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The Beergame in business-to-business eCommerce courses – a teaching report

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Abstract

In this teaching report I demonstrate the use of the so-called beer distribution game in teaching business-to-business eCommerce courses. The beergame is a role-play supply chain simulation game that lets students experience typical coordination problems of (traditional) supply chains without information sharing and collaboration. With this paper I want to show how the beergame can be used to provide students with a more profound understanding of the reasons why eCommerce technologies are used in contemporary supply chains; I also want to share my experiences and beergame materials with other information systems scholars in the field. To this end, I will introduce the beergame, demonstrate its use in a classroom setting, and show how I embed the game in a typical B2B eCommerce syllabus.

Keywords: Teaching, eCommerce, Beergame, Supply Chain, Bullwhip effect

1 Introduction

This is not a research paper. Rather, it is a teaching report in which I describe the use of the so called beer distribution game (or beergame) – a logistics and supply chain simulation game – in teaching business-to-business eCommerce. The aim of the paper is twofold: First, I want to demonstrate how the beergame can be used to provide students with a more profound understanding of the reasons why eCommerce technologies are used in contemporary supply chains to exchange information and to facilitate collaboration. Second, I want to share both my experiences and my materials for using the beergame in eCommerce courses with the IS community, i.e. those scholars that teach (business-to-business) eCommerce or supply chain management courses.

The beergame is a role-play simulation game in which students enact a four stage supply chain. The task of this supply chain is to produce and deliver units of beer: the factory produces and the other three stages deliver the beer units until it reaches the customer at the downstream end of the chain. In doing so, the aim of the players is rather simple: each of the four groups has to fulfil the incoming orders of beer by placing orders with the next upstream party. Since communication and collaboration is not allowed between supply chain stages, the players invariably create the so called bullwhip effect. With ‘bullwhip’ we refer to the effect that the amount of periodical orders amplifies upstream in the supply chain towards the production end, thus causing a range of operational problems. The bullwhip effect is a well-known phenomenon and a prominent symptom of coordination problems in supply chains.

In using the beergame to create the bullwhip effect students experience first hand, not only the problems of lack of information sharing and collaboration in supply chains, but also the main causes for the creation of the bullwhip effect. Henceforth, in introducing eCommerce measures in the later sessions of the course, students can relate to these topics through their own experiences. The paper ties in with a recent discussion on the ISWorld eMail list on “how to make relevant IS teaching for students with little or no practical experience”. In teaching information systems (IS) and specifically B2B eCommerce we frequently experience problems of making relevant those topics for students. The challenge is to get them to appreciate the relevance of IS and also to provide them, not only with a superficial knowledge of the topics, but with a more profound understanding of the reasons why eCommerce technologies are used in practice. Against this backdrop I want to show how the beergame can help demonstrating the role and need of eCommerce technologies in a topic area in which the students not only lack practical knowledge (i.e. with regards to supply chains), but typically also do not have their own frame of reference to be able to relate to the topics we teach.

To this end, I will introduce the beergame, demonstrate its use in a classroom setting, present typical results created by playing the game and show how I embed the game in a typical B2B eCommerce syllabus. I begin with introducing the game and the bullwhip effect (in section 2). In section 3, I then describe the application of the beergame in a classroom setting; I give an overview of a beergame session and present typical results. Section 4 demonstrates how typical supply chain problems (and the causes of the bullwhip effect) can be deduced from the beergame experience in order to motivate the introduction of eCommerce measures for improving supply chain coordination. The section is concluded by a synopsis of typical eCommerce topics that can follow the beergame in a typical B2B syllabus (section 4.3).

2 The Beergame

In the following I will first give a brief introduction to the bullwhip effect before I introduce the beergame itself, i.e. its history, structural setup and the rules of the game.

2.1 Bullwhip effect as symptom of typical supply chain problems

The bullwhip effect is a well-known symptom of typical coordination problems in (traditional) supply chains. It refers to the effect that the amount of periodical orders amplifies as one moves upstream in the supply chain towards the production end (Lee, Padmanabhan & Whang 1997a). Even in the face of stable customer demand small variations in demand at the retail end tend to dramatically amplify upstream the supply chain with the effect that order amounts are very erratic, and can be very high in one week and almost zero in the next week. This phenomenon was discovered and first described by Forrester (1961) who did research into the relationship between ordering and stock keeping patterns using simulation models (Warburton 2004). The term itself was first coined around 1990 when Procter&Gamble perceived erratic and amplified order patters in its supply chain for

baby diapers. The effect is also known by the names whiplash or whipsaw effect (Lee, Padmanabhan & Whang 1997a), which refers metaphorically to the visualisation of order patterns moving upstream the supply chain (see figure 3).
As a consequence of the bullwhip effect a range of inefficiencies occur throughout the supply chain, e.g. high (safety) stock levels, poor customer service levels, poor capacity utilisation, aggravated problems with demand forecasting, and ultimately high cost and low levels of inter-firm trust (Chopra & Meindl 2001; Lee, Padmanabhan & Whang 1997a). While the effect is not new and a lot of research has been conducted and supply chain projects have been initiated since its discovery, it is still a timely and pressing problem in contemporary supply chains. Various research studies have quantified the effect and estimate that profitability in most supply chains might improve by up to 30% by eliminating the bullwhip effect (Metters 1997; McCullen & Towill 2002).

2.2 Beergame setup and rules

Having introduced the bullwhip effect and its implications for the supply chain and its players I will now introduce the beergame, its setup and rules. I begin by providing a brief history of the game before I present the general structure and the rules of the game.

