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Editors

Manual

Lean Thinking in Office and Knowledge Work

LEAN GAMES

Rzeszow, 2018

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The materials were developed within the frame of the Project:

„Innovative Learning Approaches for Implementation of Lean Thinking to Enhance Office and Knowledge Work Productivity”

Project Number 2016-1-PL01-KA203-026293

Reviewer: Arkadiusz Gola

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Content

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Introduction

The Lean Concept is widely disseminated in manufacturing companies. Moreover, the knowledge about lean tools and their implementation in manufacturing areas is easy available in the literature. There are also many case studies published which present the ways and advantages of the lean concept implementation in manufacturing processes. A worse situation is in the lean concept implementation in office and knowledge work. There are not many publications presenting how to implement lean tools in these areas.

The goal of this work is to present, with the support of didactic games, what kind of problems and wastes can be discovered in office and knowledge work and what kind of tools can be used to improve the processes.

The manual is one of the ILA-LEAN Project results and presents how the materials developed within the frame of the project can be used in a course to teach lean in office and knowledge work. Course participants can study tablet course chapters, other ILA-LEAN project result, in order to achieve the needed knowledge. Games can be organized for the course participants to allow them "feel" the wastes and understand better how to implement lean tools in office and knowledge work.

Therefore, in this manual, first the course program on "*Lean in office and knowledge work*" is presented. The program refers to the related tablet course chapters and developed games.

The manual consists of five chapters. Each chapter refers to one lean game and contains the information about the goal of the game, materials needed to play the game, a number of players and a game organization. The intention of the authors was to develop materials that can help the teacher/trainer to prepare and lead the game and analyse, together with the game participants, the achieved results.

The first chapter concerns 5S which is the first tool usually implemented in the frame of the lean concept. Therefore, in office and knowledge work it should also be implemented at the beginning of a "lean journey". Hence, the first game presents the kind of wastes that can be identified in office and knowledge work and the kind of advantages that are possible to obtain by 5S implementation.

Then, the problem of interruptions is analysed. Interruptions may create wastes. In the game, participants can personally discover how interruptions influence work productivity.

In the companies many different processes in which office work is realized exist. One of the proposed game presents one of such processes, namely manufacturing planning processes. In the game, the participants can discover what kind of problems exist in planning processes. This processes will be analysed with the use of A3 report.

The next chapter presents a tool which can be used in the processes analysis. With the use of process mapping a product development process is presented and analysed.

Finally, the implementation of Kanban system in office and knowledge work is presented in the last game.

The presented games are supported by tablet courses. The manual is organized in such a way that the developed tablet courses are referred to in the places where the knowledge presented in the tablet courses can be useful.

The games were developed with the cooperation of the companies in which certain problems and needs to improve office and knowledge work exist.

Dorota Stadnicka

Course program

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Day 1

The goal: Understanding the Lean Thinking concept and the necessity of 5S implementation as the first lean tool.

[1] Introduction to Lean Concept **TC1**

[2] 5S method **TC3.2**

[3] A game on 5S implementation in office and knowledge work **LG1**

[4] Discussion on 5S benefits

Day 2

The goal: Understanding how lean can be implemented in office and knowledge work and what the consequences of multitasking are

[1] Office and knowledge work **TC2**

[2] Lean tools implementation in office and knowledge work **TC3.1**

[2] A game on Knowledge Work Interruptions **LG2**

[3] Discussion on Value Adding in Knowledge Work

Day 3

The goal: Understanding what kind of wastes can influence office work and what the possibilities of wastes elimination are.

[1] A3 Report implementation in knowledge work **TC3.4**

[2] A game on Lean tools implementation in knowledge work on the example of the analysis of a planning processes **LG3**

[3] Discussion on the identified wastes and the ways of their elimination

Day 4

The goal: Understanding the necessity of process mapping to see the places where the wastes exist and the process mapping implementation.

[1] Process mapping in office and knowledge work **TC3.3**

[2] A game on Process Mapping in Office and Knowledge Work **LG4**

[3] Discussion on the identified wastes and the ways of their elimination

Day 5

The goal: Reflections on lean in office and knowledge work and understanding the possibility of Kanban implementation in office and knowledge work

[1] Use of Lean Concepts in Innovation **TC4**

[2] A game on The Use of the Game-Based Learning to Teach Kanban Concept in Engineering Projects **LG5**

[3] Identification of wastes and the problem identified while playing the games

1. 5S implementation in office and knowledge work

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1.1. What is 5S

The 5S methodology is the most widely adopted techniques from the LEAN THINKING toolbox. LEAN THINKING , often simply "LEAN", is a systematic method for the elimination of waste within a process (e.g. a business process).

