[Q/48])

- Optimal decision Q for Video Rental Shop:
  - Profit = 10 * (#Rentals) - (P * Q)
    = 10 * {30 * Q * (1 - [Q/48]} - (P * Q)
    = (300 - P) * Q - (300/48) * Q^2
  - Optimal Q (d/dQ Profit = 0): $Q_{VRS} = 24*(1 - [P/300])$
  - Profit of Video Rental Shop at their optimal decision = $[24/600]*(300 - P)^2$

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[SLIDE 20] First we will study the Solitaire scenario. Let us start with the situation of the Video rental shop. For a given price P their profit is a quadratic function of their decision variable Q. Using straightforward optimization techniques the optimal quantity Q can be determined. Substituting the optimal quantity in the profit function will give the optimal profit for the Video rental shop as shown on this slide.

Solitaire

P: price for video-tape set by Movie Studio

Q: number of video-tapes purchased by Video Rental Shop

Supplier: (P-50)Q Buyer: 10(#Rentals)-PQ #Rentals: 30Q(1-[Q/48])

- Optimal decision P for Movie Studio:
  - Profit = (50 - P) * Q
  - Assuming the Video Rental Shop chooses their Q optimal:
    Profit = (50 - P) * Q_{VRS}
    = (24/300) * (P - 50) * (300 - P)
  - Optimal P (d/dP Profit = 0): $P_{MS} = 175$
  - Profit of Movie Studio at their optimal decision: 1250
  - Purchased number of video tapes at price 175: $Q_{VRS} = 10$
  - Profit of Video Rental Shop at their optimal decision: 625

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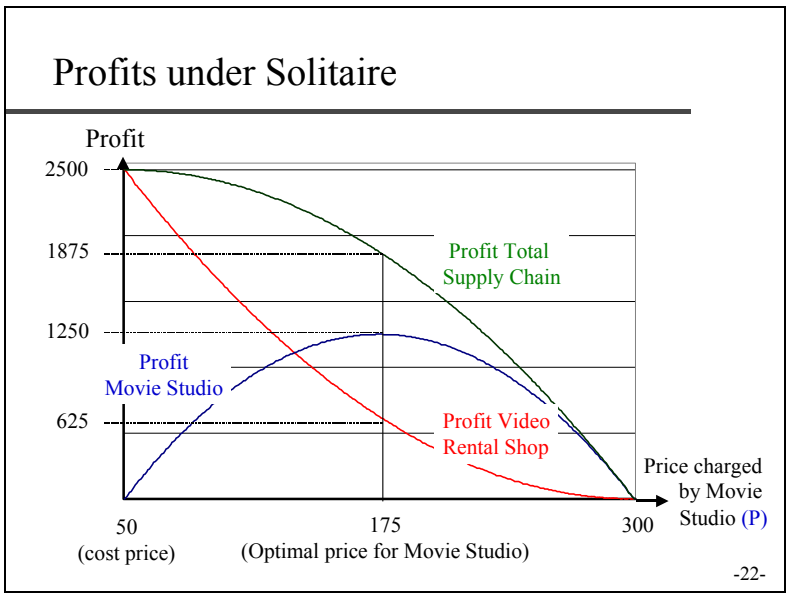
[SLIDE 21] Let us now take a look at the situation of the Movie studio under the Solitaire scenario. Assuming that the Video rental shop will order their optimal quantity, the profit for the Movie studio can be expressed as a quadratic function in P. Again it is easy to find the optimal value of P which turns out to be 175. The profit of the Movie studio will be 1250. Consequently the Video rental shop will purchase 10 tapes and their profit is 625.



[SLIDE 22] Even if the earlier analysis went to quickly for you, it is worthwhile studying the graph on this slide. The red line shows the profit of the Video rental shop for various prices charged by the Movie studio. Please do note that this line assumes that the Video rental shop will order their optimal quantity. It was to be expected that the higher the price the Movie studio charges for the videotapes, the lower the profit of the Video rental shop is. So, no surprises here.

The blue line shows the profit for the Movie studio for the various prices charged by themselves. Initially the profit line goes up which shows the benefit from the increased price received per unit. But after a certain point the profit goes down again reflecting that the Video rental shop will buy fewer tapes from the Movie studio. As observed earlier, the optimum price is 175 with associated profit 1250.

Usually the actual price P and therefor the associated profits for the Movie studio and Video rental shop are the outcome of the negotiation between the two entities.

The green line shows the total profit of the supply chain, which is obtained by adding the profits of the two entities.

Now, there are at least three important observations to be made from this graph. The first observation is that the supply chain profit is not a fixed amount. The higher the price is, the lower the joint profit of the Movie studio and the Video rental shop. In other words the pie does not always have the same size. By choosing various values for the price P, the supply chain pie gets larger or smaller.

The second observation is that in the case that both entities optimize their own situation, which is reflected in the graph by P = 175, the supply chain profit is not at its maximum. In other words: here local optimization does not lead to global optimization.

The third observation is that the maximum supply chain profit of 2500 is only reached if the price of the videotapes would be 50. That is if the price is equal to the variable cost of making the tape. Although this price would be very beneficial to the Video rental shop, the Movie studio is very unlikely to agree to such a price, as their profits will become zero. So, whatever the outcome of the price negotiation is, the supply chain profit will not reach the highest possible value. In other words, the supply chain will not be optimized in the Solitaire scenario.

Partnership

P: jointly determined price for video-tape

Q: number of video-tapes purchased by Video Rental Shop

Supplier: (P-50)Q Buyer: 10(#Rentals)-PQ #Rentals: 30Q(1-[Q/48])

- Profit Total Supply Chain:
  - Profit Movie Studio + Profit Video Rental Shop =
    (P - 50) * Q + 10 * (#Rentals) - (P * Q) =
    10 * {30 * Q * (1 - [Q/48]} - (50 * Q)
  - Does NOT depend on P:
    for the Supply Chain as a whole P is an irrelevant "internal" price
  - d/dQ = 0: Optimal $Q_{SC} = 20$
  - Associated profit: 2500 (maximum Supply Chain profit)

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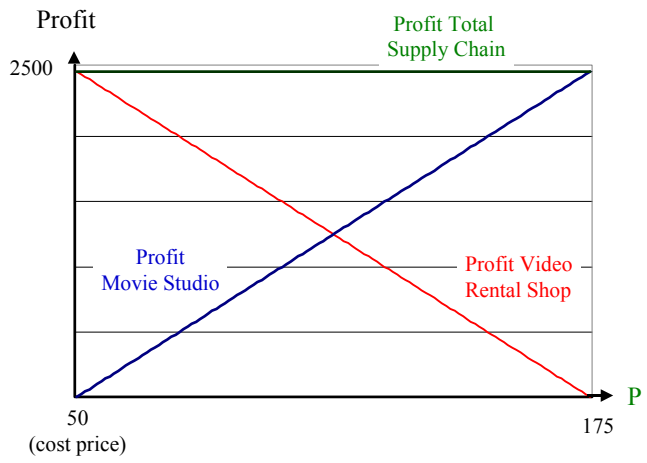
[SLIDE 23] Let's now move on to the Partnership scenario. Here the two companies sit together as real partners and jointly decide what to do. That is, they will act as if the supply chain is one unit. And the two partners jointly want to maximize the supply chain profit. It is important to note that in optimizing the supply chain as one unit, the price P charged by the Movie studio becomes irrelevant. That is, the price P becomes an internal transfer price. Whatever the Movie Studio gets is paid by the Video rental shop. In Dutch this is the famous concept of Vestzak-broekzak. So, the profit function of the supply chain is not dependent on P but is a quadratic function of Q only. Again it is easy to find the optimal value for Q, which turns out to be to make 20 tapes available to the consumers. The associated profit is 2500. This hardly is a surprise because we already saw in the Solitaire scenario that this was the highest possible profit.

