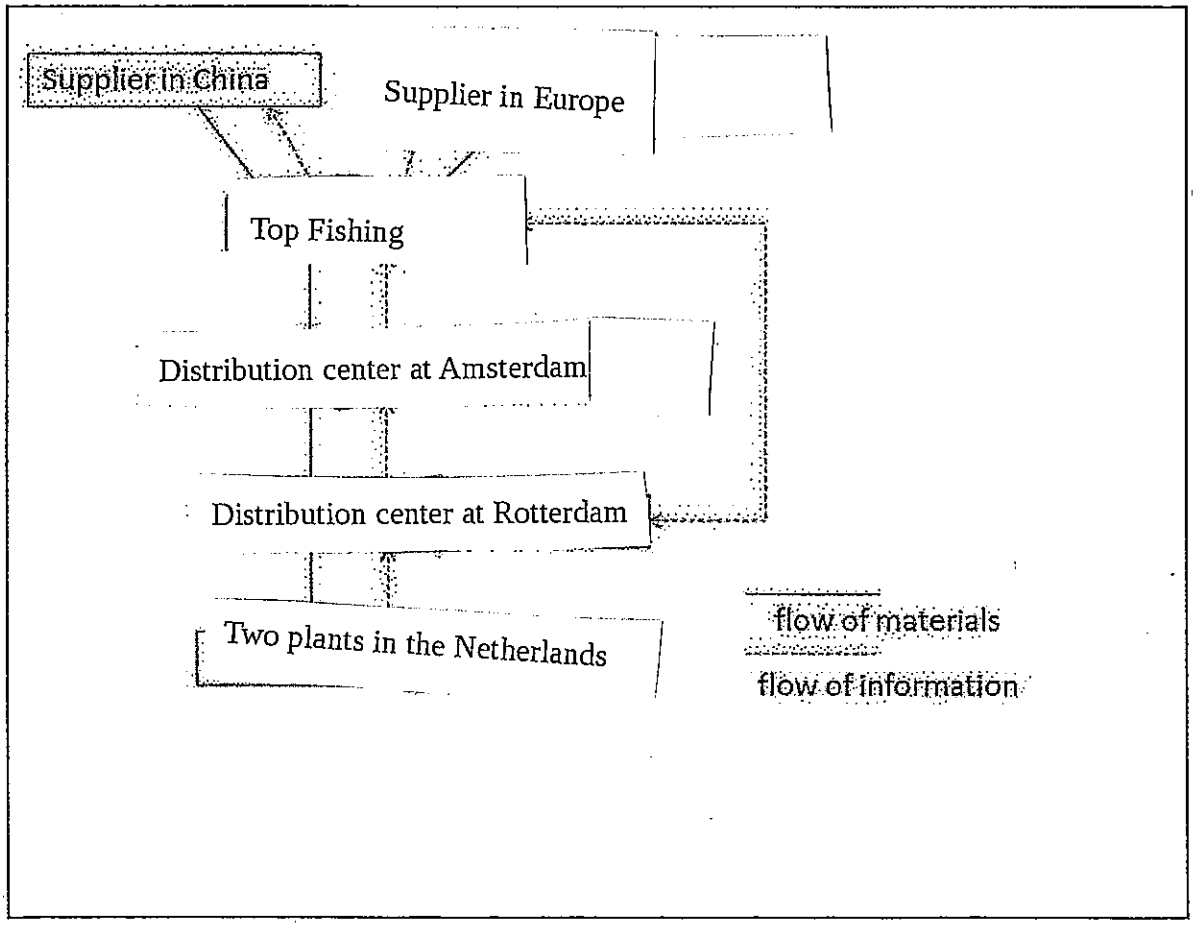
Practice Exam 2

Question 1 (15 points)