2.2.1 History of the beergame

The beergame (or beer distribution game) was originally invented in the 1960s by Jay Forrester at MIT as a result of his work on system dynamics (see Forrester 1957). While the original goal of the simulation game was to research the effect of systems structures on the behaviour of people ("structure creates behaviour"), the game can also be used to demonstrate the benefits of information sharing, supply chain management, and eCollaboration in the supply chain (Li & Simchi-Levi 2002).
A range of different versions of the beergame have emerged over the years. The original beergame was realised as a board game (Sterman 1989). Meanwhile a table version (Ossimitz, Kreisler & Zoltan 2002) and also computerised simulations (Hieber & Hartel 2003) have been developed. In this paper I predominantly draw on a table version, which I adapted from the so called Klagenfurt design (cp. Ossimitz, Kreisler & Zoltan 2002); the structural setup of the table version is shown in figures 1 and 2. I will briefly discuss advantages and disadvantages of the different game versions in chapter 3.1 where I discuss the administration of the beergame in a classroom setting.

2.2.2 General structure of the game

The beergame simulates a supply chain that consists of four stages (retailer, wholesaler, distributer and factory), each of which is played by one or better two or three players (Goodwin & Franklin Sr. 1994). Hence, a supply chain is typically played by 8 to 12 people, while more than one supply chain can be administered in one class at the same time. The task of each supply chain is to produce and deliver units of beer: the factory produces and the other three stages deliver the beer units until it reaches the external customer at the downstream end of the supply chain. In doing so, the aim of the players is rather simple: each sub group has to fulfil the incoming orders of beer. The retailer receives an externally predetermined customer demand and places orders with the wholesaler; the wholesaler sends orders to the distributor, who orders from the factory; the factory finally produces the beer. Hence, orders flow in the upstream direction, while deliveries flow in the downstream direction of the supply chain. An important structural aspect of the game is delay (i.e. time lag) in order to account for logistics and production time. Each delivery (and production order) requires two rounds until they are finally delivered to the next stage. In the structural setup of the game this is represented by two shipping delay fields located in between the supply chain stages as well as at the production end (figure 1).

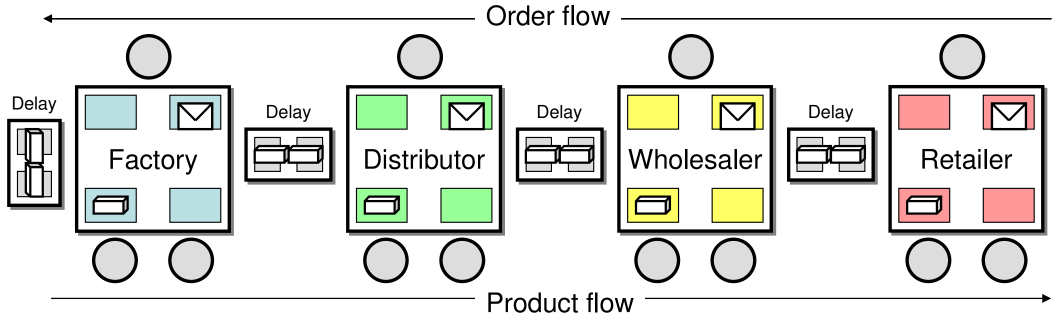

Figure 1: Supply chain setup in the beergame table version

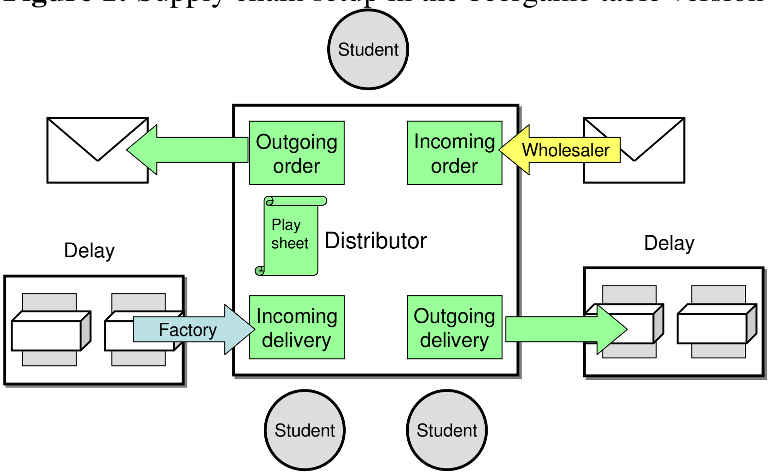

Figure 2: Detailed table layout

2.2.3 Rules of the game

The game is played in rounds, which simulates weeks. In each round the following steps have to be carried out by the players: 1) receive incoming orders, 2) receive incoming deliveries, 3) update play sheets (outstanding deliveries and inventory), 4) send out deliveries, and finally 5) decide on the amount to be ordered. In doing so, deciding on each round's order amount is effectively the only decision that players are able to make throughout the game; everything else follows a set of fixed rules. The first rule is that every order has to be fulfilled, either directly (should the players' inventory be large enough) or later in subsequent rounds. In the latter case, players have to keep track of their backlog (backorder) (Coakley et al. 1998). Secondly, inventory and backlog incur cost – each item in stock costs EUR 0.50 per week, while each item on backlog costs EUR 1.00. Consequently, the primary aim of each subgroup is to keep their costs low. Hence, the optimal strategy for the players is to run their business with as little stock as possible without being forced to "move into backorder". Thirdly, players are not allowed to communicate. The only information they are allowed to exchange is the order amount; there is no transparency as to what stock levels or actual customer demand is; only the retailer knows the external demand (Rafaeli et al. 2003). Moreover, the game is based on the simplification of unlimited capacity (in stock keeping, production and transportation) and unlimited access to raw materials at the production end (Hieber & Hartel 2003).

2.2.4 The external demand

In playing the game the external demand is predetermined and usually does not vary greatly. In the beginning, the supply chain is pre-initialised with inventory levels (e.g. 15 units), orders (e.g. 5 units) and beer units in the shipping delay fields (e.g. 5 units). In order to induce the bullwhip effect to the supply chain the external demand remains stable for a few rounds (e.g. 5 units for 5 rounds) before it suddenly shows one steep increase (jumps to 9 units) before it remains stable again at this higher level for the remainder of the game (usually 40 to 50 rounds in total). However, the one increase in external demand is enough to induce variance into the supply chain, which will inevitably lead to the creation of the bullwhip effect and to a destabilisation of ordering patterns throughout the supply chain.