LEAN = NO WASTE

The purpose of 5S is to create an uncluttered, ordered, shining, standardized and sustained workplace. The 5S methodology is based on 5 steps (**Table 1.1**).

Table 1.1. Steps of 5S implementation

1	**SORT**	Sort refers to the practice of going through everything in the workplace and keeping only essential items. Nonessential items are eliminated from the workplace.
2	**SET IN ORDER**	Set in order refers to the practice of having "a place for everything and everything in its place" in the work area.
3	**SHINE**	Shine refers to the practice of cleaning and looking for ways to keep it clean.
4	**STANDARDIZE**	Standardize refers to the practice of developing systems to maintain the work environment that is visually instructive, and monitor the first 3 S's.
5	**SUSTAIN**	Sustain refers to the practice of developing a workplace that automatically restores order and improves continuously.

The 5S method is the first practical step for making a company LEAN.

1.2. Organization of the course day

This day of the course is organized in such a way that first a theoretical introduction to Lean is presented: principal contributors, motivations for implementation, benefits of a visual workplace organization, examples of 5S applied to office work and focus on standardization and sustainability.

Then, the course participants play the game, after a short explanation on what the tasks of each person are. Then, the benefits of the 5S methodology are discussed.

This topic is supported by the tablet course TC3.2. **5S method.**

The objective of the game is:

1) Show **WHAT** can be improved by 5S
2) Show **HOW** it can be improved by 5S

1.3. The goals of the game

The goals of the game are:

- Identification of the wastes in office work
- Identification of possibilities of efficiency improvement

1.4. The competences received by the game participants

By playing the game the participants will obtain competences in:

- Reducing non-value adding activities
- Reducing search time in navigating the facility
- Improving product quality

1.5. Hardware required

The hardware required for the game (for every participant) is:

1) Some yellow sheets (i.e. 10 sheets)
2) Some red sheets (i.e. 10 sheets)
3) Some white sheets (i.e. 15 sheets)
4) 1 Ballpoint pen with black ink cartridge
5) 1 Ballpoint pen with blue ink cartridge
6) 1 Ballpoint pen with red ink cartridge
7) 1 Ballpoint pen with green ink cartridge
8) Sheets of minutes, ripped sheets, highlighters and other office stationery

In order to manage all the required hardware better, collect it in a transparent A4 size envelope or a plastic box for each participant.

An A3 sheet is also necessary for the 4S step application.

Preparation of the PHYSICAL ENVIRONMENT of the game:

a) Disassemble the ballpoint pens, so that only cartridges can be handled;
b) Stick some scotch tape pieces to the cartridges
c) Put the whole hardware material inside the transparent envelope and shake it;

THE ENVELOPE IS NOW FULL OF UNSORTED HARDWARE MATERIAL AND REPRESENTS A CHAOTIC PHYSICAL WORKING ENVIRONMENT

1.6. Software required

The software required for the game is:

1) 5S game slideshow – BEFORE 5S
   THE SLIDESHOW "BEFORE 5S" REPRESENTS CHAOTIC-UNSORTED INFORMATION ENVIRONMENT, TO BE PROVIDED TO THE STUDENT WHO WILL PERFORM THE MATHEMATICAL OPERATION
2) 5S game slideshow – HOW TO APPLY 5S (to information environment)
3) 5S game slideshow – AFTER 5S
   THE SLIDESHOW "AFTER 5S" REPRESENTS PRECISE AND WELL ORGANIZED INFORMATION ENVIRONMENT, TO BE PROVIDED TO THE STUDENT WHO WILL PERFORM THE MATHEMATICAL OPERATION

1.7. Rules of the game

Every player plays alone.

Although the game has an individual character (even one person can play the game) – the game can be played by some or several people at the same time.

The suggested maximum number of players at the same time is 10/15. This number of participants will make the final discussion easier to manage.

Input competences (knowledge, skills, social competences) for people who will play the game: the game is suitable almost for every person who can make simple calculations such as addition and subtraction.

Follow the instructions below round by round.

Round 1

The teacher will run automatically the slideshow "BEFORE 5S" and a student will be requested to write the results of the mathematical operations that will appear on the video **within the cycle time of 12 seconds/operation** :

- Using a pen with the colour as indicated (i.e. red);
- Using a sheet of the colour as indicated (i.e. yellow);

Students will be asked to put the hardware back into the envelope and to place aside the sheets with the operations results.

For example, the image presented in the Fig. 1.1 contains a task to do.