Profits under Partnership



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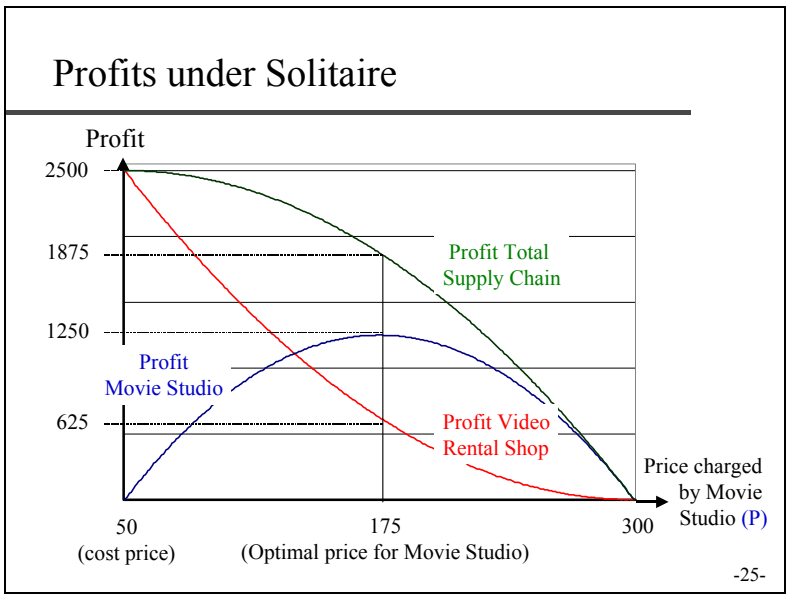
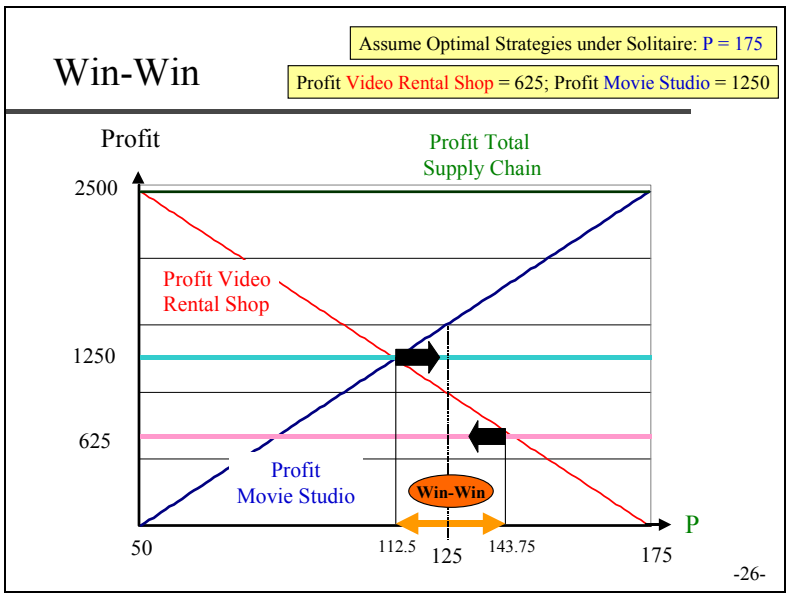
[SLIDE 24] The next issue that the Movie studio and Video rental shop are facing is how to split up the profit between them. Obviously, here the transfer price does come into play. It is easy to see that in fact the profits of the two entities become linear functions in P. The higher the transfer price of a videotape the more profit goes to the Movie studio and the less profit goes to the Video rental shop. But the important thing is that the total profit will always remain the same, namely 2500, the maximum possible supply chain profit.

Now, how would the transfer price P be determined in this situation? One thing that is likely to happen is that both entities would only be interested in a Partnership if they will gain from this Partnership when compared to the Solitaire scenario. That is, they would like to find a win-win situation.

Therefore the relevant question is: does a win-win situation actually exist? As you would have guessed, the answer is yes. Yes, a win-win situation does always exist. Well, at least within this model.



[SLIDE 25] To see how this works let us assume that in the Solitaire scenario both entities are locally optimized. Recall that this was achieved at a price of 175. At that price the profit of the Movie studio is 1250 and the profit of the Video rental shop is 625.



[SLIDE 26] Therefore the Movie studio would only be interested in the Partnership if the resulting profit would be higher than the 1250 they got from the Solitaire scenario. It is easy to see that this only happens if the blue line is above the pale blue line, which happens if the transfer price is at least 112.5. Similarly, the Video rental shop wants its profit to be at least 625 which happens if the transfer price is not larger than 143.75. So, for instance if the transfer price is 125 both entities will increase their profits when compared to the Solitaire scenario.

Win-Win from Partnership

- **Solitaire** (both players use own optimal strategy):
  - Price per video tape charged by Movie Studio: P = 175
  - Quantity ordered by Video Rental Shop: Q = 10
  - Profit Movie Studio = 1250
  - Profit Video Rental Shop = 625
- **Partnership** (optimal strategy for Supply Chain):
  - Price per video tape: P = 125
  - Quantity ordered: Q = 20
  - Profit Movie Studio = 1500 (+20%)
  - Profit Video Rental Shop = 1000 (+60%)

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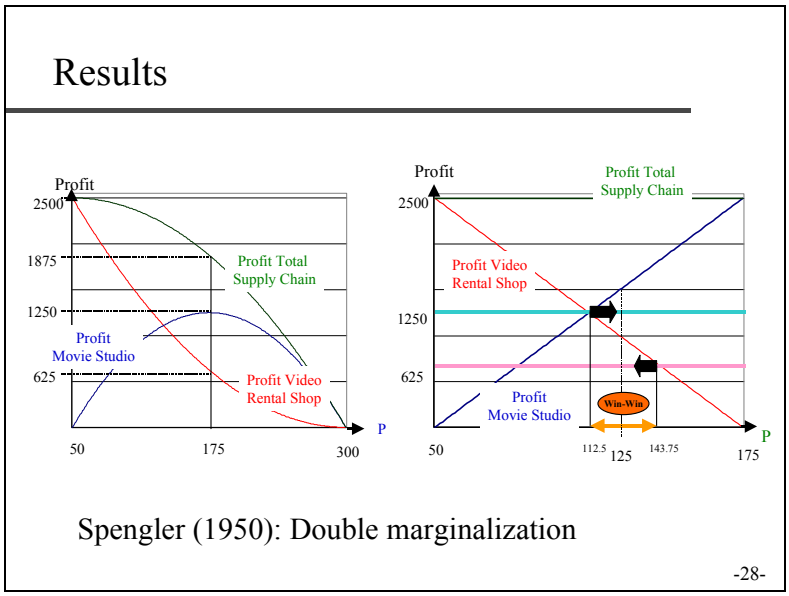
[SLIDE 27] The results so far are summarized on this slide. It can be seen that the profit increase from forming the partnership can be quite substantial. This slide also shows where the additional profits came from. The larger supply chain pie is not due to some Harry Potter type of magic, but due to Supply Chain Optimization. Since the number of tapes made

available to the consumers is doubled (from 10 in the Solitaire scenario to 20 in the Partnership scenario) the number of rentals goes up drastically, which is creating more revenue and therefore more profits. So, in fact the win-win does not only apply to the Movie studio and the Video rental shop but also to the consumers, as they will benefit from the increased availability of the videotapes.

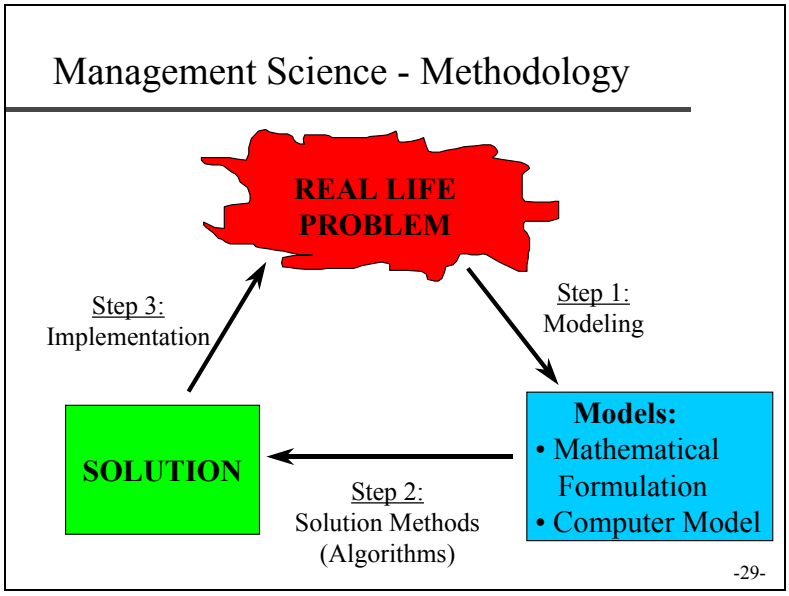


[SLIDE 28] Let us shortly review what we have found so far. First we have observed that in the Solitaire scenario it is highly unlikely that the supply chain is optimized. Only if the price is equal to the marginal cost the supply chain profit is at the maximum level of 2500. Therefore we have to come with something else. And that something else is a partnership.