3 Using the beergame in class

Having described the idea, the structural setup, and the rules of the beergame, I will now discuss the administration of the game in a classroom setting. This is followed by the presentation of typical results generated by beergame applications in eCommerces courses. These results are very useful for deriving the causes of the bullwhip effect in discussions with students in a so-called debriefing session (see section 4). For a session outline of a B2B course that uses the beergame please refer to appendix 2; the experiences shared in the following sections are more or less based on this session outline.

3.1 Administering the beergame

3.1.1 Choosing a beergame version

As mentioned above, different versions of the beergame exist for use in classroom settings. The traditional version is a board game in which tokens are physically moved on the board to represent orders and stock. The upside of the board version is that people relate well to moving actual objects. However, there are two downsides: firstly, the board game is too slow, cumbersome and complex to administer; secondly and more importantly, because physical objects are used to represent inventory on the board, people enjoy an unwanted transparency of inventory levels of other supply chain stages and can thus strategically act upon their knowledge of incoming stock.

The table version of the beergame was originally developed by a team at the University of Klagenfurt (Ossimitz, Kreisler & Zoltan 2002). It shows several improvements to the original design such as a leaner and more pragmatic approach to moving orders and stock in the supply chain. Essentially this is done by using paper slips on which numbers are written by the players. However, it still shows some administrative overhead such as a bookkeeping person that takes stock of all things happening within the supply chain using a computer. While this functions as a built-in safety net in case something goes wrong, it is still a hurdle to the application in a classroom setting and it also slows down the game, which results in long sessions and the students being bored throughout the game.

Henceforth, I have adapted the table version and essentially eliminated the bookkeeper in order to achieve a more straightforward progression of the game. The risk however is that students make mistakes in calculating order amounts or stock levels using the paper play sheet. While it helps to start slowly and to double-check the play sheet calculations during the first few rounds, in a few of my first beergame applications some people indeed miscalculated stock levels, which led to problems with interpreting the data later on. For this reason, today I use MS Excel and a laptop computer on each table for people to fill in their play sheets; this effectively eliminates the risk and ensures a quick progression of the game (see appendix 1 for a play sheet example).

3.1.2 Schedule of a beergame session

The first step in administering the beergame is the preparations of the tables. As is illustrated in figure 2, four fields have to be marked on each table, which is done by fixing to the table 4 sheets of paper using sticky tape. The same is done with the delay fields. Furthermore, cardboard boxes (or plastic cups) and envelopes have to be filled with small paper slips to pre-initialise the supply chain with orders and deliveries. Then, every table has to be prepared with a stack of order and delivery slips that will be used by the players during the game. Finally, paper slips with the external demand progression (see above) have to be prepared that are handed to the retailer groups during the game. Also, for administering more than one supply chain, (student) assistants are needed to help with moving boxes and envelopes during the game.

The second step is briefing the students; in doing so I provide a short introduction to the idea of the game, its history, structure, and rules (see above). When playing in more than one supply chain I stress the fact that groups of each stage are competing with one another (e.g. retailer vs. retailer), in order to get the students to take playing seriously. The third step is to start playing some initial trial rounds with the pre-initialised supply chain and to make sure that everyone gets used to filling in play sheets and order/delivery slips. Then, in the fourth step, the speed of playing the game is increased and the game is played for a number of 40 to 50 rounds. The game is then stopped abruptly so that the students do not have time to react strategically to the coming end of the game. The fifth and final part of the session is a short discussion directly after the game, where I ask students how they felt throughout the game and what they think the average customer demand was.

The next session after the beergame session is the debriefing session, for which the data that the groups produced throughout the game has to be consolidated, plotted and analysed. Typical beergame results and their creation are presented in the next section; the debriefing session is described in section 4.

3.2 Typical progression and results of a beergame session

Every beergame session follows roughly the same scheme, so that the progression of the game shows a recurring pattern. I usually start playing the game at a slow pace for people to get used to moving objects, taking stock and filling in the play sheets. What typically happens during these first few rounds is that people try to get rid of some of the inventory (e.g. 15 units) in order to manage their costs; hence they often only place small orders in the beginning (for an example see weeks 1-7 in figure 3). Consequently, when the customer demand jumps to the higher level in round 6 the supply chain has adjusted to a low demand scenario. After the steep increase many retailer groups tend to wait one or two rounds in order to see if the increase is permanent (as in figure 3). When they then place the first large order they invariably initiate a bullwhip effect that perpetuates throughout the chain. Typically, the order amount increases with every stage in the supply chain (as in figure 3).

What happens then is that the groups move deeply into backorder (see figure 4), because due to the delivery delays it takes quite some time for the beer to move through the supply chain to the retail end. Getting increasingly desperate players often try to send signals and place more large orders; in the end they typically lose track of what they have ordered and order way too much. The consequence is that the supply chain is flooded with beer and the inventories overflow (see weeks 20-35 in figure 4). The effect is that people cease ordering entirely; e.g. a lot of very small orders are placed. This is especially true for the higher stages of the supply chain (see table 1). In the end, while the retailer groups often manage to stabilise their business, the higher stages have no idea of the actual customer demand and are left frustrated.