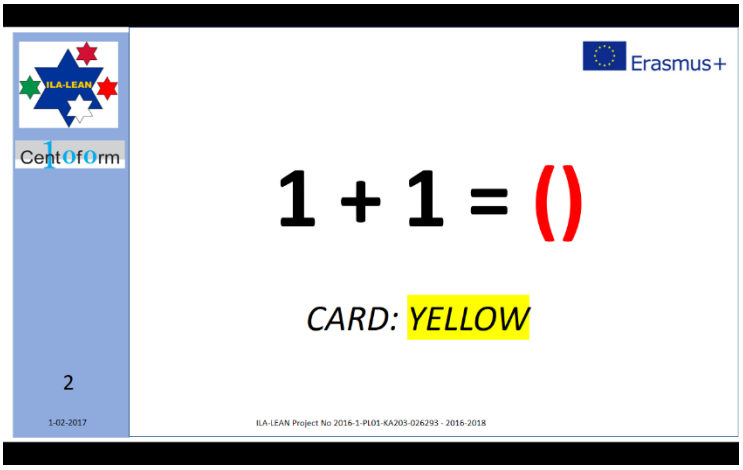

Fig. 1.1. Slide with a task to do

The task will request the output presented in the Fig. 1.2.

Fig. 1.2. An example of an output

AT THE END OF THE SLIDESHOW every student has to count the number of cards solved (quantity). Quality will be verified at the end of the second round.

The teacher will write the player's score in the Results Table (Fig. 1.3) to create a little competition.

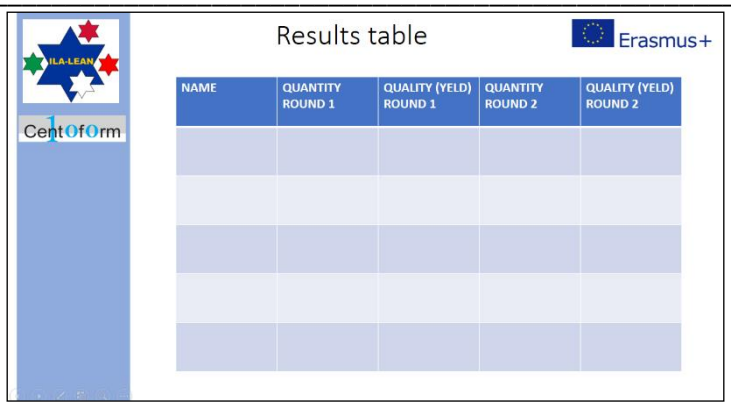

Fig. 1.3. A result table

Physical Environment and Information Environment:

The student will probably have difficulties in:

- Selecting the proper sheet where the operation result must be written (PHYSICAL ENVIRONMENT)
- Selecting the proper cartridge to write the result (PHYSICAL ENVIRONMENT)
- Performing the operations requested inside the cards that are not clear and standardized (INFORMATION ENVIRONMENT)

The 5S methodology should be applied to both environments:

5S applied to the PHYSICAL ENVIRONMENT

1S – SORT:

The teacher will request to open the envelope and to separate the necessary and unnecessary hardware, and specifically:

NECESSARY

1) Some yellow sheets (i.e. 10 sheets).
2) Some red sheets (i.e. 10 sheets).
3) Some white sheets (i.e. 15 sheets).
4) 1 Ballpoint pen with black ink cartridge.
5) 1 Ballpoint pen with blue ink cartridge.
6) 1 Ballpoint pen with red ink cartridge.
7) 1 Ballpoint pen with green ink cartridge.

UNNECESSARY

1) Sheets of minutes, ripped sheets, highlighters and other office stationery.

Remove the unnecessary hardware from the workstation (red tag area).

2S – SET IN ORDER

The teacher will request to place the hardware as shown in Fig. 1.4.

Fig. 1.4. Things to be placed

3S – SHINE

The teacher will request to remove the scotch tape pieces from the cartridges, in order to clean up the office equipment (Fig. 1.5).

Fig. 1.5. Tings to be removed

4S – STANDARDIZE

The teacher will request to reassemble the pens, asking students to match the colour of pen ink with the colour of their caps (Fig. 1.6).

Fig. 1.6. An example of a pen to be reassembled

5S – SUSTAIN

The teacher will request to set the workplace according to the player's preferences.

According to the lean approach, the workplace is organized by an operator.

In order to understand the 5th S better, an example is shown below:

- Draw a blackboard (as shown in the picture below) on a A3 sheet, putting on each place the corresponding hardware (Figs 1.7-1.8).