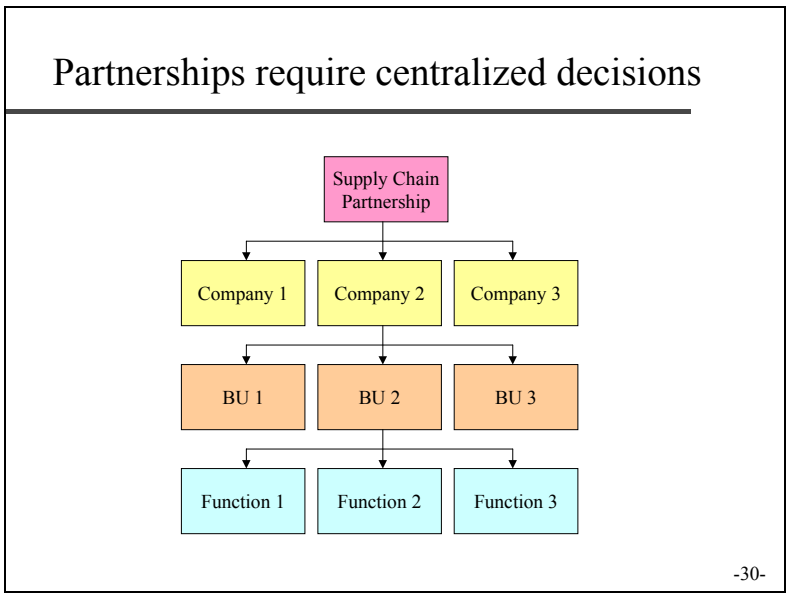
It has to be mentioned that the idea of global optimization in the supply chain is too straightforward not to have been noticed in the literature. In a paper that dates from as long back as 1950, Spengler already observed the phenomenon of what was called double marginalization. That paper was in fact meant as a counterweight to the at that time upcomming use in the U.S. of antitrust laws to prevent vertical integration. In our terminology, vertical integration relates to the various entities in the supply chain working together. According to Spengler, the antitrust laws rightfully are used against horizontal integration, that is to prevent cartels. But these laws should definitely not be used to prevent vertical integration because, as we have seen, partnerships in the supply chain are beneficial to everybody including the customers.

Surprisingly enough today, more than 50 years later, the objections of Spengler still are relevant. As explained to me recently by Marcel Noordhuis, a PriceWaterhouseCoopers consultant and IDP1 alumnus, the situation in the construction industry supply chain resembles the same difficulties as observed by Spengler. The Dutch rules and regulations currently are such that before a new building, bridge, road or whatever other construction is build, there is a separate tender for each phase such as engineering, supervision and construction. And again a separate tender by the overall contractor on each part of the supply chain activities like brick-laying, electric wiring, plumbing et cetera.

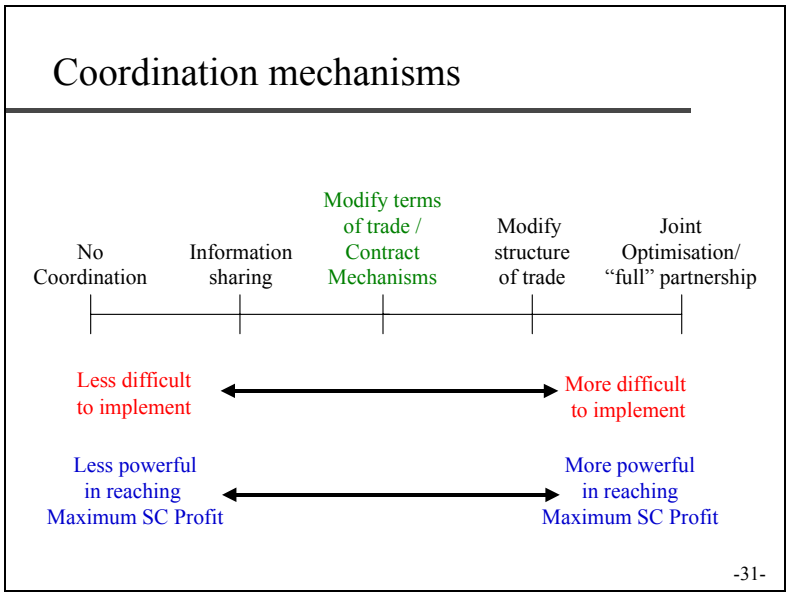
According to these rules and regulations, the several supply chain entities are not supposed to work jointly on the tender and are therefore not allowed, let alone stimulated, to coordinate the work. The reason for this is that joint bids might lead to fraud. Which in light of the recent "bouwfraude" of course is not a farfetched assumption. As a consequence, the supply chain is created by joining entities that all have suboptimized their own bids in order to get in on the construction project in the first place. The result obviously is a disaster. Indeed construction supply chains are notorious for their huge failure cost and poor delivered quality. Anyone that ever bought a house that was yet to be constructed can tell you horror stories about all the things that can go wrong and therefore will go wrong.



[SLIDE 29] Now back to the idea of a Partnership to capture the larger supply chain profit. Mathematically it all works perfectly, but what about the real life? In other words, Steps 1 and 2 in the Management Science methodology all work out just fine, but can this partnership idea also be implemented? Some of my colleagues like Pieter Klapwijk and Arjan van Weele have always questioned the feasibility of Partnerships in the real business life. Translated in my words, Pieter Klapwijk feels that most frequently the power-balance between organizations is such that one organization is inevitably the leader and there is little else to do for the other than to follow. Which hardly is a situation in which a true partnership can develop. Arjan van Weele is even more outspoken: according to him, again in my own interpretation, it is hard enough to find true partnerships between two people. However, true partnerships in the supply chain are simply non-existing. Maybe I do not want to go that far, but from an implementation point of view there indeed is a lot to say against partnerships.



[SLIDE 30] One disadvantage is that it calls for centralized decision making which implies that decision rights are taken away from the decentralized organizational units. Usually lower entities are not too thrilled about this idea. In fact, all recent management concepts stress the importance of "empowering" and putting responsibilities as close as possible to the actual activities. Deployment of authorities and responsibilities is a dominant trend in the current management thinking. Clearly, from this point of view centralized decision making is undesirable not to say infeasible.



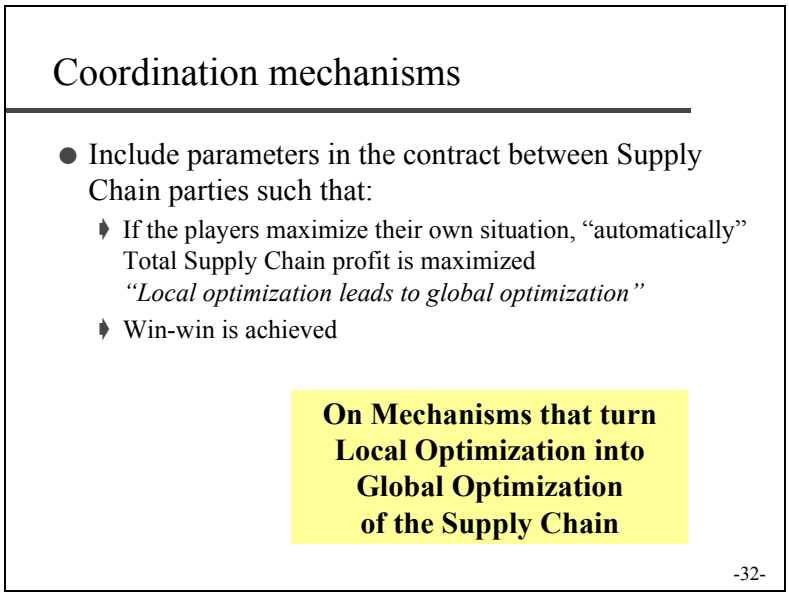
[SLIDE 31] Having observed this, the question then becomes, is it possible to capture the maximum supply chain profit without getting into full partnerships? This slide shows some of the possibilities that are available of doing just that.