A fishing boat manufacturer, Top Fishing, is having many problems with critical globally sourced parts. Top Fishing has two manufacturing facilities in Europe. The firm's reliance on efficient global supply chain operations is increasing as the manufacturer is sourcing more and more parts overseas, including critical components. The component is manufactured overseas in Shanghaiby a supplier, Supplying Inc. The Supplying Inc. production schedule is based on orders sent via fax from the Top Fishing warehouse. They operate on a 90-60-30 day forecast along with a weekly order. Upon completion of the component, Supplying Inc. sends the component via truck to the Hong Kong Port where it is loaded onto a ship heading to Europe. Upon arrival in Europe, the component is unloaded to a Top Fishing distribution center at port after customs inspect. From there, the component is trucked to the Top Fishing warehouse in Amsterdam where the 6-week inventory buffer has been mandated. From the warehouse, the components are trucked to plants in Europe triggered by electronic orders from each of the Pro Fishing plants. Further, the component produced by SupplyingInc. is made up of two main raw materials from two suppliers: one from Shanghai and the other from Europe. It is interesting to note that Supplying Inc. uses these suppliers due to Top Fishing's strict supplier qualification requirements.

a. Draw a figure to describe this supply chain of Top Fishing. Indicate clearly all flows of materials and all flows of information. (10 points) ***[Lecture 1]***



b. Formulate 5 logistics decision problems that might occur in this supply chain. (5 points) *[Lecture 1]*

Select component supplier.
Determine the inventory level at Manufacturing Inc. and the Pro Fishing warehouse.
Perform demand forecasting of the component.
Determine the production schedule at Manufacturing Inc.
Schedule of ships, trucks, trains that distribute the component.

Question 2 (15 points)

Consider the production system consisting of three processes, where the inter-arrival time is 2 minutes. Products are randomly assigned to process 1a or 1b. From multiple observations it is known that on average 60% of the products is assigned to process 1a and 40% to process 1b. One operator is available at process 1a. The operation time for process 1a follows a normal distribution with a mean of 3 minutes and a standard deviation of 1/2 minute. Conveyor A, capable of transporting a large number of products simultaneously, transports a product in 9 minutes to process 2. Also one operator is available for process 1b. The operation time for process 1b takes exactly 5 minutes. Conveyor B, capable of transporting a large number of products simultaneously, transports a product in 5 minutes to process 2. There is a batch production at Process 2 with a batch size of 5 products. The setup time is 3 minutes per batch. The production time per product is 45 seconds. 4 operators are working in parallel at process 3. The operation time per product equals exactly 7 minutes. Thereafter, products leave the system. Note that question 2 is for deterministic performance estimation.

a. What is the average throughput time of a product? (5 points) *[Lecture 2]*

Time for Path 1:
3+9+3+45*5/60+7=25.75 minutes
Time for Path 2:
5+5+3+45*5/60+7=23.75 minutes

The average throughput time:
0.6*25.75+0.4*23.75=24.95 minutes

b. If the arrival rate is increased to 50 per hour, what is the productive utilisation at Process 3? (6 points) *[Lecture 2]*

The arrival rate at 1a is 30 per hour.
The capacity at 1a is 20 products per hour.

The arrival rate at 1b is 20 per hour.
The capacity at 1b is 12 products per hour.

Both 1a and 1b have insufficient capacity compared with the corresponding arrival rate. Process 1 is the bottleneck.

The arrival rate at Process 2 is 32 products per hour.
The capacity of Process 2: $60*5/(3+3.75)= 44.44$ products per hour.

The arrival rate at Process 3 is 32 products per hour.
The capacity at Process 3 is $60*4/7=34.29$ products per hour.

The productive utilization at Process 3 is $32/34.29=0.93$

c. Suppose that Process 2 is in repair for 10% of the time. The inter-arrival time is still 2 minutes. What is the minimal batch size in order to achieve a throughput of 30 products per hour? (4 points) ***[Lecture 2]***

The arrival rate at Process 2 is 30 per hour.

Denote the batch size as z.

$0.9*60*z/(3+45*z/60) \geq 30$

$z \geq 2.857$

The minimal batch size is 3.