Fig. 1.7. An example of a drawn blackboard

Fig. 1.8. An example of items placed on a drawn blackboard

This will be a new workstation layout:

Considering the fifth S as a sort of audit, it will be possible to create a checklist (Fig. 1.9) in order to verify the proper placement of hardware on the blackboard.

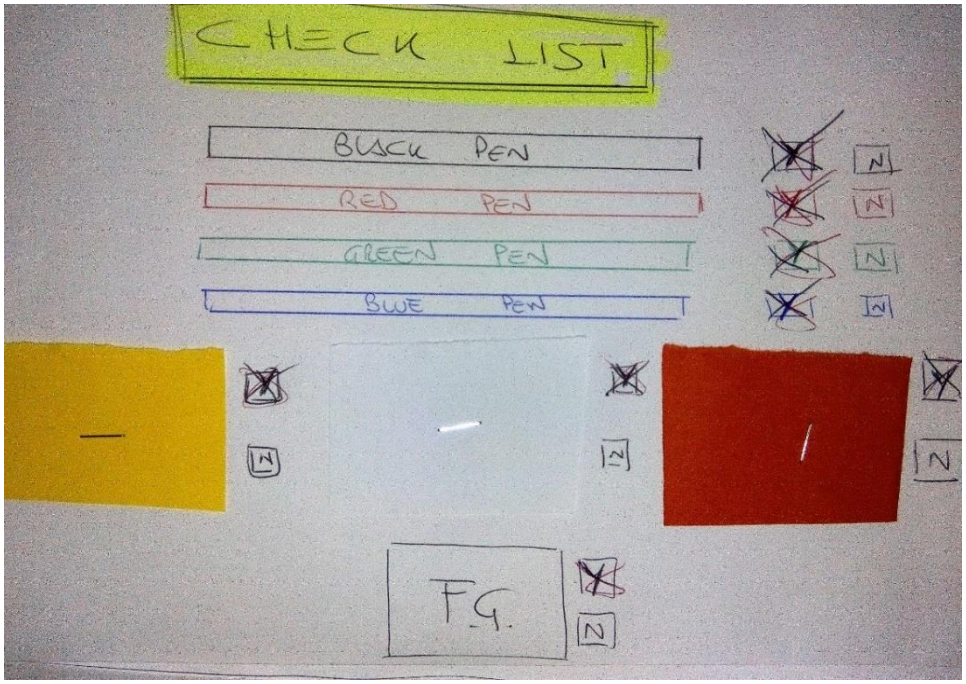

Fig. 1.9. An example of an audit checklist

Printable formats of the blackboard and a checklist are available (5th S printable) and their layouts are shown in Fig. 1.10 and Fig. 1.11 respectively.