I have pictured the coordination mechanisms on a scale indicating the ease of implementation. On the left-hand side we have "no coordination". Sure enough this is very easy to do. But of course it is not helping in optimizing the supply chain. So strictly spoken, this should not be in this slide at all. I just put it there for comparison reasons. On the other end of the spectrum we have the full partnership. As just argued, this is hard and/or undesirable to implement. In between these two extremes there are some other options. The first one is simply sharing information. Each supply chain member will make their information available to the others. Information might include final customer demand, inventory levels and production plans. In many cases this will really help the other entities in the supply chain by making their own plans and decisions.

Other coordination mechanisms are more complex. One option is to modify the structure of the trade. One well-known example along this line of thinking is Vendor Managed Inventory and/or consignment stocks. Here the idea is that the Supplier is responsible for the amount of inventory at the location of the Buyer.

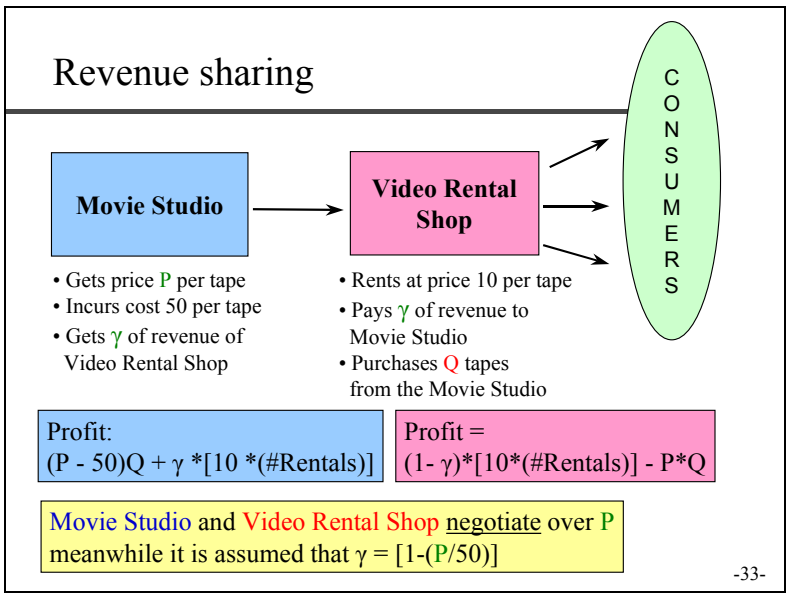
I would like to spend some more time on the option in the middle, the so-called contract mechanisms. The idea of contract mechanisms is as follows.

In a way contract mechanisms are what can be called a typical Dutch "polder" approach. It tries to combine the best of both worlds. That is, they are relatively easy to implement yet powerful enough to get to the desired results.



[SLIDE 32] By using contract mechanisms, we leave the structure of the supply chain unchanged. But in the contract negotiation between the various entities we include more parameters. And the parameters are set in such a way that if all the entities would strive for their local optimum this would automatically lead to the global optimum.

In fact this is the concept that brings me to the title of this inaugural address. Many people have asked up-front what the title meant. Now only it becomes clear. That is, if you have not lost track in the meanwhile. Which of course you have … not.



[SLIDE 33] Let's apply one of the contract mechanisms namely Revenue-sharing, to the video rental model we studied before. This mechanism is the one that is used in real life. The idea underlying Revenue-sharing is that the price P charged by the Movie studio is decreased significantly. To compensate for the loss of income because of the lower price, the Movie studio will get a percentage gamma of the revenues earned by the Video rental shop.

Therefore in the contract negotiations, there are two parameters to decide about, namely the price per videotape P and a percentage gamma of revenue transferred from the Video rental shop to the Movie studio. For the remaining part the structure and rules are as in the Solitaire scenario.

Since both parameters P and gamma can individually create a smaller or larger profit for each entity, there is no problem making one dependent on the other. Let us assume that gamma is set equal to 1 minus P over 50. Of course this is not just any value, but carefully picked to get to the desired result. If we adopt this equation we can do the analysis similar as before.

Revenue sharing

- Optimal decision Q for Video Rental Shop:
  - Profit = (1- γ) * 10 * (#Rentals) - (P * Q)
    = (1- γ) * 10 * {30 * Q * (1 - [Q/48]} - (P * Q)
  - Optimal Q (d/dQ Profit = 0):
    Q_{RS} = 24*{1 - [P/((1- γ)*300)]}
  - Since γ = [1-(P/50)] it holds that
    Q_{RS} = 24*{1 - [P/((1- γ)*300)]} = 20 = Q_{SC}
  - Whatever the negotiated P is, the **optimal Supply Chain profit** is realized!

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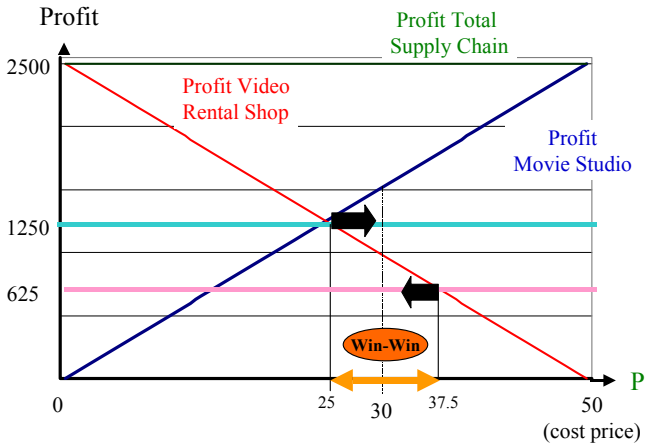
[SLIDE 34] The optimization problem for the Video rental shop is given here. After a careful analysis it so happens that the optimal purchase quantity is not depended on the price P. This is realized by the specific value chosen for gamma. The important thing is that the optimal order quantity Q for the Video rental shop is in fact equal to the optimal order quantity for the entire supply chain! In other words, in optimizing their own situation, the Video rental shop is automatically optimizing the entire supply chain! Through the Revenue-sharing contract, local optimization automatically leads to global optimization.

Profits under Revenue sharing

γ = [1-(P/50)]



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[SLIDE 35] The results are shown in this slide. You might have the feeling of already having seen this slide before. It appears to resemble the situation of the Partnership scenario. Well, indeed it is almost the same but only a little bit different. Only the interval given for P differs.

Note that also here the maximum supply chain profit is realized no matter what the negotiated price P is. Also note that also here a win-win situation is always possible.

Although the profit outcomes are exactly the same, the difference is that Revenue-sharing does not require joint optimization and hence a full partnership is not really needed. The only requirement is changing the terms of trade. That is, include additional parameters in the contracts.

Contract Mechanisms

- **Revenue sharing**
  - Next to price *P* per item there is a percentage γ of the Buyer's revenue that goes to the Supplier
- **Two part tariff / License fees**
  - Next to price *P* per item there is a lump sum *L* (License fee) paid by the Buyer to the Supplier
- **Quantity discounts**
  - The price *P* per item is lower if a higher number items is purchased by the Buyer
- **Pay-back / Return payments**
  - Next to price *P* per item there is an agreement that the Buyer can return any unsold units to the Supplier at price *S*

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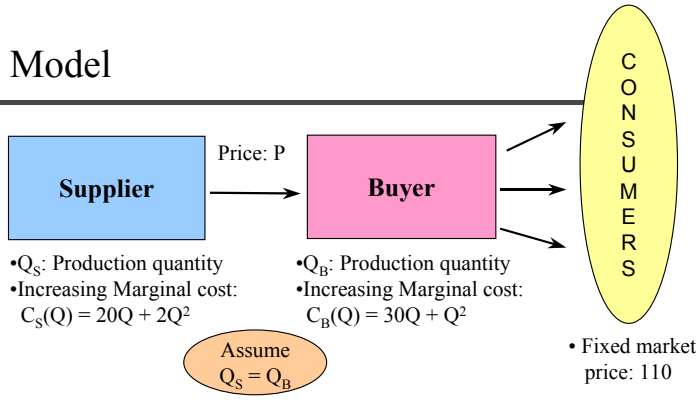
[SLIDE 36] In various other models, representing all kinds of situations, we have studied several contract mechanisms, some of which are listed here on this slide. In many of the models we studied, it appeared that at least one of these mechanisms is able to get to the desired result.

