Assignment: Wood supply game

Learning goals

This assignment is about the wood supply game, a simulation game on inventory management in the wood supply chain. The goals of this assignment are:

(i) to **experience the bullwhip effect**
(ii) to understand what the bullwhip effect exactly is
(iii) to understand the **causes of the bullwhip effect**
(iv) to learn how **information exchange** and decision **coordination in the supply** may reduce the bullwhip effect.

Literature

This assignment is related to **Chapter 10** ("Coordination in a Supply Chain") of the book "Supply Chain Management – Strategy, Planning and Operation" by Sunil **Chopra**, Seventh edition, Pearson.

Deliverables

Together with your group, you will play **three different scenarios**. After each scenario, you are asked to **collect your results** (key performance indicators, graphs and tables as provided in the Wood Supply Game), **analyze and interpret your results**. The precise questions are stated before each scenario. The deliverable is a report in which you answer all questions. The report length is **at most five pages (excluding appendices)**. In **three appendices**, you should add the graphs and tables displaying each of the three scenarios that you played. For sake of convenience, you can make screen captures of the graphs and tables that are generated in the Wood Supply Game.

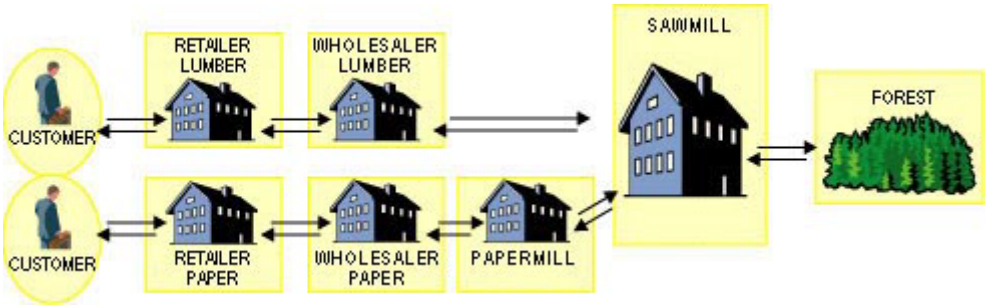
Please submit this document to **Canvas** using the assignment created for this purpose.

Introduction to the wood supply game

The forest products industry is one that includes all the facilities that produce and transform wood and wood products. In this industry, the value creation cycle from the forest to the end customer is long and complex. Each enterprise in the value creation network is an independent decision making unit and this can result in a lack of synchronization of operations. However, information is an important tool when managing the value creation network. Incomplete and incorrect information causes delivery problems (the right products available at the right place and at the right time) and customer dissatisfaction. The Wood Supply Game simulates the operations in the forest

product supply chain in order to demonstrate the dynamics at work in the value creation network and showS the importance of information sharing between enterprises.

Each game is played with a **maximum of 7 students**, each being responsible for the management of one enterprise in the network. The supply chain is represented by different downstream business units of the end customer. These units are: **the forest, the sawmill, the paper mill, two wholesalers (lumber and paper), and two retailers (lumber and paper)**. The **divergent** nature of the forest products industry supply chain is simulated by dividing the material produced at the sawmill into **chips and lumber**. Chips are supplied to the **paper mill**, lumber to the **wholesaler lumber.**



Each business unit manages its own inventory of items, which have certain carrying cost per item and per time unit. Each week, managers of every business unit must **decide the amount of items to order** from their supplier with aim of having to have a high level of customer satisfaction and low inventory costs.

Customer satisfaction (service level) is measured by the availability of products in the right place and at the right time. If products are not available when the client's order is received, **supply of products is delayed (backordered) until the order can be filled**. The business unit manager faces costs for each unit of time that a product is backordered. In this assignment, you try to minimize total **inventory and backorder costs**. These costs per unit per week will be defined later on. As a group, you play the Wood Supply Game three times for different scenarios. Each scenario consists of **30 rounds (weeks).**

Scenario I: Each player gets one of the seven roles (enterprises, positions or business units) in the wood supply chain and aims to **minimize its own inventory holding and backorder costs.**

Scenario II: Same as scenario 1, but the **roles are switched** and each player tries to improve its performance based on the experiences in the first scenario.

IMPORTANT! In these scenarios 1 and 2, you are **not allowed to communicate** any information on your status (inventory, backorders, replenishment orders to arrive) with other players. This represents a traditional supply chain in which information exchange is limited.

Scenario III: You **collaborate as a supply chain team and aim to minimize the total costs in the supply** chain, irrespective your own holding and backorder costs.

In contrast to the first two scenarios, you should communicate about your inventory status and decide jointly about orders to be placed into the supply chain in Scenario 3. During this scenario you will also have the possibility to see how the other business units are performing. Below, we elaborate each of the three scenarios. After playing each scenario, you have to report your results, answer some questions, and draw relevant conclusions.

Process logic and decisions

Every week, each enterprise in the supply chain has **to replenish its inventories**. That is, you have to decide how many items to order from your supplier. With the products that you have on hand, you will have to meet the demand of your customer. **If you order more than you sell, the items are put into your inventory and your inventory costs** will rise. On the other hand, **if you have not enough products** on hand to satisfy customer demand you face **backorder costs, and you have to fulfill the order later**. You can find these costs in the **upper right corner** of the screen during the whole game. In the end, your total costs have to be as low as possible. When ordering products, please keep in mind that you face a **replenishment order lead time** that equals four weeks and consist of two parts:

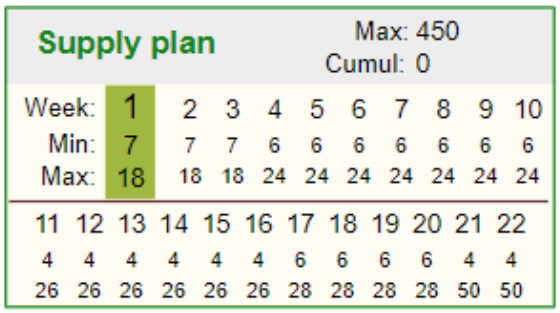
(i) An **order delay of two weeks**. That is, any order release will be received by the supplier two weeks later. At that point in time, the supplier picks the quantity requested from stock (if available) and ships it to the customer. If you do not have enough inventory to fulfill the order completely, the order is partly filled and the rest is backordered until the supplier has received additional products. This backordered quantity is shipped later. You do not see the ordered quantities directly on your screen (only after they are in transit, see transport delay), but you can view "history" to trace previous orders (see explanation of the screen below)

(ii) A **transport delay of two weeks**. It takes two weeks until your order arrives. You can see the orders in transit that will arrive during the next two weeks on your screen (see explanation of the screen below).

This means that for a quantity **ordered in week 1**, the order will be processed in week 2 and 3, the products will be transported in week 4 and 5, and the products are **available to fill demand from week 6** on.

At the **Sawmill,** additionally you have **to choose how you want to allocate incoming products between wood chips for the paper mill and lumber for the lumber wholesaler** (in addition to the replenishment orders). You can set a percentage, which means that incoming products are allocated to lumber and wood chips based on this ratio. Once the incoming products have been allocated, they are processed by the saw mill and they are specific for each branch of the supply chain. This means, **you cannot use lumber inventory to fill customer demand for wood chips, and vice versa**.

When you have the role **Forest**, it is important to know that the Forest has a supply plan (see screenshot to the right).



This supply plan shows the **minimum and maximum quantity to harvest in each week, as well as the total maximum quantity that you can harvest over the entire planning horizon**. Any replenishment decision, whether manual or by computer has to satisfy these restrictions. The time for forest operations is **one week**. That is, any **quantity ordered to be harvested in week 1** is in process in week 2 and is **available to fill demand in week 3**.