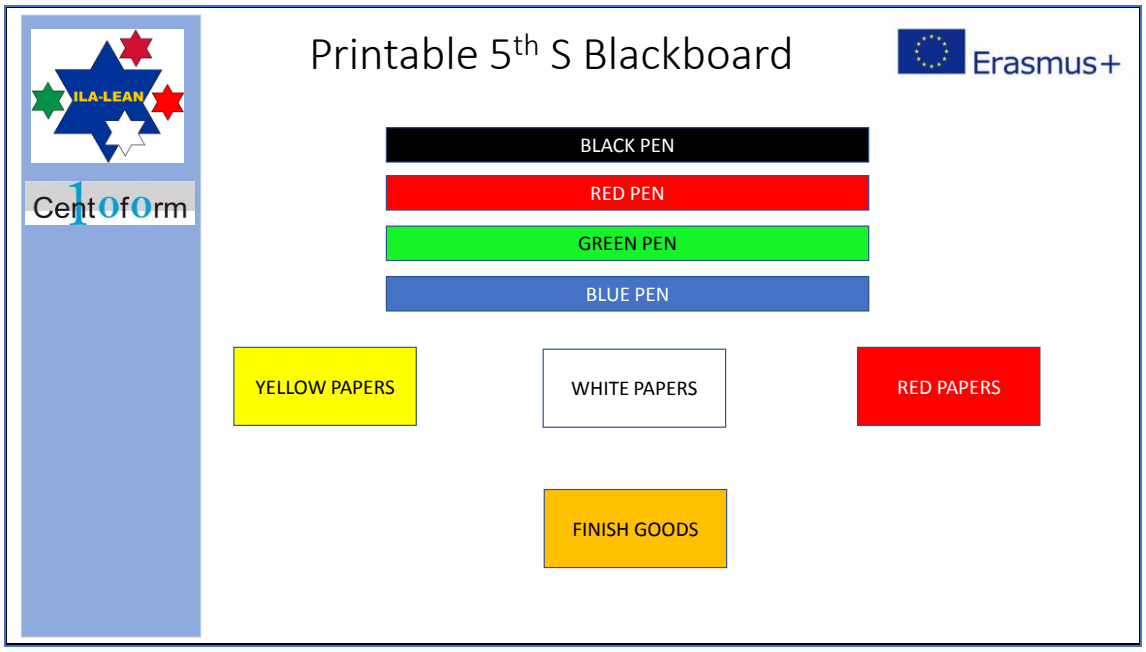

Fig. 1.10. A printed blackboard

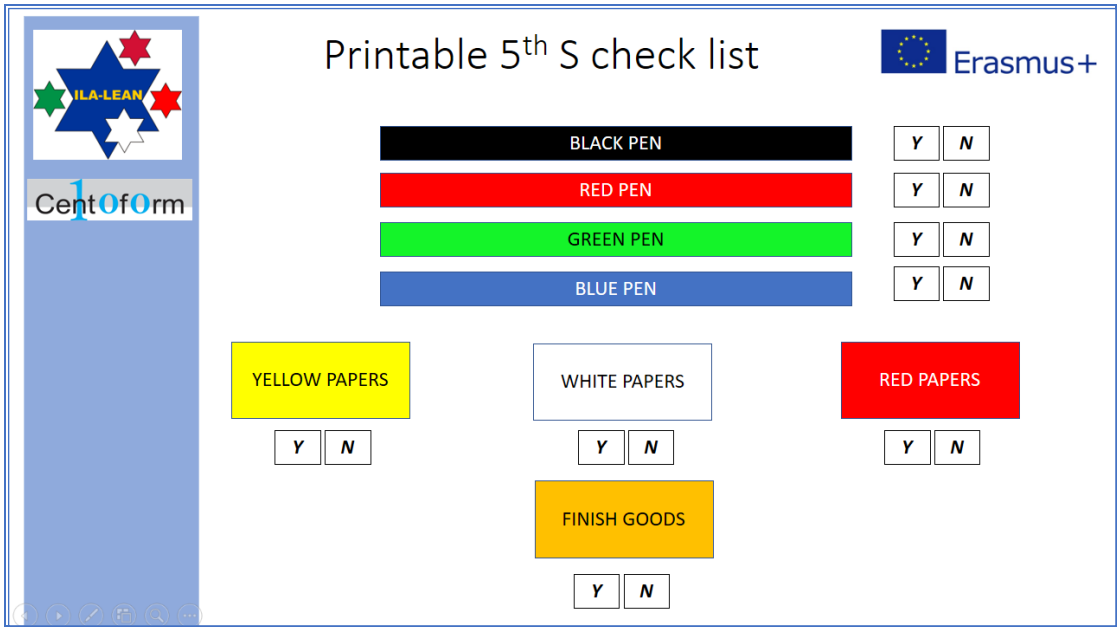

Fig. 1.11. A printed audit checklist

5S applied to the INFORMATION ENVIRONMENT:

The teacher will show the application of 5S within the information environment running the "HOW TO APPLY 5S" slideshow.

1S – SORT

Cards describing something not requested by the final Client have been removed from the slideshow (Fig. 1.12).

Fig. 1.12. This card should be removed

2S – SET IN ORDER

Sheets that will be used to write the calculation results have been ordered by colour.

The slideshow will display the sheets ordered as shown in the image below: yellow sheets first, then white and finally red sheets (Fig. 1.13).

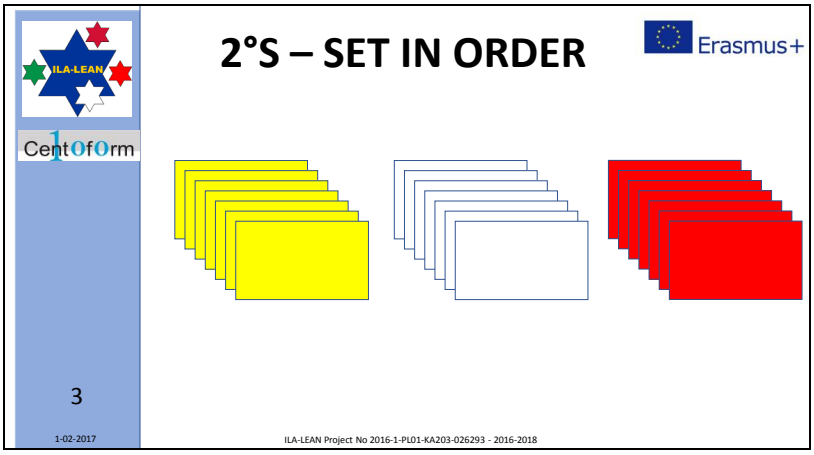

Fig. 1.13. Cards have been ordered by color

3S – SHINE

Each item covering formulas and numbers and not allowing the proper reading of the card has been removed (Fig. 1.14).