Model



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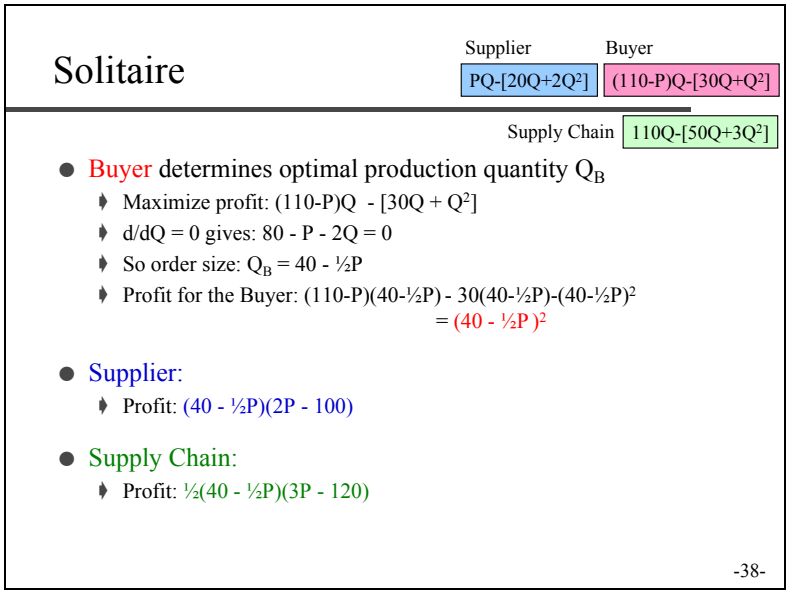
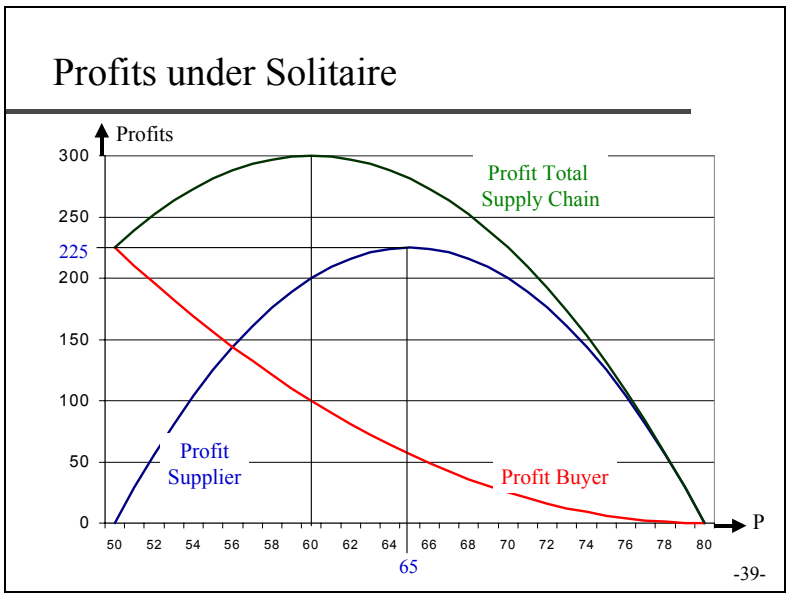
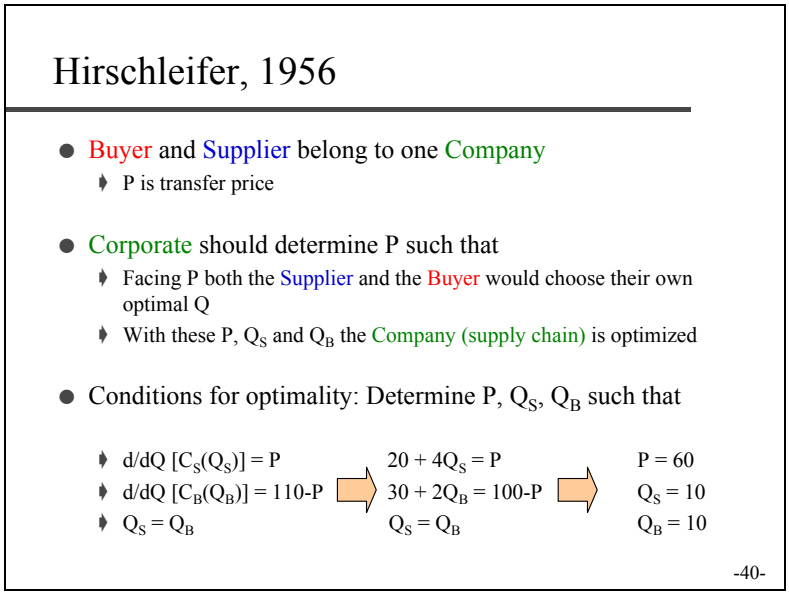
[SLIDE 37] To test our findings in a different setting, let me now take you to another model. Although the supply chain structure in this model is exactly the same as in the video rental model, the assumptions are somewhat different. It is assumed that the Supplier and Buyer both have cost functions that have increasing marginal costs. Also both are faced with revenues that are determined by price * sold quantity. In a way this is what I would call a typical old-fashioned economic setting. Companies can sell all they can make but are restricted in their sales volume by their own increasing marginal cost. It will be assumed that the market price for the endproduct is fixed at 110 and that the price charged by the Supplier for the half-product is equal to P. Furthermore, in order to keep calculations fairly simple, the cost-functions C_S for the Supplier and C_B for the Buyer are quadratic in volume, which is denoted by Q.



[SLIDE 38] If we perform the analysis similar to what we did for the video rental supply chain, it is easy to come to the optimal production quantity of the Buyer, as a function of the price P charged by Supplier. From this we can determine, as before, the associated profits of the Supplier, Buyer and Supply chain.

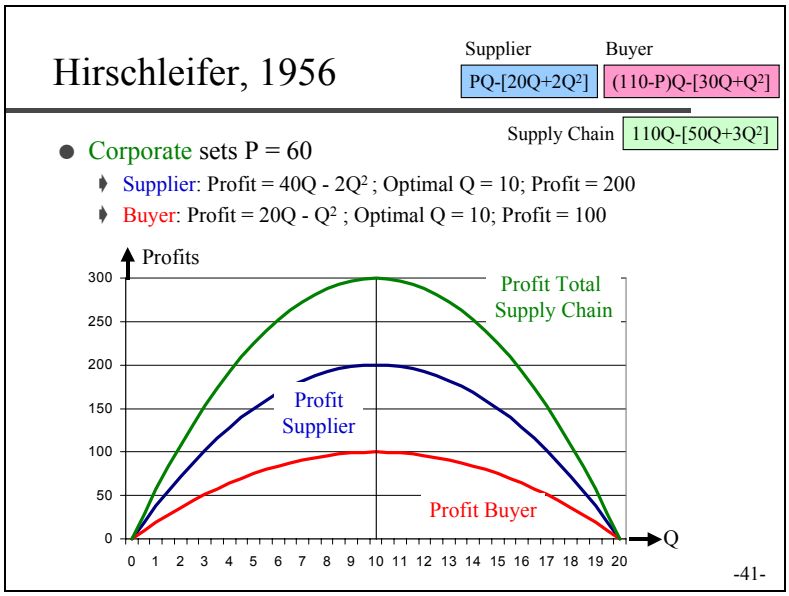


[SLIDE 39] The results are shown in this graph. Again we find that the pie is not always of the same size. Different values of P give different values for the overall supply chain profit. Also here the situation where both supply chain entities do optimize their own situation does not correspond to the optimal situation for the supply chain. The decision P = 65 is the best for the Supplier but not for the supply chain. To maximize the supply chain profit, then the choice should have been P = 60.