Playing the wood supply game

To **assign roles to students in each scenario, please number the students 1, 2, 3, 4 (5, 6, 7)**, depending on the number of students in your project group. **Each student will keep the same number during the whole assignment**.

To play the wood supply game, you do the following steps:

1. Choose one person from the group who will be the ***Administrator*** **(the person who will create the games in addition to playing a position in the game itself)**. The steps to be followed by the administrator for setting up the game are described in detail **in Appendix II**.
2. Every group member should go to http://forac-old.fsg.ulaval.ca/woodSupplyGame/AideJeuBois/EN/indexEN.htm
   (If there are issues with opening the game, **allowing Flash Player or changing the internet browser usually helps**, e.g., Internet Explorer, Microsoft Edge. Also for Mac OSx, downloading Firefox may be needed**.)**

Scenario I

First, the **administrator should create a game and set the parameters according to the instructions in Appendix II** (Scenario I). Please **read the questions** that you will have to answer for scenario 1 **before you start the game**. You do not have to answer those questions yet, but you know where to pay attention while playing the Wood Supply Game. **After playing the scenario, save all you graphs because they will not available anymore.**

Questions Scenario I

A. How did you/your position perform in Scenario I in terms of costs and customer satisfaction? And how did the other positions perform? Provide the following three figures / tables:
   i) The orders placed by every position in the supply chain during the 30 weeks (if not provided by the game, accessible by the administrator - history: lumber chain, paper chain; alternative: click on "orders", copy and paste the data to excel and make your own graph)
   ii) The behavior of inventory and backorders at every position in the supply chain during the 30 weeks (if not provided by the game, accessible by the administrator - history: lumber chain, paper chain; alternative: click on "inventory", copy and paste the data to excel and make your own graph)
   iii) Table of the inventory costs, backorder costs and customer satisfaction per role (cumulated over 30 weeks): if not provided by the game, accessible by the administrator - history - costs".

   Discuss these results in the project group. In your report, you should mention which position performed best and which one performed worst and what were the key reasons for this. Briefly explain the policies of the best and worst players and if there are external causes for underperformance or excellent performance. Add the figures as Appendix A to your report.

B. For each player: Describe your role, explain briefly how you intend to modify your decisions when playing the next scenario and why you believe that this will reduce your own costs.

Playing Scenario I

Each player will be assigned to one of the positions in the supply chain. The task you get in this round is to keep the costs you make at your position as low as possible (inventory holding costs plus backorder costs).

1. Click on one of the servers. All group members should click on the same server. Sometimes one of the servers doesn't work. If that happens, choose a server on another continent. You can do this by choosing one of the servers marked in the red box on the screenshot to the right[1].

[1] In exceptional cases, it may happen that your screen remains blank, which may be due to specific browser settings. A simple way to avoid this is to use another browser (e.g. Firefox or Google Chrome)

2. Every group member clicks “Play game”.
3. Fill in your name, choose the game that the Administrator just made (with a unique name) and choose the position in the supply chain which belongs to your unique number within your group:

Group member	Position (4 members)	Position (5 members)	Position (6 members)	Position (7 members)
1	Paper Retailer	Lumber Retailer	Lumber Retailer	Lumber Retailer
2	Paper Wholesaler	Paper Retailer	Paper Retailer	Paper Retailer
3	Sawmill	Paper Wholesaler	Paper Wholesaler	Paper Wholesaler
4	Papermill	Sawmill	Sawmill	Lumber Wholesaler
5		Papermill	Papermill	Sawmill
6			Forest	Papermill
7				Forest

   Every week you will have to make decision(s) as described under “Process logic and decisions” above.
4. Press “Go”. The screen that will appear is explained in detail in Appendix I.
5. Play 30 weeks: every week you have to place replenishment orders. With these orders you have to meet the demand of your customers. At the same time you want to keep your costs as low as possible. You can find the costs for your position in the upper right corner. Once all players submitted their decision, the game moves to the next round (week) automatically. If the game does not move to the next round, it is probably because not all players completed their decisions. If this is the first round, this can be also because the administrator did not assign remaining positions to the computer. The administrator should do that by clicking on the “Complete” button in the setup of the game.
6. After playing all of the 30 weeks of this scenario, every group member has to collect the data of the game: Go to “history” in the right corner of your screen, click on this button and make print screens of all the figures you can find here. An example of the figures can be found in Appendix I.
7. After playing the scenario, save all you graphs because they will not available anymore.
8. Answer the questions of Scenario I. You find them above.

Scenario II

First, the administrator should create a game and set the parameters according to the instructions in Appendix II (Scenario II). Settings of Scenario II and I are similar with one exception. We introduce **some randomness (seasonality) to the demand to** improve the learning effect. Please read the questions that you will have to answer for Scenario II before starting the game, but answer them after the game finishes.

Questions Scenario II

A. How did you/your position perform in Scenario II? And how did the other positions perform? Make three figures / tables:
   i) The orders placed by every position in the supply chain during the 30 weeks (if not provided by the game, accessible by the administrator - history: lumber chain, paper chain; alternative: click on "orders", copy and paste the data to excel and make your own graph)
   ii) The behavior of inventory and backorders at every position in the supply chain during the 30 weeks (if not provided by the game, accessible by the administrator - history: lumber chain, paper chain; alternative: click on "inventory", copy and paste the data to excel and make your own graph)
   iii) Table of the inventory costs, backorder costs and customer satisfaction per stage (cumulated over 30 weeks): if not provided by the game, accessible by the administrator - history - "costs".

   Discuss these results in the project group. In your report, you should mention which position performed best and which one performed worst and what were the key reasons for this. Add the figures as Appendix B to your report.
B. How did the whole supply chain perform in terms of costs and satisfaction of the final customers? How do these costs vary over the 30 weeks? Has it been better or worse than in Scenario I? Why? Please make a figure or use an existing one and discuss it.
C. For each player: Describe your role, explain whether you recognize the bullwhip effect? Is your bullwhip effect experience different from that in Scenario I? Remember that you have a different position in the supply chain here than in Scenario I.
D. Make a scheme of the total supply chain in which you include how long it takes for a certain order to move through the whole supply chain via all different business units. You could think of describing the path of a tagged tree from the forest: how long does it take before a tagged piece of paper or lumber (from that tagged tree) arrives at a customer?
E. As a team, design a strategy that you can use in the next scenario to minimize supply chain costs rather than individual costs. Which supply chain information does each player need to make better decisions? How should ordering decisions be aligned in the supply chain? Prepare a strategy for the best supply chain performance in the third scenario. Clearly describe how you are going to make decisions based on the extra information that you will use now.

Playing Scenario II

In Scenario II you will get another position in the supply chain. The task you get in this scenario is again to keep the costs of your position as low as possible.

1. The game should be set up for scenario II (see Appendix II). This step should only be done by the *Administrator*.
2. Click on one of the servers. All group members should click on the same server.
3. After the game has been set up by the Administrator, every group members should press the “Play game”-button to select the game to play.

4. Fill in your name, choose the game that the Administrator just made, and choose the position in the supply chain which belongs to your unique number within your group:

Number	**Position (4 members)**	**Position (5 members)**	**Position (6 members)**	**Position (7 members)**
1	Papermill	Paper Wholesaler	Paper Wholesaler	Paper Wholesaler
2	Sawmill	Papermill	Forest	Lumber Wholesaler
3	Paper Wholesaler	Sawmill	Sawmill	Forest
4	Paper Retailer	Lumber Retailer	Lumber Retailer	Sawmill
5		Paper Retailer	Paper Retailer	Lumber Retailer
6			Papermill	Paper Retailer
7				Papermill

5. Press "Go".
6. Play 30 weeks: every week you have to purchase orders. With these orders you have to meet the demand of your customers. At the same time you want to keep your costs as low as possible. You can find the costs you made in the upper right corner. Once all players play the round, the game moves to the next round (week) automatically. If the game does not move to the next round, it is most probably because not all players completed their decisions, or if this is the first round, this can be also because the administrator did not assign remaining positions to computer. The administrator should do that by clicking on "Complete" button.
7. After playing all of the 30 weeks of this round, every group member has to collect the data of the game: Go to "history" in the right corner of your screen, click on this button and make print screens of all the graphs you can find here.
8. After playing the scenario, save all your graphs because they will not available anymore.
9. Answer the questions of Scenario II. You will find them above.