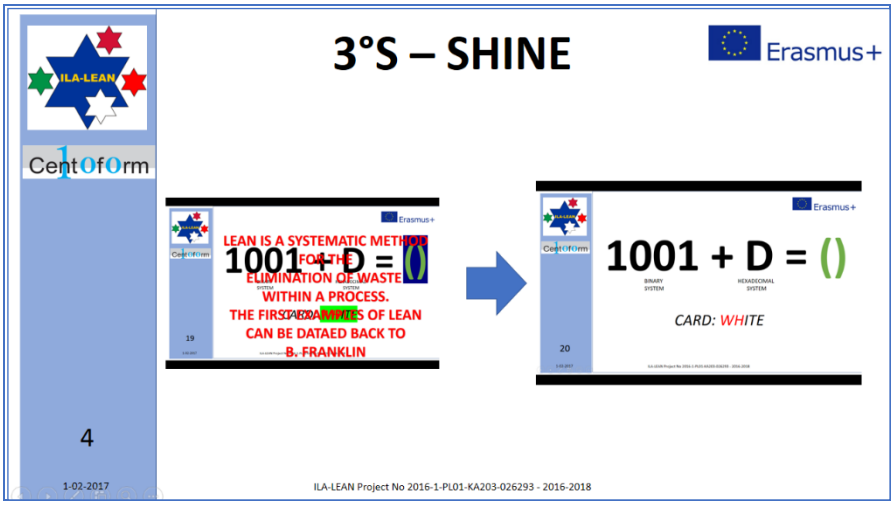

Fig. 1.14. Example of game card cleaning

4S – STANDARDIZE

Cards have been standardized (Fig. 1.15):

- Numeration systems: from binary, Roman, hexadecimal systems to a decimal system.
- The format defining the pen colour and the sheet to be used;

An example you can see in Fig. 1.15.

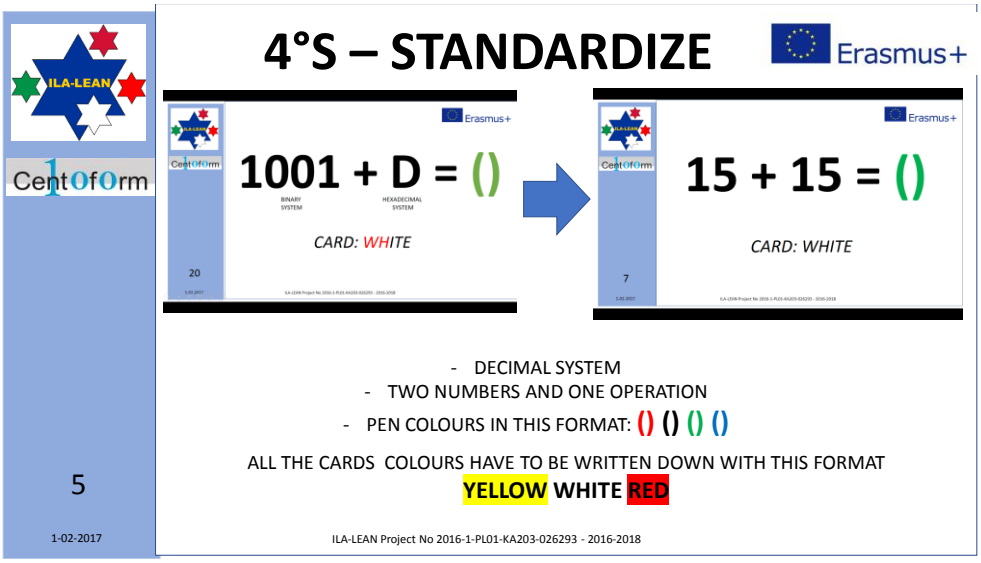

Fig. 1.15. Example of game card standardization

5S – SUSTAIN

Considering the fifth S as an audit process, it will be possible to produce a checklist in order to verify whether the users have written the information properly.

For example see image on Fig. 1.16.