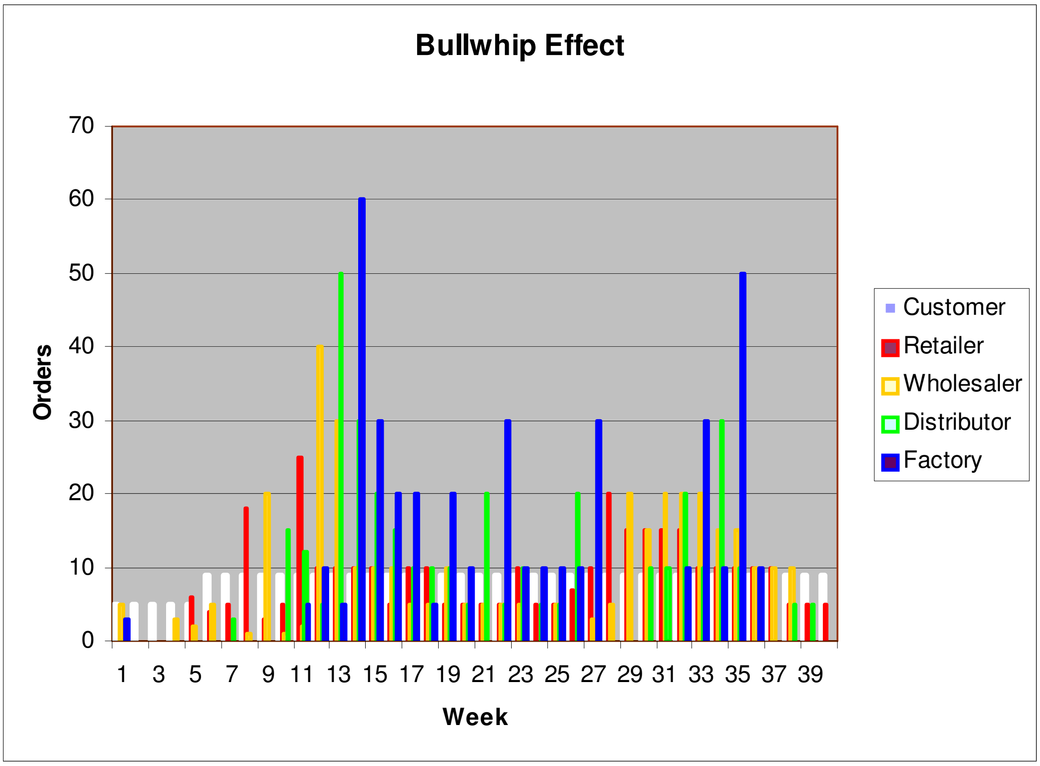

Figure 3: Plot of order distribution, visualising the bullwhip effect

Figure 3 shows the order distribution over 40 weeks and a typical bullwhip effect. Figure 4 shows the inventory fluctuation, with negative inventory representing back order. Table 1 finally shows the decrease in customer demand information upstream visualised by the average order amount by the four stages of the supply chain in this example. More importantly, the increase in order fluctuation up-stream the supply chain is illustrated by the largest amount having been ordered in each stage and the number of small orders that were placed. This translates into an increase in inventory fluctuation as well. All this information is being used in the following debriefing session to discuss the bullwhip effect, its implications and the reasons for its existence.

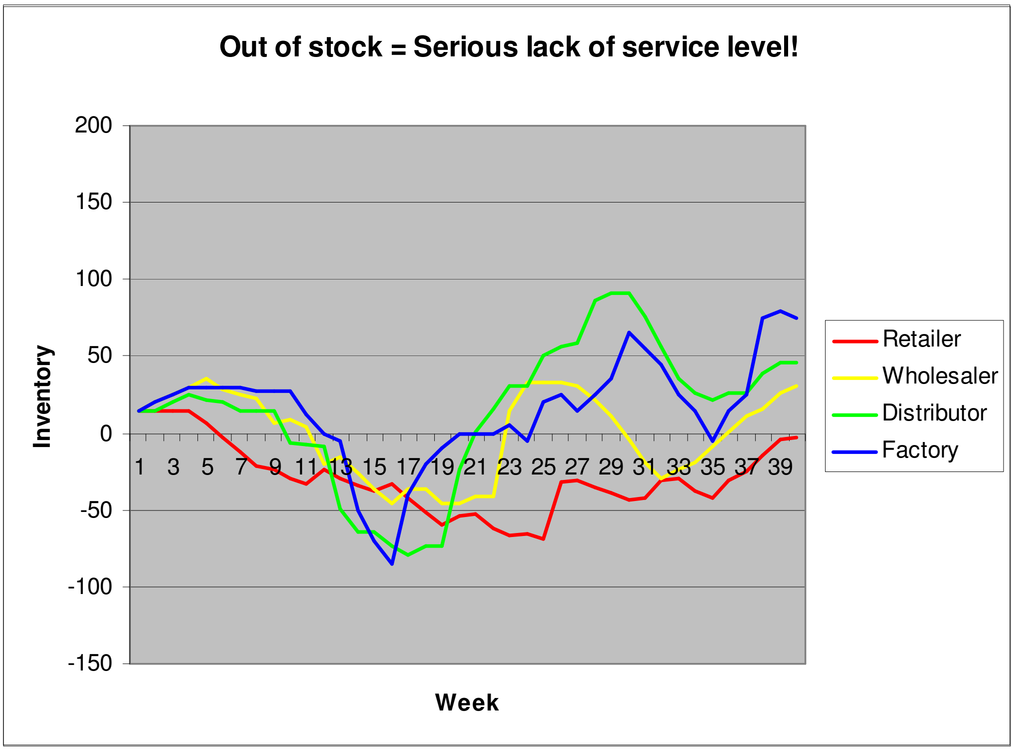

Figure 4: Example of inventory fluctuation (negative inventory = backorder)

Key figures	Retailer	Wholesaler	Distributor	Factory
∅ order amount (units of beer)	8.33	8.68	8.75	9.95
Largest order amount	25	40	50	60
No of small orders (0-2 units)	4	11	14	18
Inventory fluctuation range	84	81	170	165

Table 1: Example of key figures derived from the beergame

4 Learning from the beergame results

Having presented the way in which the beergame is administered and a typical progression of the game and its results, I will now first show how a debriefing session can be used to illustrate supply chain coordination problems and to derive typical causes for the creation of the bullwhip effect. Based on these causes one can then quite easily motivate eCommerce measures and ICT-based supply chain reform initiatives that aim at reducing the bullwhip effect and improving supply chain coordination.

4.1 The debriefing session

The debriefing session follows the beergame session (see appendix 2). I usually begin the session with a brief discussion of students' experiences throughout the game. Typically, the following questions are being discussed:

- Did you feel yourself controlled by forces in the system from time to time? Or did you feel in control?
- Did you find yourself "blaming" the groups next to you for your problems?
- Did you feel desperation at any time?