Scenario III

First, the administrator should create a game and set the parameters according to the instructions in Appendix II (Scenario III). Please read the questions that you will have to answer for Scenario III before starting the game, but answer them after the game finishes.

Questions Scenario III

A. How did you/your position perform in Scenario III? And how did the other positions perform? Make three figures / tables:
   i) The orders placed by every position in the supply chain during the 30 weeks (if not provided by the game, accessible by the administrator - history: lumber chain, paper chain; alternative: click on "orders", copy and paste the data to excel and make your own graph)
   ii) The behavior of inventory and backorders at every position in the supply chain during the 30 weeks (if not provided by the game, accessible by the administrator - history: lumber chain, paper chain; alternative: click on "inventory", copy and paste the data to excel and make your own graph)
   iii) Table of the inventory costs, backorder costs and customer satisfaction per stage (cumulated over 30 weeks): if not provided by the game, accessible by the administrator - history - "total costs".

   Discuss these results in the project group. In your report, you should mention which position performed best and which one performed worst and what were the key reasons for this. Add the figures as Appendix C to your report.
B. How did the whole supply chain perform in terms of costs and satisfaction of the final customers? How do these costs vary over the 30 weeks? Has it been better or worse than in Scenario I and II? Why? Please make a figure and discuss it.
C. Which aspects of the strategy that you developed in advance worked out well and which not? How do you think that you can improve your supply chain ordering strategy further as a team?
D. What do you think companies could do to further reduce the bullwhip effect?

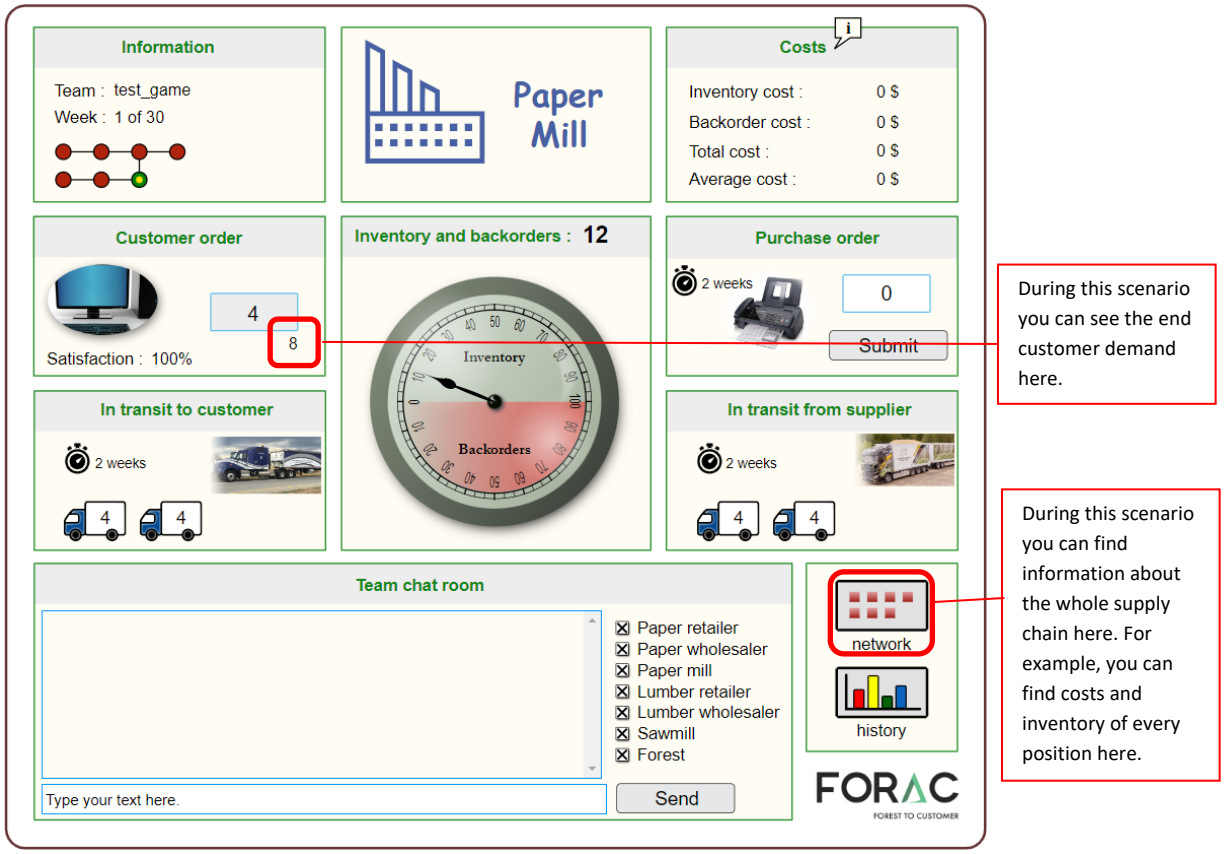
Playing Scenario III

In Scenario III you will keep the same positions in the supply chain as in round two. The task you get in this round is to keep the costs of the total supply chain (the inventory and backorder costs of all positions together) as low as possible. Keeping the costs of your own position as low as possible is not the main goal anymore: the costs of the total supply chain are more important.

1. The game should be set up for scenario III (see Appendix II). This step should only be done by the *Administrator*.
2. Click on one of the servers. All group members should click on the same server.
3. Every group members should press the “Play game”-button to select the game to play.
4. Fill in your name, choose the game the Administrator just made and choose the position in the supply chain which belongs to your unique number within your group:

Number	Position (4 members)	Position (5 members)	Position (6 members)	Position (7 members)
1	Papermill	Paper Wholesaler	Paper Wholesaler	Paper Wholesaler
2	Sawmill	Papermill	Forest	Lumber Wholesaler
3	Paper Wholesaler	Sawmill	Sawmill	Forest
4	Paper Retailer	Lumber Retailer	Lumber Retailer	Sawmill
5		Paper Retailer	Paper Retailer	Lumber Retailer
6			Papermill	Paper Retailer
7				Papermill

5. Press "Go". The screen you start with is the following (or a screen that is similar to this one). In the image below the display you will have in front of you, is explained. It differs a bit from the screens used in Scenario I and II:



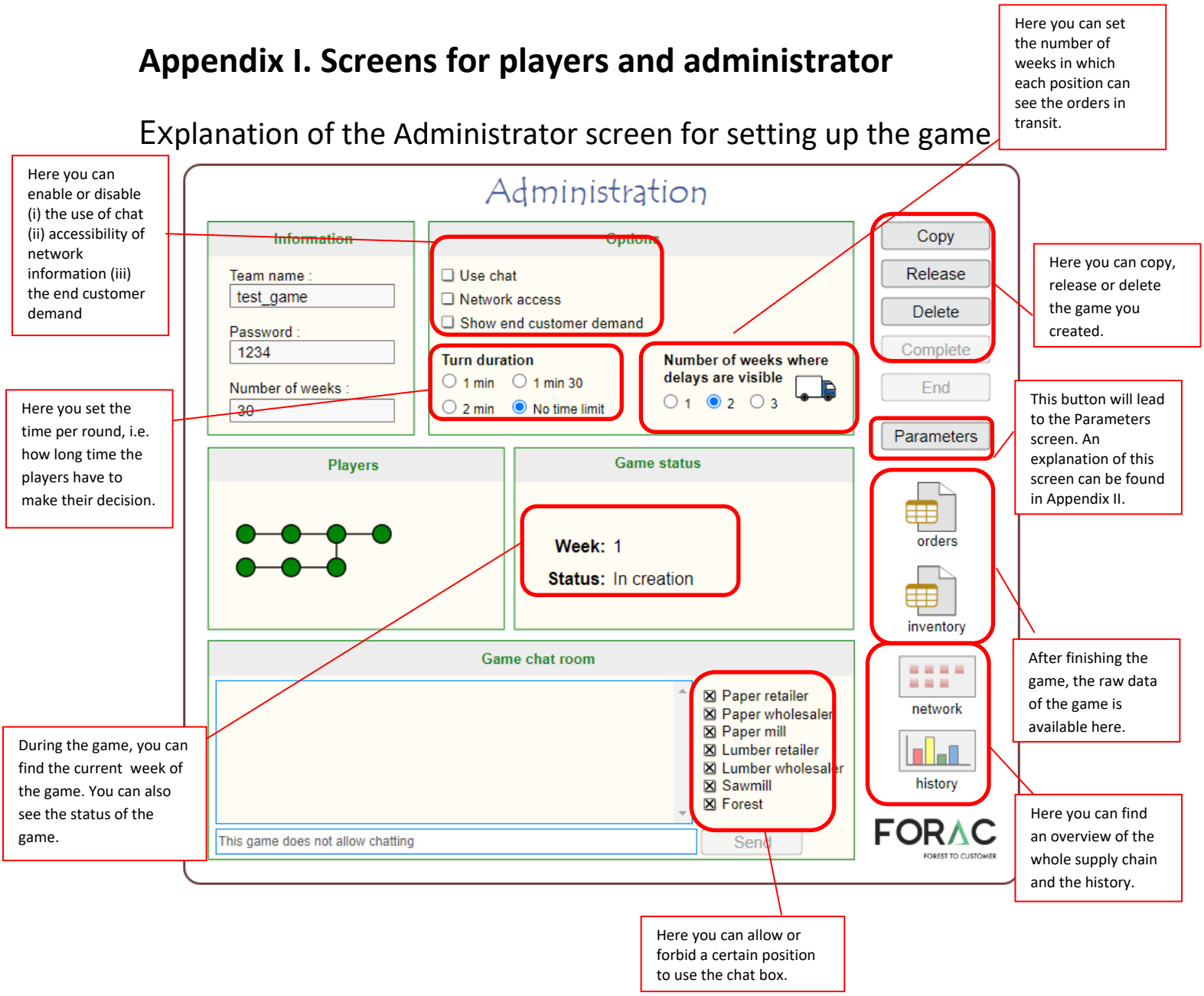
6. Play 30 weeks: every week you have to purchase orders. With these orders you have to meet the demand of your customers. At the same time you want to keep the costs of the total supply chain as low as possible. You can find the costs your position made in the upper right corner. Once all players play the round, the game moves to the next round (week) automatically. If the game does not move to the next round, it is most probably because not all players completed their decisions, or if this is the first round,

this can be also because the administrator did not assign remaining positions to computer. The administrator should do that by clicking on “Complete” button.

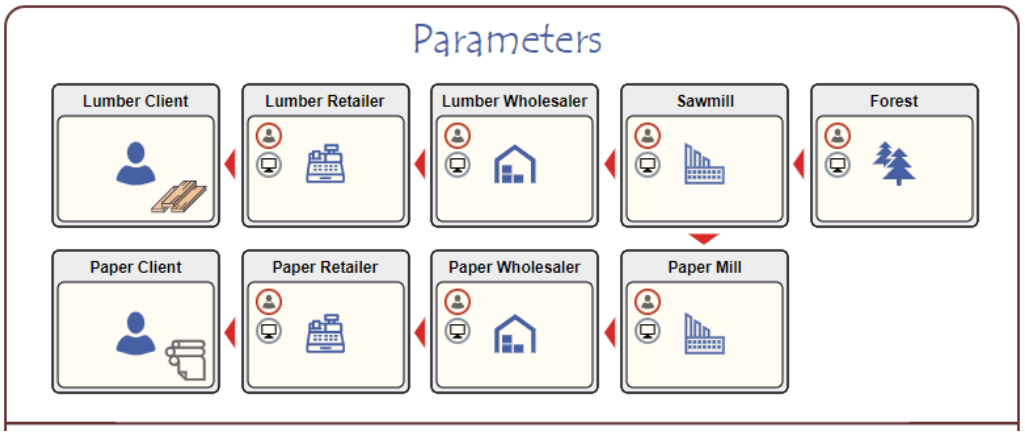
7. After playing all of the 30 weeks of this round, every group member has to collect the data of the game: Go to “history” in the right corner of your screen, click on this button and make print screens of all the graphs you can find here.
8. **After playing the scenario, save all you graphs because they will not available anymore.**
9. Answer the questions of Scenario III. You will find them above.

Appendix I. Screens for players and administrator

Explanation of the Administrator screen for setting up the game



When you click on "Parameters" at the right side, you enter the following screen:



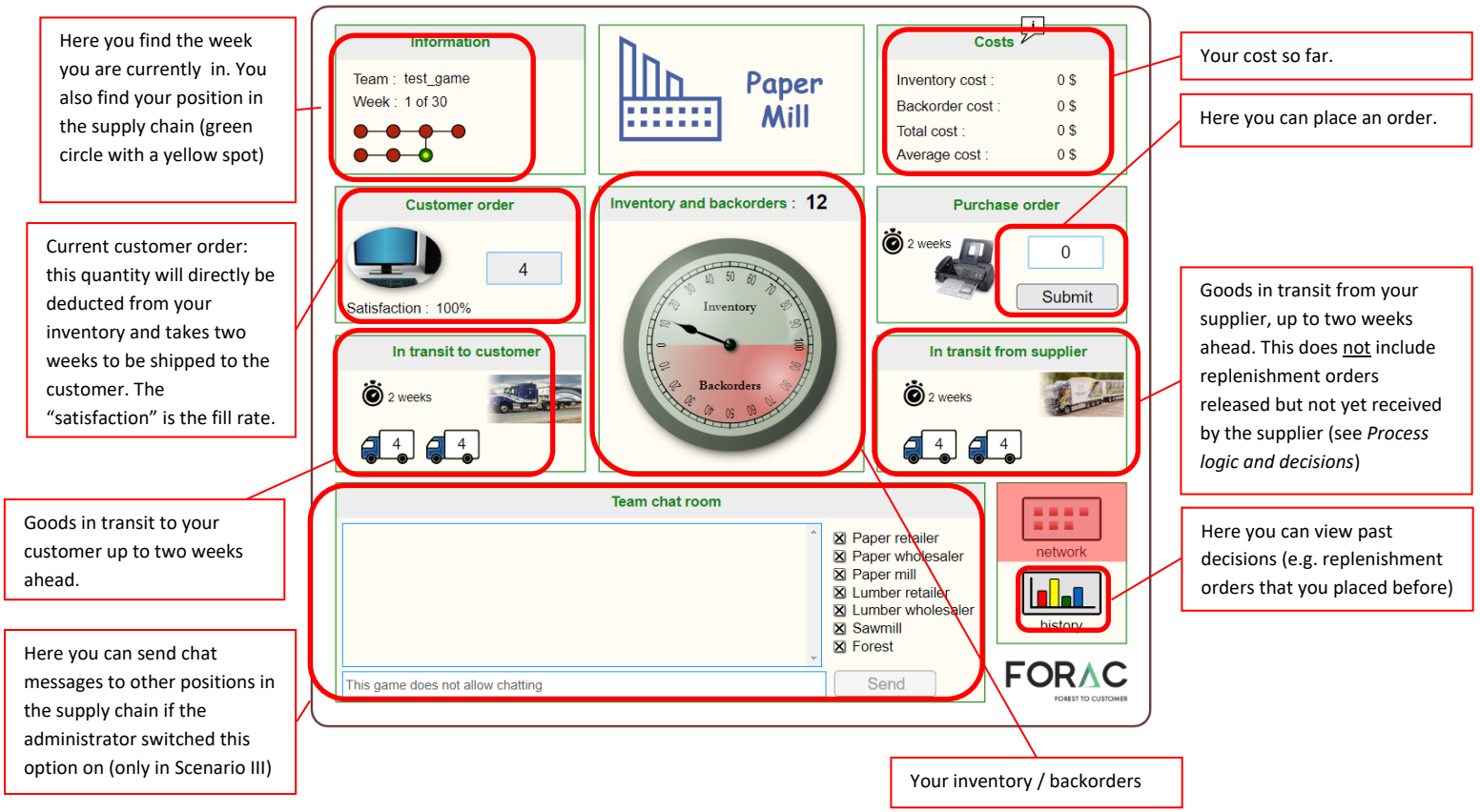
An Administrator can set the initial inventory levels at each position in the supply chain. Additionally, you can set the inventory control policy that the computer will apply when playing a certain position in the supply chain.