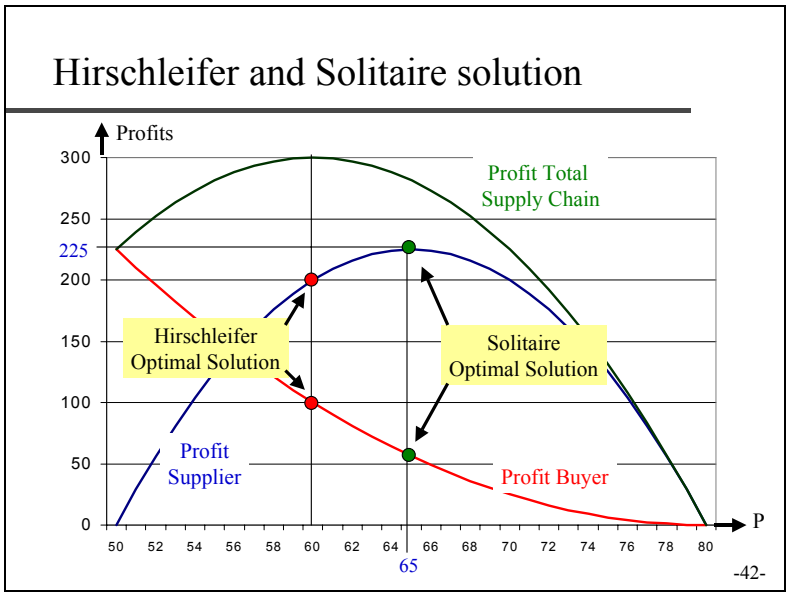


[SLIDE 40] It is interesting to see that this model was in fact already studied in ancient history. That is, in 1956, so even before I was born, Hirschleifer published a paper on the situation where the Buyer and Supplier were two business units within one company. In other words, he looked at the situation as it was the second level of Supply Chain Management. In what is considered in the Accounting literature as a classical paper in transfer pricing,

Hirschleifer derived an optimal value for the transfer price. His approach was that Corporate should set the transfer price and that then each business unit could determine the production volume that suited them best. Obviously, the desired outcome should be that both business units would produce the same quantity. And of course, together they should produce the optimal quantity for the company as a whole.

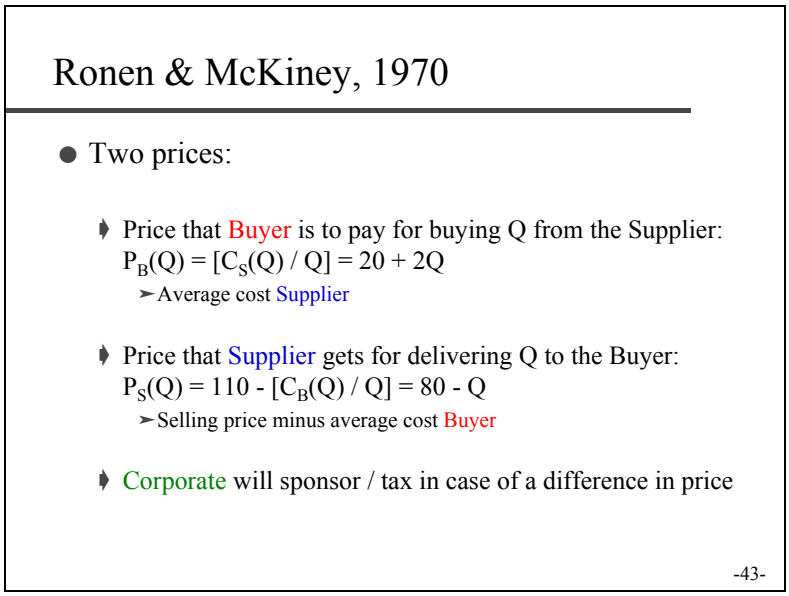


[SLIDE 41] This slide shows that indeed Hirschleifer's optimal transfer price P, which is determined by Corporate and equal to 60, brings the Supplier and Buyer to a situation where both would produce 10 units. Also note that this coincides with the optimal production volume for the supply chain. In other words, the Hirschleifer method indeed optimizes the supply chain.



[SLIDE 42] Please note that Hirschleifer's optimal situation is in fact exactly the same as the optimal supply chain solution in the Solitaire scenario, namely P = 60, the profit of the Supplier is 200 and the profit of the Buyer is 100. When compared to the Solitaire optimal situation where P is equal to 65, however the Hirschleifer solution is not achieving win-win! The profit of the Supplier is reduced a little bit, but this is more than compensated by an increase in profit of the Buyer.

So, to summarize: Hirschleifer is optimizing the supply chain but not achieving win-win. The win-win however is not really required, as Hirschleifer is looking at Supply Chain Management at the second level. Moreover, he specifically makes use of a Corporate division that sets the transfer price.



[SLIDE 43] In their 1970 paper Ronen and McKinley came with a truly intriguing approach in this model. They suggested introducing two transfer prices. One for the Buyer and one for the Supplier. So what the Buyer pays, that is P_B, is not the same as what the Supplier gets, that is P_S. Note that both of these prices are quantity dependent and relate to the average cost of the other party. Obviously, the difference in price is only possible if Corporate is taking the responsibility for paying the difference in prices.

Two prices

Supplier: $PQ-[20Q+2Q^2]$ | Buyer: $(110-P)Q-[30Q+Q^2]$

Supply Chain: $110Q-[50Q+3Q^2]$

- Supplier:
  - $P_S(Q) = 80 - Q$
  - Profit = $(80-Q)Q - [20Q+2Q^2] = 60Q - 3Q^2$
  - Same profit function as Supply Chain in Solitaire scenario
  - Optimal Q = 10; $P_S = 70$; Profit = 300
- Buyer:
  - $P_B(Q) = 20 + 2Q$
  - Profit = $(110-[20+2Q])Q - [30Q + Q^2] = 60Q - 3Q^2$
  - Same profit function as Supply Chain in Solitaire scenario!
  - Optimal Q = 10; $P_B = 40$; Profit = 300

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[SLIDE 44] To see how this works, let us work out the profit functions for the Buyer and Supplier. Since the price paid and received are quantity-dependent, the resulting functions depend on Q only. Through the specific choice of P_B and P_S, a situation is achieved where the profit function of the Supplier and the profit function of the Buyer are in fact exactly the same as the profit function of the supply chain in the Solitaire scenario. So, from this perspective, it is no surprise that if the Supplier and the Buyer optimize their own situation, they will in fact optimize the supply chain. So, again local optimization automatically leads to global optimization.

Two prices and Solitaire compared

Two prices		Solitaire	
Supplier:		Supplier:	
Revenue = 10*70 =	700	Revenue = 7.5*65 =	487.5
Manufacturing cost =	400 -/-	Manufacturing cost =	262.5 -/-
Profit	300	Profit	225
Buyer:		Buyer:	
Revenue = 10*110 =	1100	Revenue = 7.5*110 =	825
Manufacturing cost =	400 -/-	Manufacturing cost =	281.25 -/-
Purchasing cost = 10*40 =	400 -/-	Purchasing cost = 7.5*65 =	487.5 -/-
Profit	300	Profit	56.25
Corporate:			
Subsidy cost = 10* (70-40) = 300 -/-			
Supply Chain:		Supply Chain:	
Profit	300	Profit	281.25