This discussion typically shows that people indeed were blaming their neighbouring supply chain partners for not doing their jobs right (either not ordering in a sensible way or not being able to deliver); desperation and frustration are common feelings during the last rounds of the game. A first learning from this discussion is that it is the structure of the game (i.e. the supply chain) that causes the behaviour. This is precisely what its inventor (Forrester) intended to achieve and what is referred to as the effects of systems dynamics.

A second set of questions can then be discussed in order to reflect upon the beergame itself and its degree of simulating real world conditions:

- What, if anything, is unrealistic about this game?
- Why are there order delays?
- Why are there production delays? Shipping delays?
- Why have both distributor and wholesalers; why not ship beer directly from the factory to the retailer?
- Must the brewer be concerned with the management of the raw materials suppliers?

Using these questions and by stressing the fact that real-life supply chains are much more complex (a huge variety of products and supply chain partners exist, as well as complex criss-crossing networks of relationships) the students can quickly be convinced that real-life conditions favour the emergence of the bullwhip to a much greater extent and that the beergame is indeed a good vehicle to simulate the creation of the effect. Having established this necessary bit of legitimisation, the session can then proceed with presenting the beergame results and with identifying the underlying causes.

Hence, the next step essentially is to present, for all supply chain groups, the data (table 1) and figures (3 and 4) presented above. In doing so, I typically have a very interactive and lively discussion. I ask what people thought while playing the game and what led them to, for example, place a huge order at a particular point in the game. In discussing the extreme examples, the class usually shares a laugh, which, as a nice by-product, leads to a more casual atmosphere and contributes to setting an open tone for the remainder of the course. I also honour the winning supply chain teams at this point in time. This is also the time where I introduce the concept of ‘cumulated supply chain cost’, e.g. by pointing out that the product at the customer end has to earn all (cumulated) costs of all supply chain parties; this insight serves as a first step in establishing the idea of global thinking and chain-wide optimization, which essentially requires eCollaboration technologies.

At this point in the session one can then either go straight to identifying the causes and effects of the bullwhip effect (see below), or take a little (useful) detour in discussing a teaching case to corroborate the results and to give the results of the beergame some more credibility. In doing so, I use the case of Italian pasta manufacturer Barilla, one of the first documented cases in which a company launched a project to identify the causes of the bullwhip effect and to introduce some countermeasures (see Simchi-Levi, Kaminsky & Simchi-Levi 2003, p. 91).

4.2 Identifying the causes of the bullwhip effect

The bullwhip effect, as simulated in the beergame, is mainly caused by three underlying problems: 1) a lack of information, 2) the structure of the supply chain and 3) a lack of collaboration and global optimisation. These three causes can be identified in an interactive session with the students by discussing the beergame experiences and then be corroborated with insights from practice and the literature.

4.2.1 Lack of information

In the beergame no information except for the order amount is perpetuated up the supply chain. Henceforth, most information about customer demand is quickly lost upstream in the supply chain. Moreover, no other information is being shared. With these characteristics the beergame simulates supply chains with low levels of trust, where only little information is being shared between the parties. Without actual customer demand data, all forecasting has to rely solely on the incoming orders at each supply chain stage. In reality, in such a situation traditional forecasting methods and stock keeping strategies contribute to creating the bullwhip effect (Lee, Padmanabhan & Whang 1997a; Simchi-Levi, Kaminsky & Simchi-Levi 2003). Unexpected increases in orders from downstream partners translate into even higher order increases upstream, because when players regard the increase to be permanent and want to avoid running out of stock, they need to update their safety stock levels; hence they place an even larger order. Later, when it turns out that an increase was only temporary, safety stock levels are lowered and players might order nothing for a while, hence contributing to the bullwhip effect.

4.2.2 Supply chain structure

The supply chain structure, with its design as separate stages and the long lead times, contributes to the bullwhip effect. The longer the lead time, i.e. the longer it takes for an order to travel upstream and the subsequent delivery to travel downstream, the more aggravated the bullwhip effect is likely to be. With traditional ordering, the point in time where an order is typically placed (the order point) is usually calculated by multiplying the forecasted demand with the lead time plus the safety stock amount, so that an order is placed so far in advance as to ensure service level during the time until the delivery is expected to arrive (Simchi-Levi, Kaminsky & Simchi-Levi 2003). Hence, the longer the lead time is, the more pronounced an order will be as an reaction to an increase in forecasted demand (especially in conjunction with updating the safety stock levels, see above), which again contributes to the bullwhip effect.

4.2.3 Local optimisation

Local optimisation, in terms of local forecasting and individual cost optimisation, and a lack of cooperation are at the heart of the bullwhip problem. A good example for local optimisation is the batch order phenomenon. In practice, ordering entails fix cost, e.g. ordering in full truck loads is cheaper then ordering smaller amounts. Furthermore, many suppliers offer volume discounts when ordering larger amounts. Hence, there is a certain incentive for individual players to hold back orders and only place aggregate orders. This behaviour however aggravates the problem of demand forecasting, because very little information about actual demand is transported in such batch orders. And batch ordering, of course, contributes directly to the bullwhip effect by unnecessarily inflating the orders. This might lead to lower local cost in the short term, but translates into higher overall cost at the chain level.

4.3 eCommerce measures to tackle the bullwhip effect

Having identified and discussed the three problem areas with regard to both the beergame and their real-world counterparts, I then present three areas of improvement that directly correspond to the three problem areas: 1) information sharing in terms of electronic data interchange, 2) ICT-enabled supply chain redesign, and 3) supply chain collaboration for global optimisation (see figure 5). In terms of teaching, these three bundles of eCommerce measures and initiatives can then be briefly introduced in one session (see appendix 3) or in more (technical and organisational) detail in three separate sessions (see appendix 2). In the following sections I give a brief overview of what can be part of those sessions.