Assignment 4 (20 points)

Cén T-am or CTA is a Swiss producer of luxury watches with around 400 employees. The company aims to survive in the turbulent top segment of the market by focusing on excelling product features and mechanical solutions. The company, therefore aims mainly on customers with a keen interest for science and technology. This is clearly recognizable in product lines such as 'Gallileï', 'Racing Watch' and 'Engineer'. Since 1903 the official motto of the company in Latin is 'Probus Raetia', which means proper, solid craftsmanship from Northern Switzerland. The company presumes that at least six generations should use a CTA watch. This is why the mechanical date indicator runs until the year 2200. In the year 2200 the company ensures the by then owner can replace the old date indicator with a new one making the watch to be up to date until the year 2400. Within CTA two product groups are distinguished: the 'regular' watches (ranging from €10,000 to €50,000 per watch) and the 'horloge dificil' watches (ranging from €150,000 to €350,000 per watch). CTA produces approximately 20 types of watches in a very stable collection. This stability relates to the classical appearance of CTA watches. Annually CTA produces approximately 30,000 regular watches and 400 'horloge dificil' watches.

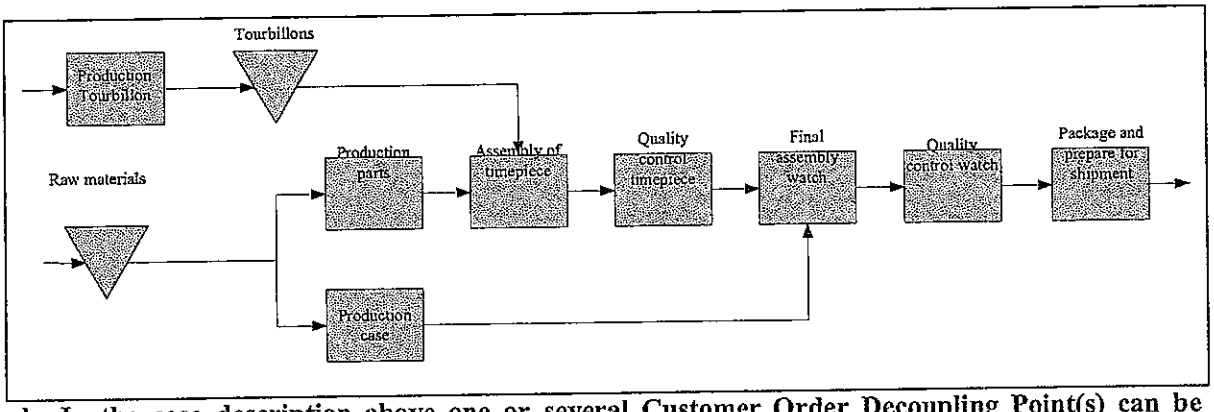
A regular watch consists of a timepiece in a case with wrist strap. The timepiece is composed of a so-called gear work and a tourbillon, which acts as the motor of the timepiece. The tourbillon consists of 81 separate parts and the gear work of approximately 300 separate parts. The housing is always manufactured from a solid piece of metal (e.g. gold, silver, steel). Each regular watch uses the same type of tourbillon. Compared to the rest of the watch the tourbillon is relatively inexpensive. As raw materials for a tourbillon have a very long delivery time, the tourbillons are held in stock. The purchase of raw materials for the tourbillons and consequently the assembly is triggered once the tourbillon stock falls below 400 pieces. CTA sells its watches only through national distributors, every distributor places orders for its own region. Once an order for a regular watch is accepted by CTA, all raw materials for time pieces and housings are collected from the warehouse. As soon as these are present, production is started.

The parts manufacturing department ensures that all 300 parts are produced for a specific gear work. Once all parts are finished they are transported to the assembly department where some fifty experienced watchmakers assemble the timepieces (composing the gear work and adding the tourbillon). After the timepiece is assembled and oiled it is transported to the quality department. Here the timepiece is tested, completely disassembled, cleaned, oiled, reassembled and retested. This is done to ensure the timepiece is perfect. At the same time the metal body is milled within the machine department. Once a timepiece is approved by the quality department it is transported to final assembly. Here, it is put into the case and the wrist straps are added. After final assembly the most important quality check is executed. Finally, after approval, the watch is packed in a luxury box and is prepared for shipping.