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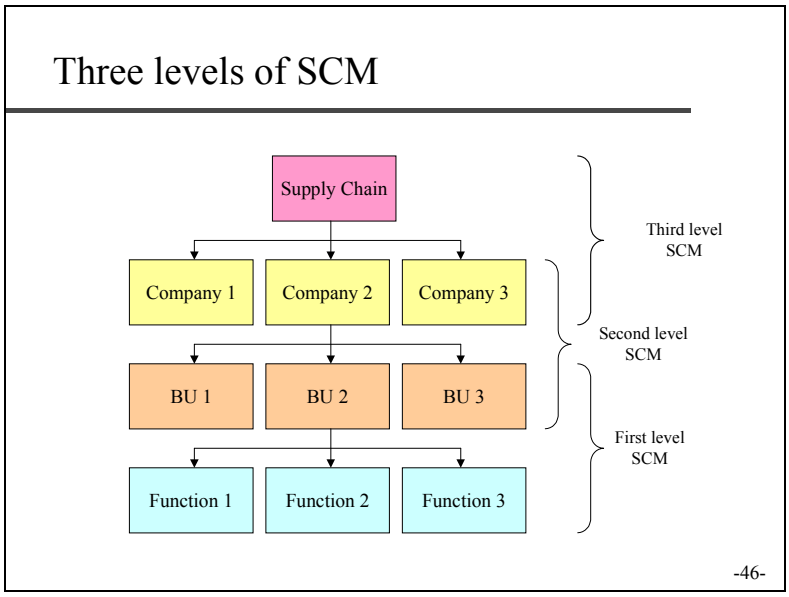
[SLIDE 45] If you do this analysis very quickly, like I just did, you might get the feeling that I put you go through a course named “how to bluff with mathematics”. Or maybe more relevant nowadays, considering Enron and other companies that I will not mention because that might

be too painful, it seems that I try to teach you a lecture on “how dirty accounting tricks can be used to boost profits illegally”. But in fact this is not true.

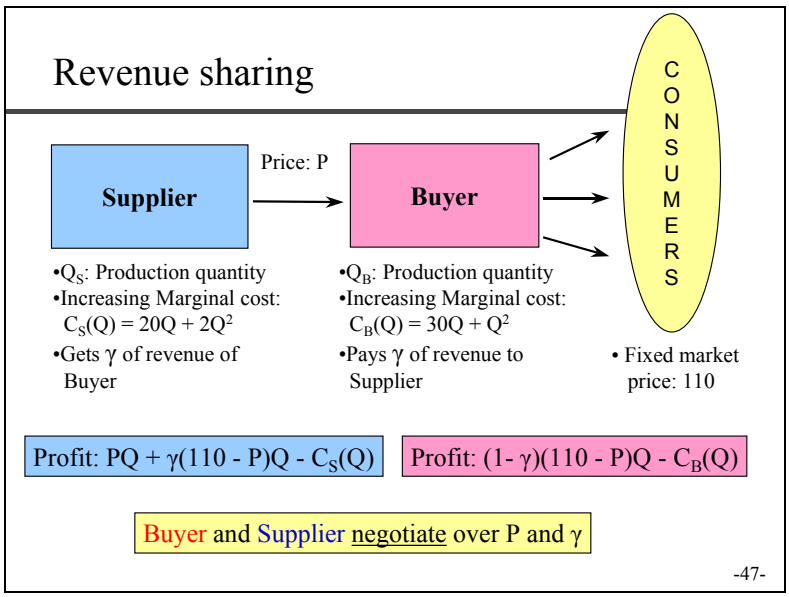
This slide shows you how the Two prices strategy works. The Supplier gets a price of 70 whereas the Buyer only pays 40 per unit. The remaining 30 per unit comes as a subsidy from Corporate. The result is that the profits of the Supplier and Buyer get as high as 300, which is significantly more than under the Solitaire scenario. Of course the Corporate sponsoring results in a big loss at that level. But when everything is added up, it can be observed that indeed the supply chain is optimized and the company is better of with the Two prices system than it was in the Solitaire scenario.

Summarizing, in the Two prices system, the supply chain is optimized, local optimization leads to global optimization and win-win is achieved.

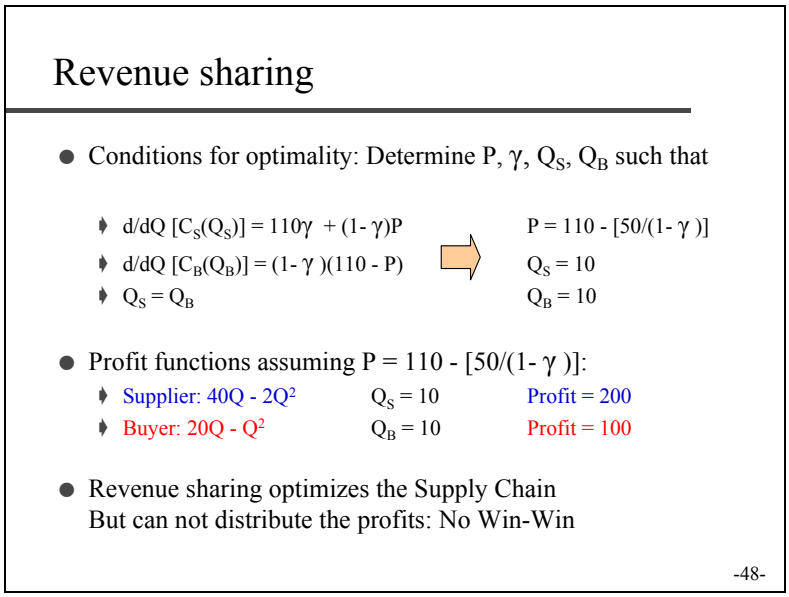
Now this might all be true, but obviously the Two prices system does only work for Supply Chain Management at the second level. If we look at Supply Chain Management on the third level, that is if we consider the Supplier and Buyer as separate autonomous companies, there simply is no Corporate. And without a Corporate there is no Two prices system.



[SLIDE 46] This observation brings me to an important conclusion. Mechanisms that work for Supply Chain Management on the third level, by definition will also work for Supply Chain Management on the second level. So, everything that is concluded from research on contract mechanisms in Supply chains will have an effect on transfer pricing and Accounting methods in multi-division companies. However, the mechanisms used in Accounting most certainly are not always usable in Supply Chain settings. Again, this reinforces my statement that indeed Supply Chain Management on the third level is fundamentally different from Supply Chain Management on the second level.



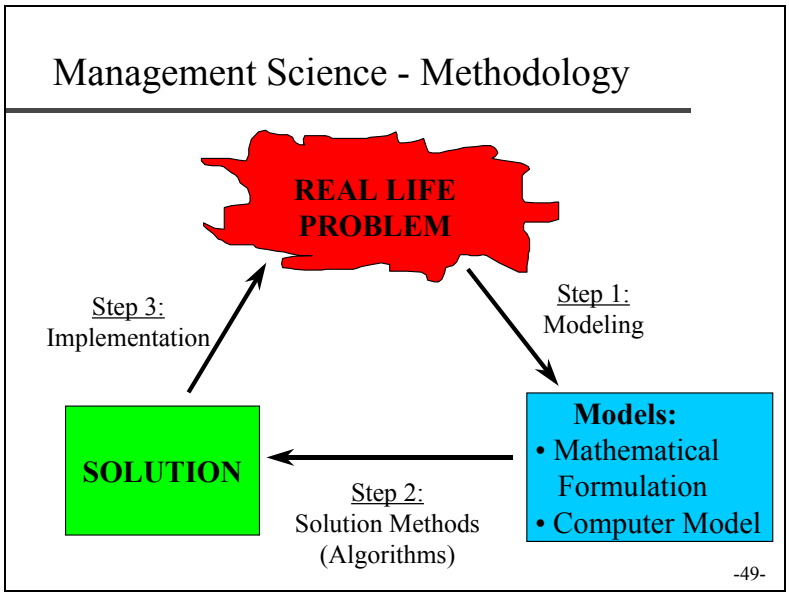
[SLIDE 47] So, what happens in this model if the two companies are autonomous? Let's see whether the mechanism used in our previous model also works here. Let's see whether revenue-sharing can also be implemented in this model. In the analysis everything goes pretty much like it did before. The Buyer will pay a share of gamma of his revenue to the Supplier. And the Buyer and Supplier will negotiate over the price P and transferred revenue gamma.