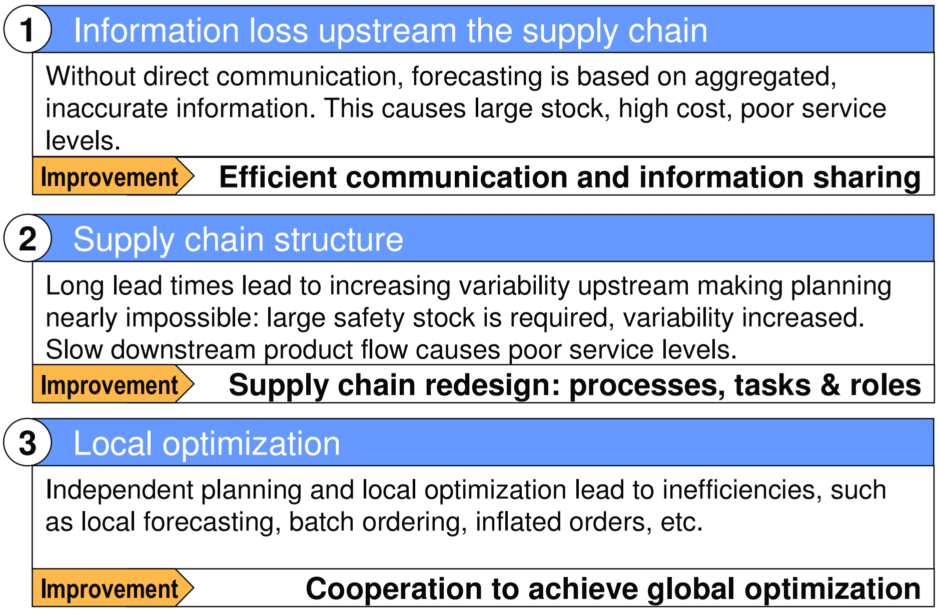

Figure 5: Summary of bullwhip causes and areas of improvement

4.3.1 Efficient communication

One of the most basic learnings from the beergame is to improve information sharing along the supply chain (e.g. of point-of-sale customer demand data); information sharing is the first step towards more advanced supply chain coordination (Muckstadt et al. 2001). Henceforth, the first step in teaching eCommerce measures is to present the principles and technologies of electronic data interchange. In doing so, I first of all discuss with the students the "principles of digitally mediated replenishment of goods" by Johnston (1999), essentially a collection of principles for effective inter-organisational electronic data interchange, such as the "once-only data entry principle" or the "synchronicity principle". Based on these fundamental principles I discuss the ways in which traditional document-based ordering can be reformed using electronic data interchange. While these topics might seem to be outdated from a modern information systems perspective, it lays the foundation for a step-by-step increase of complexity that aims at providing the students with a more substantial knowledge of the problems and ideas behind ICT-enabled supply chain reform than can be achieved by a simple presentation of the latest communication technologies.
The next step in this endeavour is to introduce technologies that are needed to enable effective inter-firm data interchange and electronic ordering, such as product numbering schemes and automatic product identification technologies. In most supply chains physical products have to be handled; hence ways are needed to attach information to these objects. Consequently, I introduce the following technologies:

- *Standardised product numbering schemes*: Here, the history, proliferation, functioning and impact of numbering schemes such as the Universal Product Code (UPC), the European Article Numbering (EAN) code and more specialised codes like for example container codes (SSCC) are introduced. Most of these codes today are administered by the standardisation organisation GS1 (2005).

- *Automated product identification technologies*: The technology with the greatest diffusion in the market is the barcode; while specialised barcodes exist in some industries, the most common one is the UCC/EAN-128 (Coyle, Bardi & Langley 1996). The second, much newer technology to be discussed here is Radio Frequency based Identification (RFID).
- *Electronic Data Interchange (EDI)*: EDI is the basis for electronic ordering. Here, traditional EDI standards, such as the UN/EDIFACT, which was jointly developed by ISO and the UN (Coyle, Bardi & Langley 1996), can be discussed, as well as newer techniques such as Internet-based WebEDI and XML-enabled order exchange.

In discussions with the students these enabling communication and data exchange technologies can then be related back to the beergame experience in that they 1) speed up the order process, thus reducing lead time and 2) enable more sophisticated information sharing of POS data. Moreover, they are the basis for the next step, the ICT-enabled redesign of supply chain structures.

4.3.2 ICT-enabled supply chain reform initiatives

The second building block in dealing with the bullwhip effect comprises a range of different supply chain reform initiatives that can be subsumed under the concept of efficient replenishment. As such, two distinct types of measures can be distinguished: 1) inventory management concepts that aim at changing the ways in which actors in the supply chain carry out their roles of stock keeping and ordering and 2) logistics concepts that aim at improving actual material and information flow.

Efficient inventory management is based on the idea that suppliers have timely access to POS data and can thus eliminate traditional forecasting and change the way ordering and inventory management is carried out (Lee, Padmanabhan & Whang 1997b). Three concepts with increasing degrees of complexity can be distinguished:

- *Quick Response*: The idea behind this concept is for the supplier to become more responsive to changes in customer demand through the sharing of POS data. Retailers still prepare individual orders, but suppliers are better prepared.
- *Continuous Replenishment*: Suppliers continually receive POS data from retailers to prepare shipments at agreed-upon levels.
- *Vendor Managed Inventory (VMI)*: Under this initiative the suppliers manage all inventory aspects for their own products at the retailer end. Suppliers decide on shipment levels without any orders from the retail end to be placed. In fact, the retailer has very little to do with the operational aspects in VMI (Waller, Johnson & Davis 1999).

The second type of efficient replenishment measures is efficient logistics (see Simchi-Levi, Kaminsky & Simchi-Levi 2003). Here, two main building blocks can be discussed:

- *Warehousing and delivery concepts*: Depending on the kinds of goods that are moved along the supply chain, different kinds of warehousing and delivery can be applied in order to achieve an optimal flow of goods. *Cross docking* is a concept in which warehouses function as inventory coordination points rather than actual inventory storage points; hence, goods are only re-shuffled between trucks coming in from suppliers and trucks leaving for stores. This instrument can be used for fast selling products. For bulk products *central warehousing* can be used; while fresh products benefit from *direct delivery*.