For example, for the Lumber Wholesaler, the initial inventory (the inventory this position starts with) is set to 12. Furthermore, the inventory cost per unit and the backorder cost per unit are set. The numbers on the right tell you the initial quantity and delay of the first order and the first transport. This order is already made for you when you start the game and the transport is already requested. For the Lumber Wholesaler this means that he has ordered 4 units when you start the game and that this order has an order delay of 2 weeks and a transport delay of another 2 weeks. We refer to the body of the document ("Process logic and decisions") for details. The inventory control policy that the computer will apply when playing a certain position in the supply chain is also based on the initial quantity of the orders and the transport.

The same kind of numbers can also be found for all other positions. For the forest, only the initial harvest is set automatically.

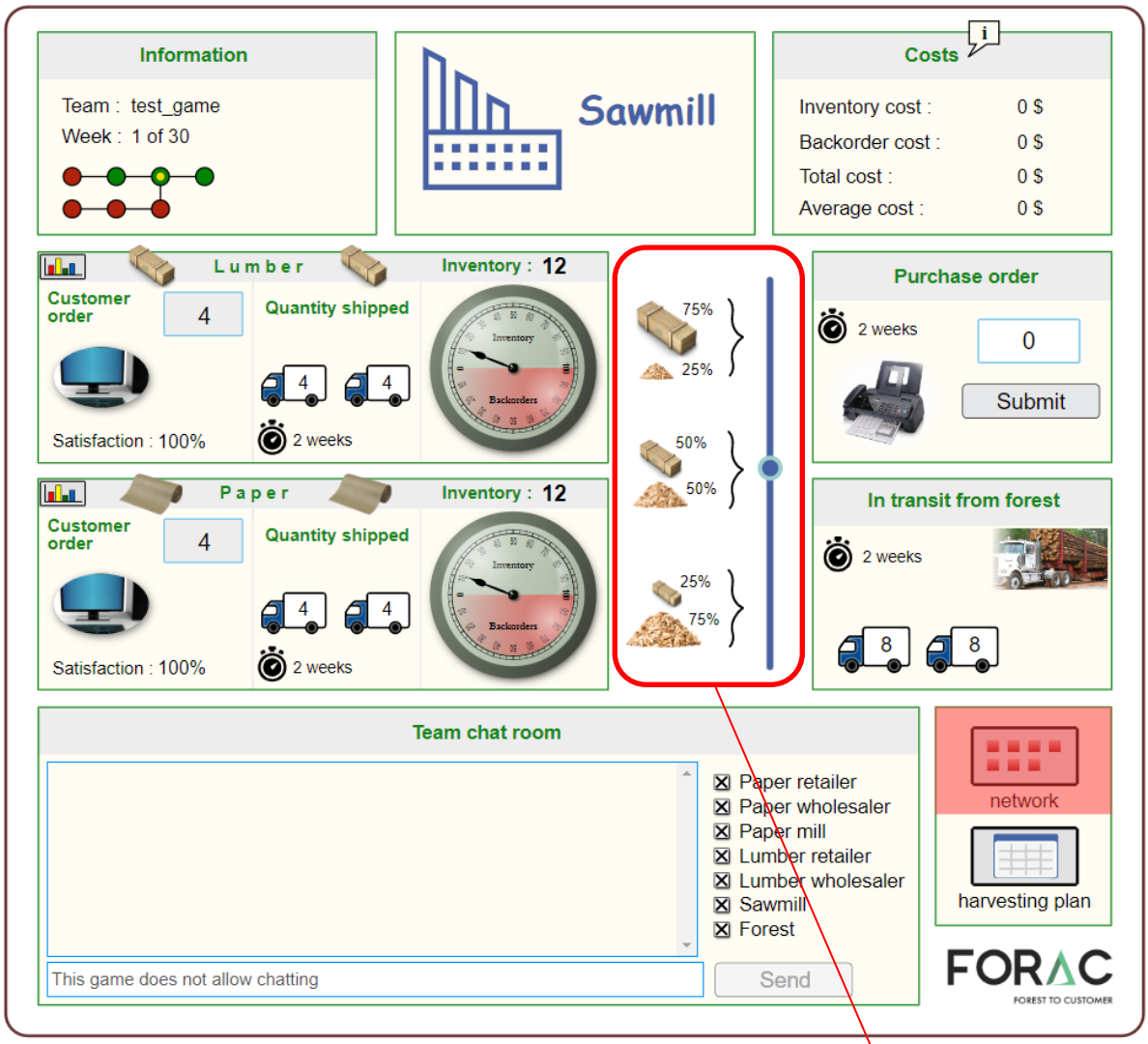
Explanation of the main screen while running the game

The main game screen (or a screen that is similar to this one) is shown below with an explanation of the different segments:



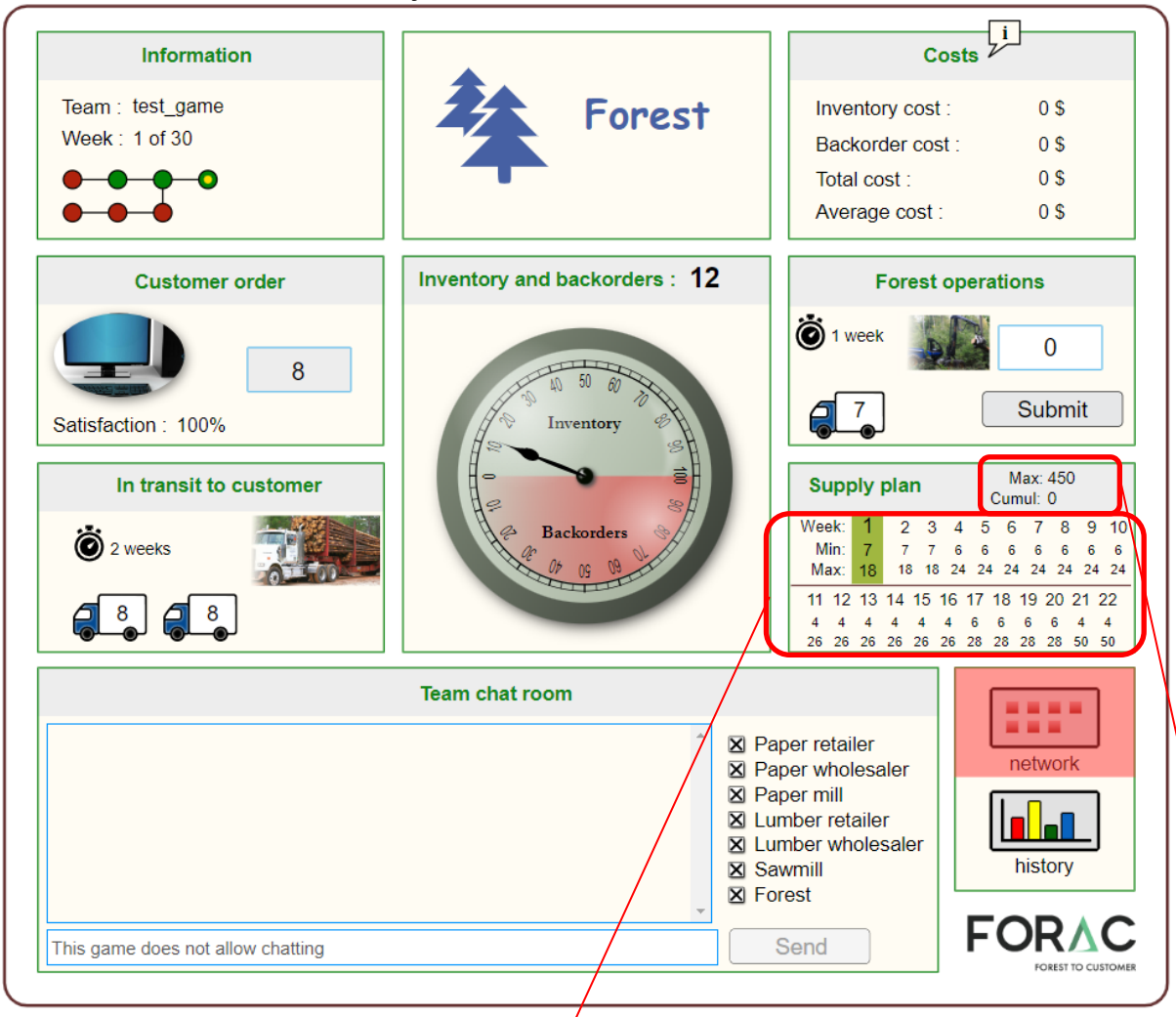
Special screen for Sawmill:

If you have the position of the **Sawmill**, your screen will differ slightly, because the Sawmill has to deliver to two distinct positions in the supply chain, the paper mill and the wholesaler lumber (see "Process logic and decisions" above). You can set which percentage of incoming products should be allocated to both wood chips (for the paper mill) and lumber (for the lumber wholesaler). You can choose between the allocations (25% / 75%), (50% / 50%), (75% / 25%). The place where you can set this allocation is marked with a red circle in the figure below:



Special screen for Forest:

If you have the position of the **Forest**, your screen will also differ slightly. The forest deals with a certain supply plan, see “Process logic and decisions”. During the game, you also observe how much has been harvested so far. The cumulated amount harvested is restricted to a maximum, and supply will be discontinued if that maximum is reached. In that case, you can only order a quantity of 0. Both the supply plan and the maximum amount to harvest can be set by the administrator.

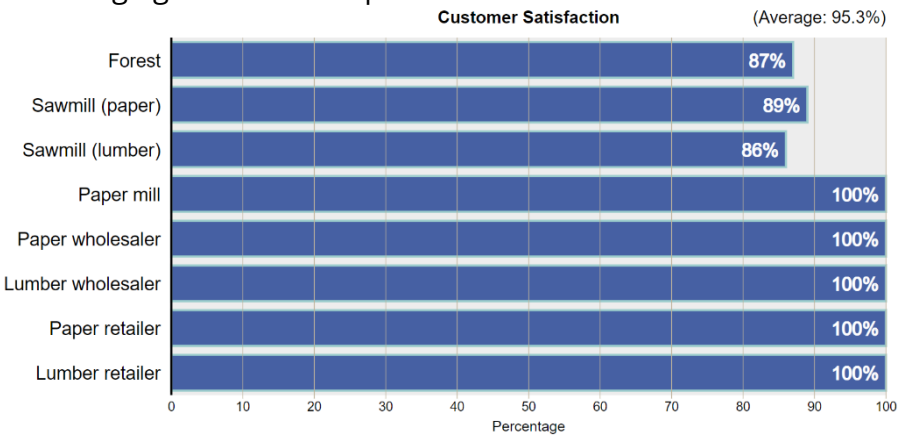


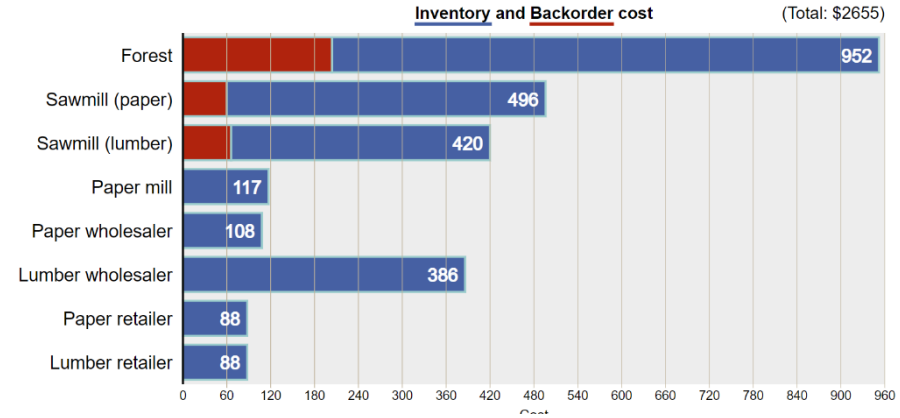
The supply plan, showing the minimum and maximum quantity to harvest per week

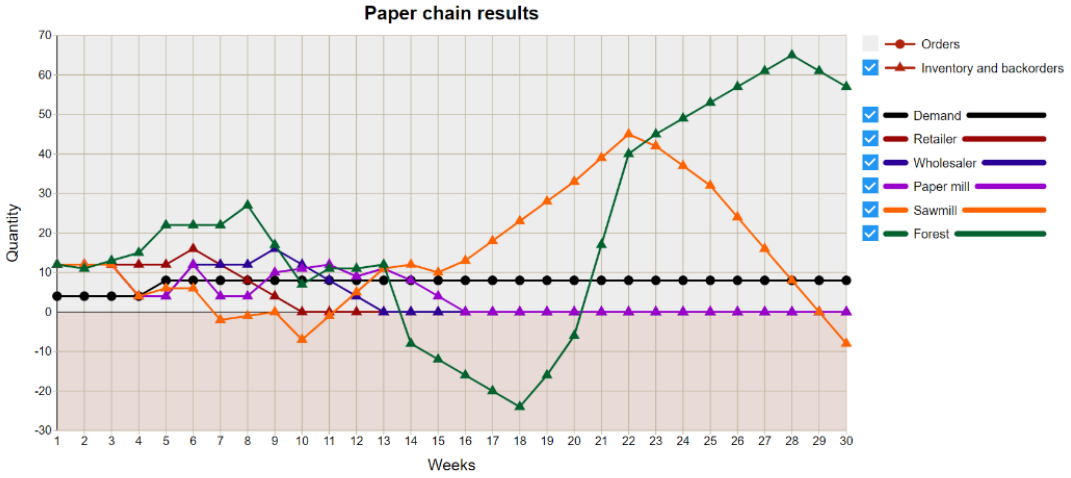
The maximum amount to harvest (cumulative over all weeks) and the cumulated amount harvested so far.