The 'horloge dificil' watches undergo similar process steps as the regular watches. The difference is that the 'horloge dificil' watch is made from very expensive materials (platinum, diamonds, rubies) and the gear work is much more complex than that of regular watches. In addition, an exclusive tourbillon is used. For this type of watches all raw materials, including those of the tourbillon, are purchased once a distributor order is received. The complexity of the timepiece makes the production time over four times as much as the production time of regular watches.

Scheduling of customer orders is done on a First Come First Serve basis. As CTA has a very stable production process, the planning department can make an accurate estimate of the total lead time for each order based on the amount of watches currently in production and the amount of orders pending. For luxury producer as CTA lead times are actually not a priority. An accurate prediction of delivery is, however, very important. Customers have no problem being on a waiting list for three months, when indeed, they receive their watch at the promised date.

a. Draw a process flow diagram for the production of regular watches. (4 points)*[page 175-177]*



b. In the case description above one or several Customer Order Decoupling Point(s) can be distinguished. Explain for each CODP how you recognize it, how you characterize it (e.g. MTO, MTS) and where it is positioned in the process. (4 points)*[page 175-177]*

Regular watches: Make-to-Order. Once an order for a regular watch is accepted by MdT, all raw materials for time pieces and housings are collected from the warehouse. As soon as these are present, production is started. CODP is with the raw materials.

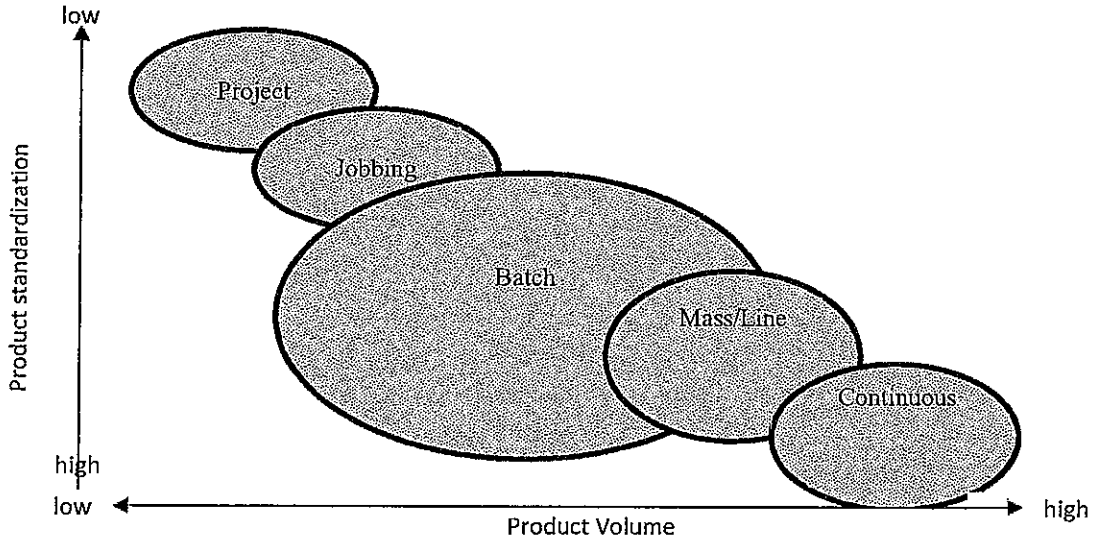
Horloge Dificile: Purchase-to-Order: For this type of watches all raw materials, including those of the tourbillon, are purchased once a distributor order is received.

c. An external consultant advised CTA to move the CODP for the 'horloge dificil' more downstream. By doing this, the consultant argues, the customers of CTA are shielded more properly from disturbances in the production process. Based on your knowledge of upstream forces and downstream forces discuss whether this advice is wise. (4 points) *[page 175-177]*

When the CODP is moved further downstream inventory costs for CTA will rise enormously, initially much more raw materials need to be on stock. Should the CODP be moved further downstream also stocks of components should be held, this results in a risk of obsolescence. The case gives no indication that CTA cannot control its process, so there is little evidence of likelihood of disruptions. The customer has no problem with waiting. In short, the consultant provides a solution to a problem that is not there. Predictability in the demand of such luxury watches is very low; how do you know whether you have the right amount of raw materials in stock, or the right amount of components?