- *Full-blown just-in-time delivery (JIT)*: Most commonly found in the automotive industry, 'just-in-time' describes a concept, whereby supplier and manufacturer align their logistics and production processes to a degree that no (or very little) inventory is needed. Goods can be directly delivered from the production at the supplier to arrive just in time to be used in production at the manufacturer end (e.g. Johnson & Wood 1996).

Changing the way in which inventory is managed means to effectively change the supply chain structure. For example, by implementing VMI the supply chain partners eliminate one stage of ordering, thus eradicating one step in the typical bullwhip chain of events. Moreover, by speeding up product flows using the logistics concepts lead time is being reduced, which in turn softens the bullwhip effect. Consequently, all measures discussed in this section can be directly motivated by the beergame. In presenting this block to the students I also point out, for every singly concept, the role of information systems and eBusiness technologies.

4.3.3 eCollaboration: joint planning and global optimisation

The third block of eBusiness measures for tackling the bullwhip effect is the most sophisticated one and builds on the first two blocks. Global optimisation of supply chain processes can only be achieved through the collaboration of supply chain partners under a joint initiative. I present the Collaborative Planning Forecasting and Replenishment (CPFR) initiative as an example from the Grocery industry (VICS 2001) and also discuss (sometimes only briefly) joint product development initiatives in the automotive industry.

CPFR as a concept builds on and extends concepts such as VMI by aiming at establishing a long-term planning of joint promotion activities. CPFR is based on the observation that a combination of inventory management and logistics concepts (see section 4.3.2 above) can reduce the bullwhip effect for day-to-day deliveries, but that these concepts still can not cope with demand variations induced by promotion activities. Hence, CPFR aims at jointly planning promotions and to create transparency as to the expected demand increases induced by these promotions. The concept is based on the use of shared eMarketplace infrastructures, which I also discuss in some detail in this section. Again, the application of eCommerce technologies can be nicely illustrated using the beergame.

4.3.4 Summary

The discussion of the three building blocks of eCommerce measures culminates in the development and presentation of an integrated model of eCommerce-based supply chain management informed by the key learnings from the beergame. The model is presented in figure 6. Following the line of argument in the last sections, it becomes obvious that the beergame can be used to motivate and substantiate large parts of a typical eCommerce masters course (as in appendix 2). In the next section I draw some final conclusions and briefly reflect upon the use of the beergame in a classroom setting.

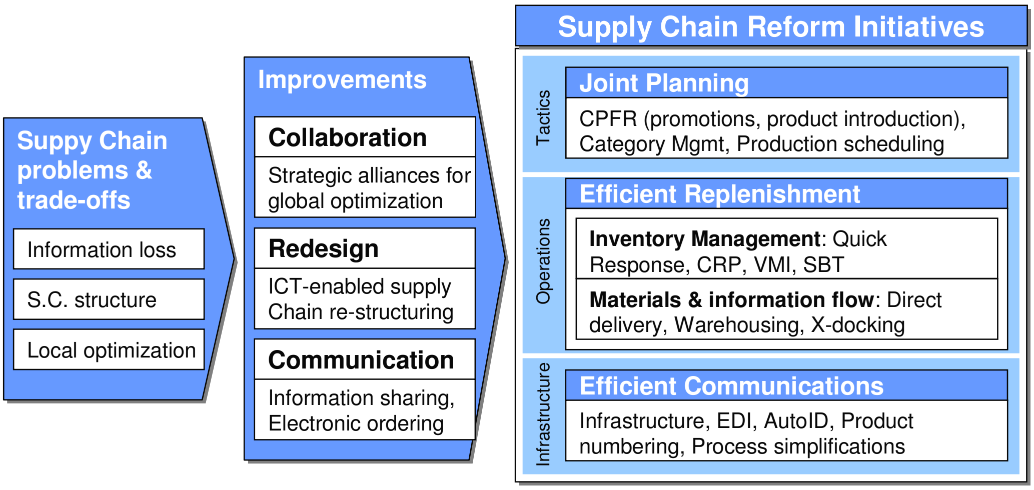

Figure 6: A comprehensive eCommerce and supply chain model

5 Conclusion and outlook

I have introduced the beergame and demonstrated its usefulness in teaching B2B eCommerce and supply chain management. To the present day, I have used the beergame mainly in eCommerce masters courses at different Universities in different national contexts. The experiences and also the teaching evaluations have always been positive and very encouraging. While I believe that the beergame, and the way it is embedded in my B2B eCommerce syllabus, works well in providing students with both a profound understanding of the underlying wisdoms of eCommerce, as well as with a good overview of eCommerce measures, there is more to it than that. Playing the beergame is great fun, for the teacher and for the students, and it is always a good experience in itself. As such, the beergame is also very helpful for the general course atmosphere and the creation of positive team dynamics in the group.

For the future, we are working on a software version of the beergame, which can be used in a classroom setting in the same interactive role-play style, but avoid some of the still remaining problems of the table version. While software versions today only provide a simulation (instead of role-play) mode and are not built for classroom use, a client-server software version of the game might replace the cumbersome logistics aspects (the moving of boxes) and help in gathering data that can be used for debriefing straight away. Moreover, it would be great to be able to play the beergame with different setups, e.g. with implementing effective sharing of (customer demand and inventory) data in order to demonstrate, in a second round of play, the usefulness of information sharing in reducing the bullwhip effect. To this end, our software will be flexible enough to incorporate such exploration of different supply chain modalities.[1]

[1] For further information please see: http://www.beergame.org.