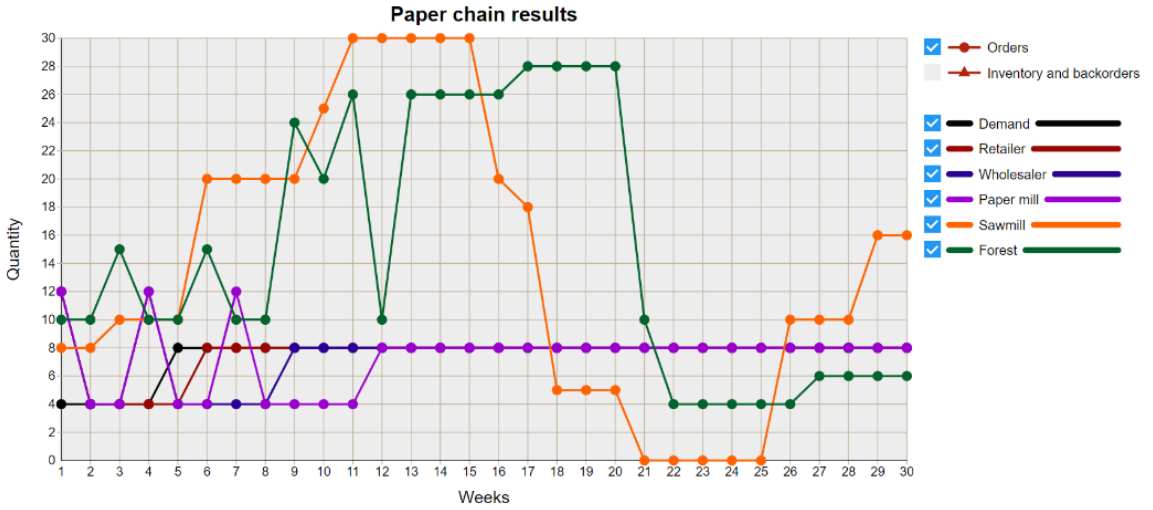
Figures and numbers after each scenario

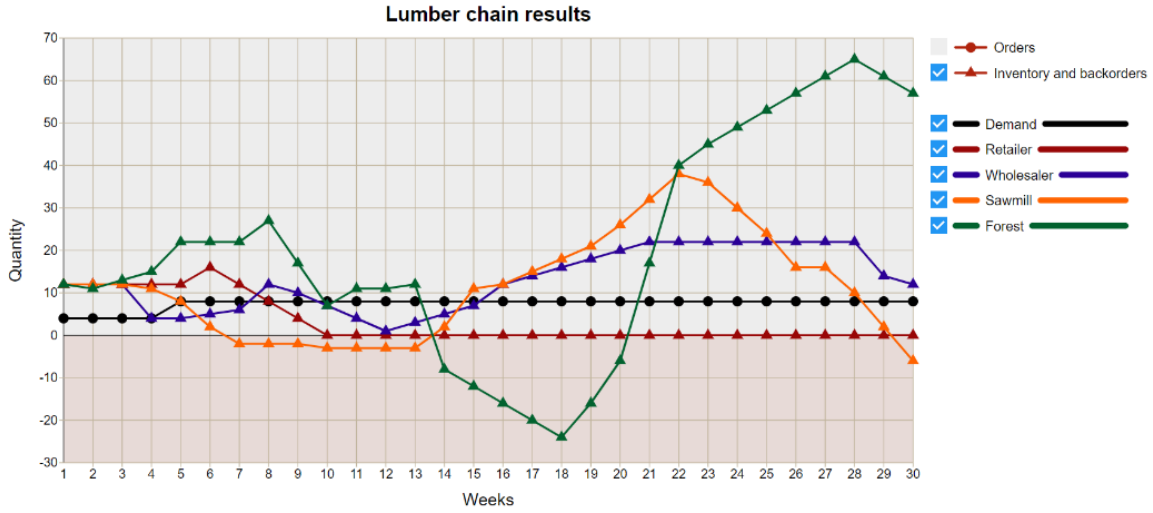
After playing each Scenario, you will have to make save the figures displayed to the administrator. When answering the questions, please provide larger figures yourself. The following figures are examples.

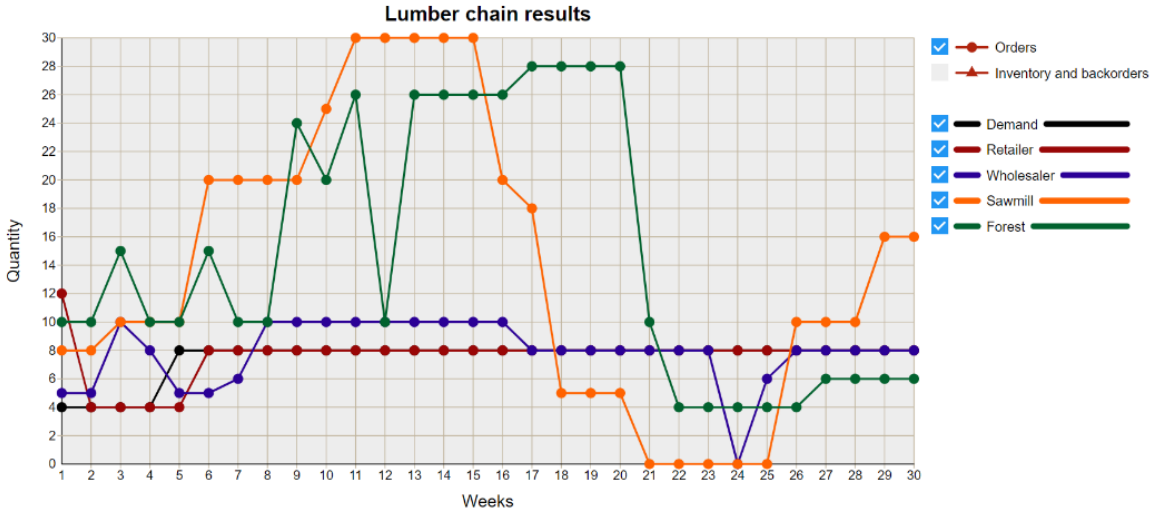







Paper chain results
Quantity
Weeks
Orders
Inventory and backorders
Demand
Retailer
Wholesaler
Paper mill
Sawmill
Forest


Lumber chain results
Quantity
Weeks
Orders
Inventory and backorders
Demand
Retailer
Wholesaler
Sawmill
Forest