[SLIDE 48] When optimizing the situation, everything is pretty straightforward. We end up with a situation where P and gamma are related to each other in order to achieve an optimized supply chain. When everything is worked out further we come to the conclusion that both the Supplier and the Buyer should produce 10 units. Furthermore their profits are 200 and 100 respectively. This indeed coincides with the maximum Supply chain profit. So, everything is fine here and this works conveniently.

But wait a minute! Where is the win-win? It seems like the profits are fixed under the revenue-sharing contract. They do not depend on P nor on gamma! No matter what the negotiated P is, assuming that we want to optimize the supply chain, the win-win situation can not be achieved. When I first saw this, it came to me as a shock. Apparently, Revenue-sharing does not always work. It worked in the Video rental chain model but not here. The question is why? Or put in a broader perspective: When does Revenue-sharing work and when does it not work? And what other contract mechanisms do work here? The honest answer to all these questions is: I really don't know.

All these unanswered questions bring me right to my research agenda for the years to come.



[SLIDE 49] To my opinion contract mechanisms have a huge potential in supply chain management. They can realize substantial improved profits for all parties involved without the hassle of joint decision making. To further explore these opportunities, I need to do further research. In fact my research is likely to be related to all three stages of the Management Science methodology.

First I am interested in all kinds of models of supply chain decisions where local optimization is not enough to lead to global optimization. In fact I am only at the start of this exploration. So far we are studying really simple models just to get a grasp of what is going on although we would like to move on to more realistic hence more complex models.

With respect to the second stage I want to get further into the mathematical tools needed to solve more complex models. The parametric analysis of even the simple models that I worked on so far turned out to be quite complex. But more importantly, new mathematical problems appeared. To many people this work might seem rather dull, but I find formulating and solving the underlying mathematical problems intriguing, fascinating and challenging. Some of the solutions found are truly elegant and beautiful and gave me tremendous joy.

The third stage in the Management Science cycle might proof to be most difficult but also most rewarding from a managerial perspective. If we find that from a mathematical point

of view it is good to get into for instance a Revenue-sharing contract what then are the roadblocks or practical problems that would prevent managers from implementing it? And how to remove these roadblocks? Here also behavioral aspects come into play. Here other factors besides rational decision making to optimize the situation are often found in the real life situation.

Fortunately, I am not alone in doing the research. Many of the ideas I formulated here came from joint research with my friend and colleague Professor Venugopal. Together we share the love of Supply Chain models and applications. Since recently, we are very fortunate to have Vijay Reddi with us at Nyenrode. Supervised by Venugopal and myself, Vijay will do his PhD on supply chain optimization models and contract mechanisms very much in line with what I discussed in this lecture.

Furthermore, I am very happy that two external practitioners have recently approached me to supervise their part-time work on a PhD thesis related to Supply Chain Management.

Arjan Bakx, an executive at SEW-Eurodrive has formulated the hypothesis that in practice Supply Chain Management on the third level can be as effective as Supply Chain Management on the second level. Co-supervised by Ad van Goor and myself, Arjan will gather real life cases and empirical material to test this hypothesis. It is not very hard to imagine that in light of everything that I told here, for me this truly is an interesting research topic.

Marcel Noordhuis is starting up a PhD-thesis on reducing failure cost in construction supply chains. Together with Haico Ebbers I intend to supervise his work which will be focussed on establishing mechanisms that will allow, and even stimulate, the various parties to work together without running the risk of them bonding together against the final customer.

This research agenda kind of brings me to the end of the formal part of this lecture. But I won't let you escape before I have thanked some people that have been proven really important in making this occasion, this inaugural lecture possible.

Ik ben vele mensen dank verschuldigd. Die kan ik natuurlijk niet allemaal noemen want dan loopt deze bijeenkomst nog meer uit, wordt de pedel boos en u ongeduldig. Maar een paar mensen moeten toch echt worden genoemd.

Allereerst en vooral mijn ouders.
Pa en Ma, het behoeft eigenlijk geen betoog dat zonder jullie nooit aflatende steun en vertrouwen deze oratie nooit had plaatsgevonden. Jullie hebben mij een ijzersterk fundament meegegeven waarop ik heb kunnen bouwen. Oerbegrippen als "Doe maar gewoon dan doe je gek genoeg", "Werken voor je geld", "Nait soezen", en gisteren nog "Kop der veur" zijn me met de paplepel ingegoten en daarvan profiteer ik nog elke dag. Deze dag is wat mij betreft ook voor een belangrijk gedeelte jullie dag.

Prof.dr. Venugopal
Dear Venu, it is hard not to underestimate the influence you have had on me and my work at Nyenrode. Your friendship and insights have made me a richer person. I am deeply thankful for knowing you and working with you. Together we have done so many good things. Although the pressure is always high at Nyenrode I am really looking forward to our continued collaboration.

Prof.dr. Robben
Beste Henry, Jouw komst naar Nyenrode begin 1997 was een keerpunt. Sinds die tijd ziet de Nyenrode wereld er voor mij totaal anders uit. Onder jouw leiding hebben we samen gewerkt aan het opzetten en runnen van het Center for Supply Chain Management. Een periode waar ik met zeer veel genoegen naar terugkijk. Nog belangrijker was de manier waarop jij leiding gaf. Ondersteunen, coachen, enthousiasmeren en altijd oog voor het menselijke aspect zijn kenmerken die bij jou horen en die bijzonder waardeer. Jij geloofde dat ik hoogleraar kon worden ver voordat ik dat zelf geloofde. Als klap op de vuurpijl heb je in 2000 je positie als directeur van het center eraan gegeven om mij als nieuwe hoogleraar-directeur te kunnen laten benoemen. Een zeldzame actie. Hoewel er misschien een klein vleugje eigen belang bij zat heeft het voor mij nieuwe wegen geopend. Ik ben je buitengewoon dankbaar voor alles wat je voor mij hebt gedaan.

Decaan Prof.dr. Palm
Beste Hans, de laatste jaren heb wij een bijzonder prettige relatie opgebouwd. Je openheid, je Nyenrode-hart, en je aanstekelijk enthousiasme hebben me altijd bijzonder gestimuleerd. Daarnaast heb je hebt me altijd door dik en dun gesteund en heb je niet nagelaten me op belangrijke punten te coachen. Hiervoor dank ik je van harte.

Prof.dr. Commandeur,
Beste Harry, de afgelopen 3 jaar was de eerste vraag die altijd stelde als we elkaar zagen: hoe is het met je oratie. Eindelijk heb ik een bevredigend antwoord. Graag wil ik je bedanken voor je niet aflatende druk om de oratie op korte termijn te doen. Ook wil je bedanken voor de spiegel die me regelmatig voorhoud en de nuttige adviezen die je daarbij geeft. Ik stel dat zeer op prijs.

Nyenrode colleagues,
Nyenrode is truly a fantastic environment to work in. If you work here as long as I do, you sometimes forget how good it is here. Sure, the work-presure can be very high. But if you come to Nyenrode late at night or in the weekends you can be sure that you are not alone. And always we are open to, and interested in, each other and willing to help the other. As only a small example, I can mentioned the great help that I got from Frank Verbeeten and Haico Ebbers when preparing for this lecture. I truly can not image a more stimulation atmosphere to work in. I thank you all for creating that atmosphere. A special thank you goes to the colleagues in the Center for Supply Chain Management. Through you my insights in our area have developed tremendously and the friendly ambiance in our center is highly appreciated.

Programma management MSc en PDP
Marijn, Nynke, Marije en Marjolijn
De afgelopen anderhalf jaar heb ik als programmadirecteur met jullie mogen samenwerken. Hoewel ik voordurend word uitgescholden als “de baas” moet ik toegeven dat het een feest is om dit werk met jullie te kunnen doen. Samen met de PA’s hebben we een fantastisch team en mogen we schitterende programma’s runnen. Ik wil jullie bedanken voor alle steun en al het plezier.

Wenche Asijee
Lieve Wenche. In mijn onderzoek wordt een partnership als optimaal gedefinieerd. Wij weten samen dat een partnership niet alleen in wiskundige termen optimaal is maar ook in het echte leven. Ons leven. Ik dank je voor alles.

En ten slotte wil ik iedereen bedanken die de moeite heeft genomen om hier vandaag aanwezig te zijn. Thank you all for coming.

Ik heb gezegd.

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