Also the customer is more interested in a dependable than in a fast delivery.

d. In lecture 4 the five different process types were discussed into detail. Indicate these process types in the figure below. Further in the figure mark the position where you expect the process type for 'horloge dificil' is. (6 points) *[page 181, exhibit 6.3]*



The process type for 'horloge dificil' could be one of jobbing, batch, mass/line.

e. **The high-end watch industry focuses more and more on the triple bottom line. One of the pillars of the triple bottom line is Economic Prosperity. Name the two other pillars and give a concrete example for both related to the high-end watch industry.** (2 points) ***[page27, exhibit 2.1]***

Environmental Stewardship:
Environmentally friendly mined raw materials

Social Responsibility:
Honest wages, no blood diamonds, no war gold

Assignment 5 (10 points)

a. **Jacobs & Chase introduce Hau Lee's uncertainty framework. For each quadrant provide the supply chain strategy which is most suitable.** (4 points) ***[page 439]***

		Demand Uncertainty	
		Low (Functional Products)	High (Innovative Products)
Supply Uncertainty	Low (Stable Process)	Grocery, basic apparel, food, oil and gas Efficient Supply Chain	Fashion apparel, computers, popular music Responsive Supply Chain
	High (Evolving Process)	Hydroelectric power, some food produce Risk-Hedging Supply Chain	Telecom, high-end computers, semiconductor Agile Supply Chain

b. **In lecture 6 the 'Bull-whip effect' was addressed. Discuss three causes of the bull-whip effect.**(3 points) ***[page436-437]***

Order synchronization
Customers order on the same order cycle, e.g., first of the month, every Monday, etc.

Order batching

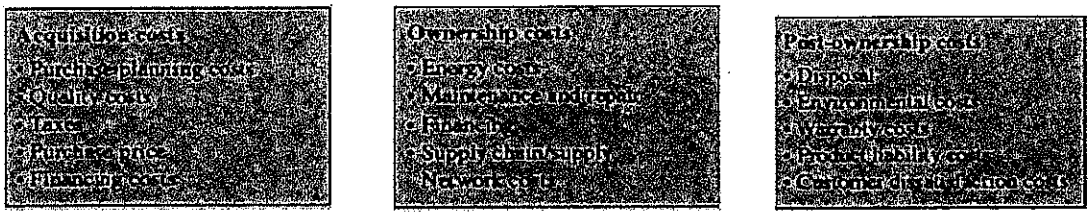
Retailers may be required to order in integer multiples of some batch size, e.g., case quantities, pallet quantities, full truck load, etc.

Trade promotions and forward buying
Supplier gives retailer a temporary discount, called a trade promotion.
Retailer purchases enough to satisfy demand until the next trade promotion

Reactive and over-reactive ordering
Each location forecasts demand to determine shifts in the demand process.
Responding to a "high" demand observation
Unfortunately, it is human to over react

Shortage gaming
If supplier production is less than orders, orders are rationed to secure a better allocation, the retailers inflate their orders, i.e., order more than they need

c. **'Total Cost of Ownership' takes three phases into account. Discuss each of these phases for the case in which a consumer wants to purchase a second hand but relatively new Ford diesel car.** (3 points) *[page 448]*



Assignment 6 (15 points)

a. **The Lean philosophy addresses the removal of 'waste'. In lecture 5 seven sources of waste were addressed. Consider the canteen / cafeteria of the faculty of economics and business. Discuss five sources of waste you probably will encounter.** (5 points) *[Chapter 12]*