Appendix 1: Beergame play sheet

The following table shows the play sheet of a retailer group that was filled in during a beergame session. The ‘incoming order’ column shows the external customer demand with its increase in round 6. During the game the students only have to fill in the white columns – the ‘incoming delivery’ and the ‘incoming order’ are taken from the incoming paper slips, while in the ‘your order’ column the students have to fill in their order decision for the respective weeks. Having done that, the play sheet shows exactly what has to be written on the outgoing order and delivery slips (in the dark columns). All orange columns are calculated automatically, so that students can easily keep track of their inventory and cost progression. After the beergame this data is then put together and consolidated with the data that was collected in the play sheets of the other groups of the same supply chain. It is then plotted to create figures 3 and 4 and table 1 (see above).

Week	Incoming Delivery	Available	Incoming Order	Your Delivery	Backorder	Inventory	Cost		Your Order		Please fill out play slips: Delivery	Order
0						15						
1	5	20	5	5	0	15	7,5		0		5	0
2	5	20	5	5	0	15	15		3		5	3
3	5	20	5	5	0	15	22,5		2		5	2
4	5	20	5	5	0	15	30		7		5	7
5	0	15	5	5	0	10	35		7		5	7
6	3	13	9	9	0	4	37		12		9	12
7	2	6	9	6	3	0	40		5		6	5
8	7	7	9	7	5	0	45		10		7	10
9	10	10	9	10	4	0	49		10		10	10
10	10	10	9	10	3	0	52		6		10	6
11	0	0	9	0	12	0	64		5		0	5
12	7	7	9	7	14	0	78		7		7	7
13	15	15	9	15	8	0	86		15		15	15
14	3	3	9	3	14	0	100		25		3	25
15	5	5	9	5	18	0	118		15		5	15
16	8	8	9	8	19	0	137		5		8	5
17	6	6	9	6	22	0	159		5		6	5
18	10	10	9	10	21	0	180		6		10	6
19	9	9	9	9	21	0	201		11		9	11
20	8	8	9	8	22	0	223		9		8	9
21	10	10	9	10	21	0	244		9		10	9
22	9	9	9	9	21	0	265		9		9	9
23	12	12	9	12	18	0	283		9		12	9
24	15	15	9	15	12	0	295		9		15	9
25	13	13	9	13	8	0	303		9		13	9
26	4	4	9	4	13	0	316		9		4	9
27	25	25	9	22	0	3	317,5		9		22	9
28	13	16	9	9	0	7	321		9		9	9
29	9	16	9	9	0	7	324,5		9		9	9
30	9	16	9	9	0	7	328		9		9	9
31	9	16	9	9	0	7	331,5		9		9	9
32	9	16	9	9	0	7	335		8		9	8
33	9	16	9	9	0	7	338,5		8		9	8
34	9	16	9	9	0	7	342		8		9	8
35	9	16	9	9	0	7	345,5		9		9	9
36	8	15	9	9	0	6	348,5		9		9	9
37	8	14	9	9	0	5	351		9		9	9
38	8	13	9	9	0	4	353		9		9	9
39	9	13	9	9	0	4	355		9		9	9
40	9	13	9	9	0	4	357		9		9	9

Appendix 2: Syllabus for a beergame-based B2B course

The following table gives an overview of how the beergame can be incorporated in a typical (B2B) eCommerce (masters) course (e.g. 12 weeks with 3 hour sessions). The beergame and the subsequent modules can cover up to 6 sessions. After presenting the three blocks with eCommerce improvements, an additional session can be used to discuss management challenges of inter-firm collaboration, covering issues such as trust, managing interfaces, ICT standards etc. Throughout the course, cases from the grocery and the automotive industries might be used for illustration purposes and to facilitate discussions. Depending on the setting, background readings might also be handed out to the students.

Sessions (3 hours)	Topics / session contents
1. Beergame session	a. Introduction to supply chains (why have supply chains?) b. Beergame introduction (setup, structure, rules of the game) c. Playing the game (40-50 rounds) d. Brief discussion afterwards
2. Debriefing	a. Discussion of experiences and game setup b. Presentation and discussion of beergame data (results) c. Teaching case Barilla: bullwhip causes [optional] d. Identification of the three main causes of the bullwhip effect e. Short presentation of three areas of improvement and the schedule for the next three sessions
3. Information sharing	a. Short discussion: why is information sharing important? b. Principles of electronic data sharing c. Attaching information to physical goods: standardised product numbering, Automated product identification technologies: barcodes, RFID d. Electronic Data Interchange: EDI, WebEDI, XML-based ordering
4. Supply chain reform	a. Overview: efficient replenishment initiatives b. Efficient inventory management: Quick Response, Continuous Replenishment, Vendor Managed Inventory (VMI) c. Efficient Logistics: Warehousing, Direct Delivery, Cross-Docking d. Just-in-Time Delivery in the automotive industry [Kanban]
5. eCollaboration	a. eCollaboration in the supply chain: idea and philosophy b. Collaborative Planning Forecasting & Replenishment (CPFR) c. Joint product development in the automotive industry
6. Management of inter-firm collaboration	a. Complexities of supply chain reform initiatives b. The role of trust and social capital in inter-firm relationships c. Interoperability of ICT d. Managing inter-firm interfaces

Appendix 3: Session outline for a beergame-based workshop

The following table shows a short workshop format based on the beergame. Such a workshop can be incorporated in other (general IS) courses or be a stand-alone event, for example as an executive teaching offering. The workshop is essentially made up of two sessions – the actual beergame session and a combined debriefing and learnings session. As an example industry the Grocery industry can be used to illustrate the application of the eCommerce initiatives and technologies.

Sessions (~3 hours)	**Topics / session contents**
1. Beergame session	a. Introduction to supply chains (why have supply chains?) b. Beergame introduction (setup, structure, rules of the game) c. Playing the game (40 rounds) d. Discussion of experiences and game setup

2. Debriefing & eCommerce initiatives	a. Presentation and discussion of beergame data (results)
	b. Identification of the three main causes of the bullwhip effect
	c. Discussion of three areas of improvement:
	    a. Information sharing: Product numbering, AutoID, EDI
	    b. Supply chain reform: Inventory management & logistics concepts
	    c. eCollaboration: CPFR
	d. Complexities of supply chain reform initiatives

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