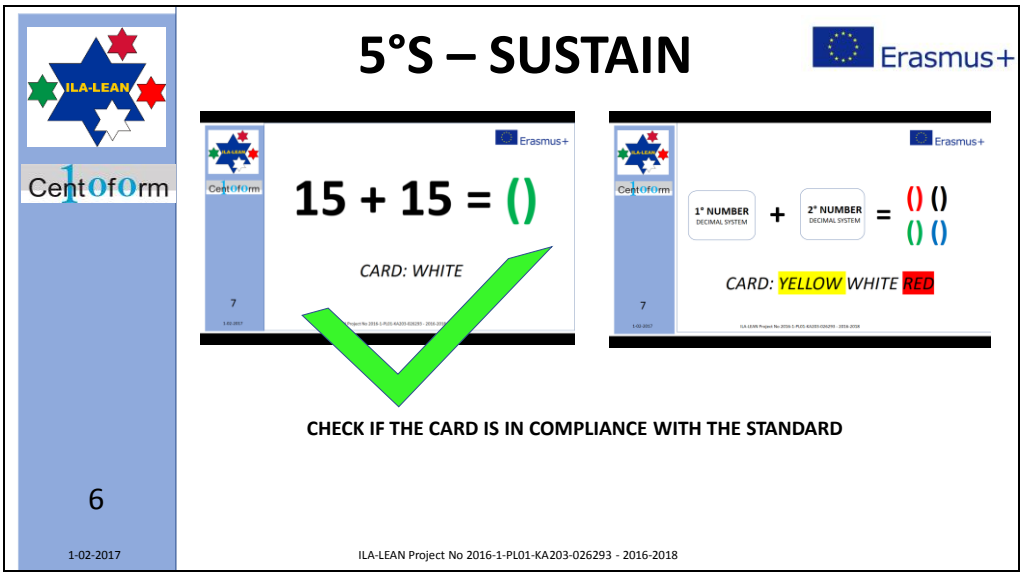

Fig. 1.16. How to apply the 5°S

Check if all the cards of the new slideshow meet the checklist.

Round 2

Repeat the exercise with a new physical workstation and a new slideshow “AFTER 5” (cycle time is still 12 seconds/operation).

AT THE END OF THE SLIDESHOW every student has to count the number of cards solved (quantity) and the number of cards reporting the correct result (quality), both for round 1 and 2.

The teacher will write the player’s score in the Results Table to create a little competition (Fig. 1.17).

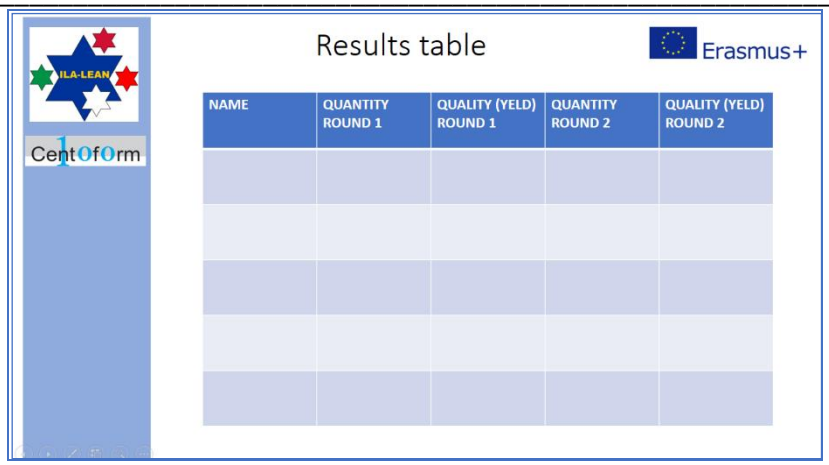

Fig. 1.17. Results table

1.8. Players

Students can play the game collectively with the teacher presenting the slideshow, as well as individually, launching the slideshow using their own PCs.

In the first case, the game winner will be the one who produced the highest number of cards with the right result, written in the right colour and on the right sheet.

IS IT WORTH INVESTING IN THE 5S? CALCULATION OF THE INVESTMENT BREAK EVEN POINT

Upgrading your workplace through the 5S method should be considered as an investment.

Many indicators are used for investment decision making: ROI, ROE, Payback Period...

In our analysis a simple and useful financial indicator could be the **BEP (BREAK EVEN POINT)**.

Break even point is the point of zero loss or zero profit. At break even point, the businesses revenues are equal to its total costs.

Break even point can be calculated in the following equation:

px = vx + FC + Profit

where

p is the price per unit,
x is the number of units sold/produced,
v is the variable cost per unit
FC is the total fixed cost.