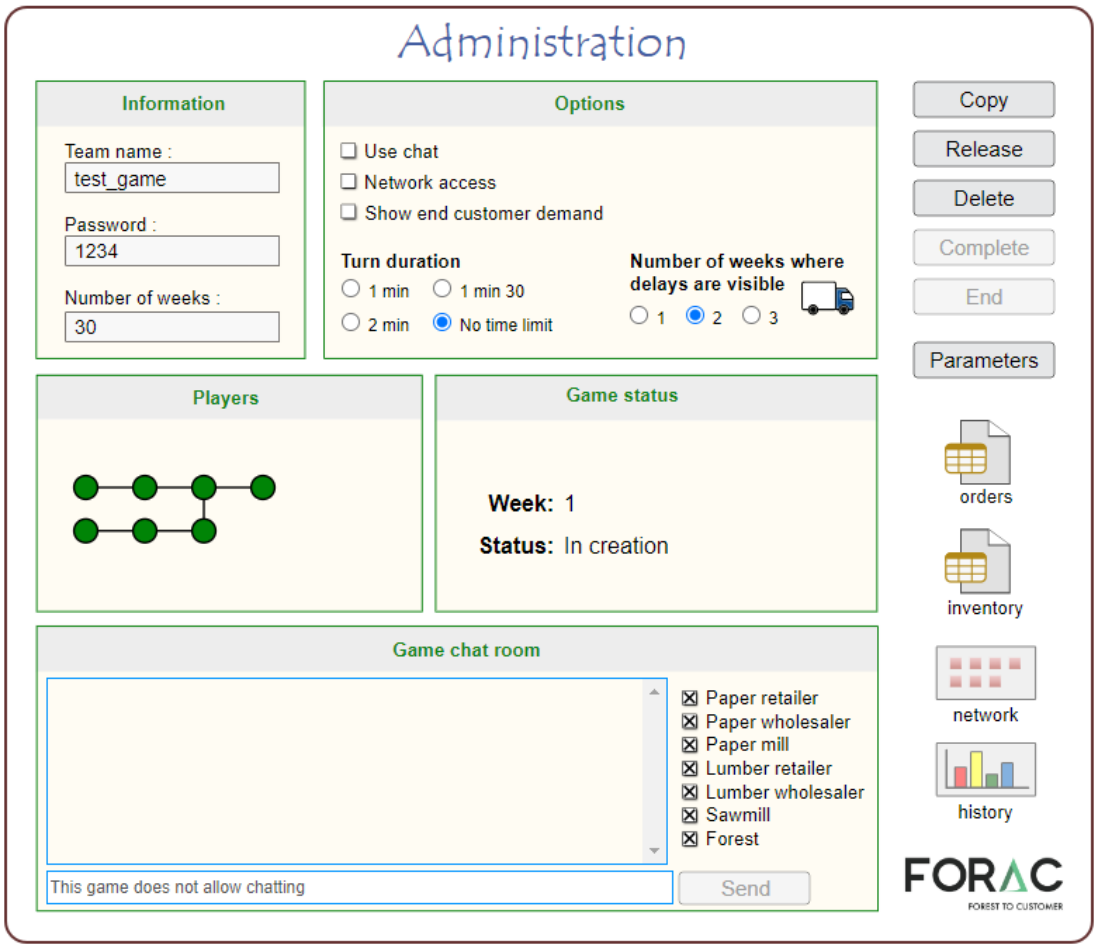

Lumber chain results
Quantity
Weeks
Orders
Inventory and backorders
Demand
Retailer
Wholesaler
Sawmill
Forest

Appendix II: Explanation for the administrator

As an Administrator you will have to setup all the games for your group to play. To do this, you will have to change some settings for every scenario. Below, we describe how you should create and set up each scenario. As an administrator, you can do that in advance before playing the game with your team members. When creating a scenario, you always have to take the following steps first:

1. Go to http://forac-old.fsg.ulaval.ca/woodSupplyGame/AideJeuBois/EN/indexEN.htm
   You will get to the following website:

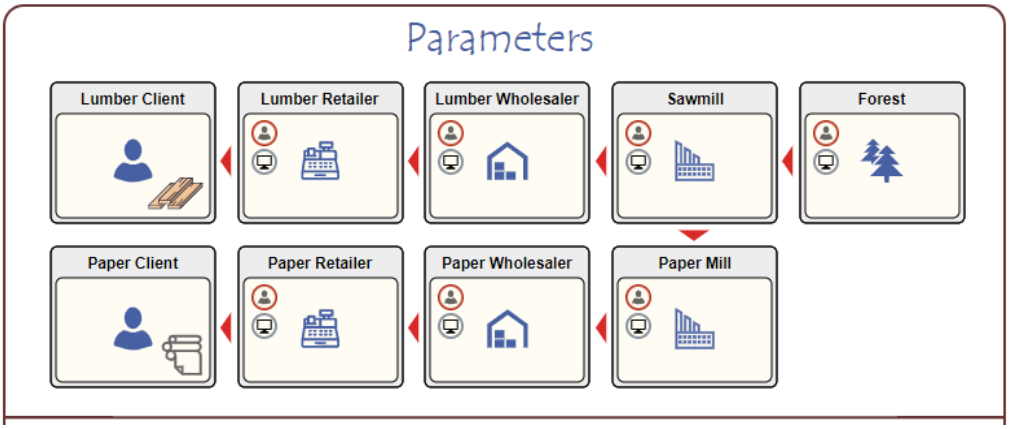
2. **Click on one of the servers**. All group members should click on the same server. Sometimes one of the servers doesn't work. If that happens, choose a server on another continent. You can do this by choosing one of the servers marked in the red box.
3. Click on "**Create a game**". You will see a screen on which you should enter a team name (that the other members of your project group can use to access the specific instance of the game) and a password (though passwords protecting may not be working). Leave the option "from game file" unchecked. For the **number of weeks, you enter "30"**. Then, click on "**Go**", and you will enter the following Administrator screen in which you can specify the parameters of the game.



You can find a detailed explanation of this screen in Appendix I. For each scenario, we will explain below how to set these parameters.

Settings – Scenario I

- **Disable** the options "**Use chat**", "**Network access**", and "**Show end customer demand**".
- Set the turn duration at "**No time limit**".
- Click on the button "**Parameters**" (on the right side of your screen). You will get the following screen (you can find a detailed explanation of this screen in Appendix I):



- Go to the Forest and click on ***Supply plan*** (at the right side of the screen). In this supply plan, you can set the minimum and maximum quantity to harvest in each week. Now change the minimum and maximum quantity in **weeks 15 and 16 from zeros into 4 and 26** (just like the supply plan that is set for week 14). For weeks **21-30, set the maximum quantity to harvest to 50**.
- Now return to the previous screen and click on the button "**Release**" (at the right side of your screen) to create the game.
- **This creates and releases the game. Now the players can select their position as indicated in the main document (see sections "Playing Scenario I/II/III"). As** a group of **4-6 students, you can play 4-6 out of the 7 positions** as follows:

Number	Position (4 members)	Position (5 members)	Position (6 members)
1	Paper Retailer	Lumber Retailer	Lumber Retailer
2	Paper Wholesaler	Paper Retailer	Paper Retailer
3	Sawmill	Paper Wholesaler	Paper Wholesaler
4	Papermill	Sawmill	Sawmill
5		Papermill	Papermill
6			Forest

Therefore, after the administrator **creates** and **releases** the game, each individual player in you group should select their position.

- You have to **assign the computer to the remaining positions**. You do this after all positions are selected by players by clicking on the button "**Complete**". Then, all remaining positions are automatically assigned to the computer.

Settings – Scenario II

- **Disable** the options "Use chat", "Network access", and "Show end customer demand".
- Set the turn duration at "No time limit".
- Click on the button "Parameters" (at the right side of your screen). Go to the Forest and modify the *Supply plan* the same way you did for Scenario I.
- **Go to Lumber Client** and click on "New pattern". Choose "**Seasonal**" and click "**Generate**".
- **Go to Paper Client** and click on "New pattern". Choose "**Seasonal**" and click "**Generate**".
- Now return to the previous screen and click on the button "Release" (at the right side of your screen) to create the game.
- All players should select their positions, then the administrator should assign the remaining positions to the computer as explained above in Scenario I.

Settings - Scenario III

- In contrast to Scenario I and II, **enable** the options "**Use chat**", "**Network access**", and "**Show end customer demand**".
- Set the turn duration at "No time limit".
- Click on the button "Parameters".
- Go to the Forest and modify the *Supply plan* in the same way as you did for Scenario I.
- **Go to Lumber Client** and click on "New pattern". Choose "**Normal**" and click "**Generate**".
- **Go to Paper Client** and click on "New pattern". Choose "**Normal**" and click "**Generate**".
- Now return to the previous screen and click on the button "Release" (at the right side of your screen) to create the game.
- All players should select their positions, then the administrator should assign the remaining positions to the computer as explained above in Scenario I.