- Transportation: Material movement
- Inventory: Work-in-Process Inventory Waste
-Motion: Unnecessary motion of producer, worker or equipment
-Wait: Waiting time of Jobs and Resources
-Over-processing: doing more work than what is required by customer
- Over-production: Producing too early, too much
- Defect: Rework, rescheduling, repair

In order to purchase an item at the Zernike supermarket each customer needs to use the automated check-out machine. To the annoyance of the customers, who want to be in time for class, several of the check-out machines provide the error message "item cannot be scanned, please scan item again" up to six times before functioning properly. Between each scan attempt an employee needs to reset the machine After assessing this situation for a while an IB&M student advises the supermarket to apply the DMAIC methodology.

b. Explain the DMAIC methodology by explaining each of the letters in the acronym. Discuss for each of the stages how they would look like in the supermarket check-out case. (5 points) *[page 314]*

Supermarket scale case:
Define: customers want to check out quickly, waiting for a check out machine does not comply with customer requirements.

Measure: How many people are waiting? How long are they waiting? How does the error log of the check-out machine look like? Which errors are displayed? How many errors occurred? How much time do employees spend on resetting the machine? Etc.

Analyze: There seems something wrong with the scanner. Sensor error? Software error? Mechanical problem? Will cleaning the scanner help? Etc.

Improve: Call a mechanic of the check-out machine supplier, clean the machine, check cables, replace scanner, upgrade software Etc.

Control: Preventive maintenance, have a stock of components, performance agreement with supplier Etc. Check whether the improvement is lasting

Rhine International is an operator of coffee vending machines. A standard cup of Rhine International coffee contains 150 ml of coffee. In order to be profitable a cup should not contain more than 156 ml coffee but in order to keep the customers happy a cup of coffee should not contain less than 140 ml.

By means of sampling one machine at the 6th floor of the Duisenberg building it is determined that the x-bar card in SPC (Statistical Process Control) on the *central line* (CL) has a value of 151ml with *upper & lower control limits* (UCL and LCL) which can have value of 6 ml higher or lower than the CL.

c. Determine the *Process Capability Index* for Rhine International (show your calculation) and use this index to determine what the operations manager should do. (5 points) *[page 323]*

Process Capability Index:
For Rhine International applies that USL = 156; LSL = 140 ; X-bar = 151 and $3\sigma = 6$. It follows that Cpk = Min{ (156-151)/6; (151-140)/6} = Min{ 0.833 ; 1.833} = 0.833

This indicates that the process is not able to provide a cup of coffee within the required specification limits.
Action of the Operations manager:

Immediate action is necessary as profitability is at stake. The operations manager should directly order the machine on the 6th floor to be readjusted. Further the operations manager should assess whether this is an incident or that other machines are also performing poorly.

Question 7 (10 points)

A small manufacturing facility is being planned that will feed parts to four heavy manufacturing facilities. The locations of the current plants with their coordinates and volume requirements are given in the following table.

Plant Location	A	B	C	D
Coordinate (x,y)	280, 300	475, -370	420, 200	-300, 300
Volume (parts per year)	2,000	8,000	5,000	10,000

a. Please determine the best location for this new facility. (5 points) *[page 465-473]*

$$C_x = \frac{280\times2000+475\times8000+420\times5000-300\times10000}{2000+8000+5000+10000} = 138.4$$

$$C_y = \frac{300\times2000-370\times8000+200\times5000+300\times10000}{2000+8000+5000+10000} = 65.6$$

The best location should be positions at (138.4, 65.6).

b. For what range of values for the volume of Location C (currently 5,000), x-coordinate of the new facility is no less than 100 and y-coordinate is no more than 100. Assume that all other volumes keep their current values. (5 points) *[Lecture 7]*

Denote z as the volume of Location C.

We require

$$C_x = \frac{280\times2000+475\times8000+420\times z-300\times10000}{2000+8000+z+10000} \geq 100 \Rightarrow z \geq 2000$$

$$C_y = \frac{300\times2000-370\times8000+200\times z+300\times10000}{2000+8000+z+10000} \leq 100 \Rightarrow z \leq 13600$$

The range is $2000 \leq z \leq 13600$.