Calculation

At break even point the profit is zero, therefore the formula is simplified to:

px = vx + FC

Solving the above equation for x (which is equal to BEP) in sales/production units, we get:

$$\textbf{BEP = Break even point [sales/ production units]} = x = \frac{FC}{p - v}$$

Example

- Price per Unit 15 €
- Variable Cost per Unit 7 €
- Total Fixed Cost 9,000 €

Solution

- p = 15 €
- v = 7 €
- FC = 9000 €

Substituting the known values into the formula for BEP in sales/production units, we get:

BEP [sales/production units] = 9000 ÷ (15 – 7)= 1125 units

Apply the BEP to the 5S game

Once familiar with the game and with the BEP calculation, it is recommended to perform the following exercise using the BEP formula adapted to our 5S game as shown below:

BEP [numbers of cards produced] = (T2)/(T1-T3)

Where:

- **T2 =** Time spent for the application of the 5S methodology to the physical and information environment (investment)
- **T1** = (slideshow time "before 5S") / (n° of right cards produced "before 5S")
- **T3** = (slideshow time "after 5S")/(n° of right cards produced "after 5S")

The calculation shows to the students how to find out the number of sheets/pieces produced, above which the time requested to apply the 5S's is already repaid.

Students will be surprised to discover how much investment is profitable.

1.9. The lesson learned

After the game, the participants will be involved in the discussion in which each person can suggest how to apply this methodology in his/her daily work.

1.10. The possibilities for improvements

Office work can be improved by the implementation of regular 5S audits, solutions that automatically restore order, useful tools to define priorities, standardized and shared procedures, etc. which can help to minimize waste of time and mistakes.

Additionally, some “best practice” videos can be shown (links are in the tablet course).

2. Demonstration of Waste (disruptions/setup times) in office and knowledge work

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2.1. The goal of the game

The goals of the game are:

- Awareness of productivity challenges in knowledge and office work.
- Identification of the wastes in knowledge work; demonstration of different kinds of disruptions in knowledge work: discuss how a knowledge worker should react to disruptions, what the possibilities to react to these disruptions are and its effects on productivity and the quality of work.
- Identification of possibilities of efficiency improvement (e.g. self-directed working methods, prioritization).
- A possibility of an additional discussion: how the knowledge work management and reaction to disruptions influence the employee's well-being at work (e.g. stress to get things done).

2.2. The knowledge received by the game participants

The competences from the game:

- Understanding the nature of waste in knowledge work, i.e. waste that is not always visible and hard to reduce.
- Understanding that Lean tools and methods can also be implemented in Knowledge Work, i.e. focus on value adding.

2.3. Overview of the game

The game is played individually. The game includes two rounds. The Game is based on the competition between individual participants. 15 participants is the optimal number of players for the game facilitation.

Materials needed during the game:

- 2 carving sheets of A4 size paper. You will need 2 sets per participant (altogether 4 sheets per player) and 2 sets for an instructor demo. Different sheets demonstrate 2 different jobs.
- 1 pen per player.

- Have the Stopwatch ready to show on the data projector (or use another method share the time).
- facilitator needs a sheet to collect results (a whiteboard or an Excel file). See Table 4.1 for the example.
- Prepared interruptions (printed out on paper): e.g. e-mails with short tasks (simple calculations), phone calls.
- PowerPoint guidance to play the game for participants.

Round 1

Game instructions for the teacher:

Description of the production:

Tear the paper with hands, cut out the 1st job, and 1st block, based on the drawing lines. Then, move to the 2nd job and cut out the 1st block. Then, move back to the 1st job, and cut out the 2nd block and so on… Make two stacks of the blocks, one for each job.

For Round 1, demonstrate the multitasking work:

***There will be interruptions (e-mails, phone calls) introduced by the facilitator (print out: slide #9 and slide #10, 5 pieces each). Give interruptions randomly to the players.*

When a participant has finished, they need to record their time and then count the number of paper pieces produced, there should be totally 30 (15 + 15).

Tell the participants to start multitasking Round 1.

Start stopwatch.

Record the results on a flipchart or whiteboard (Results)

For Round 2, ask the participants if there is a more productive way of doing the work?

Facilitate a discussion: (example questions below)

- How to minimize knowledge work interruptions? How to react to the interruptions?
- How to minimize multitasking?
- What is value adding work?
- What is non-value adding?
- How to increase the value adding time?

Example answers:

**Do one job at a time*

**Phones to a silent mode?*

**E-mail to Offline?*

**Hide the pop-up Windows notifications?*

- What can the knowledge worker do?
- Who decides what is possible for the knowledge worker?
- What does Lean for Knowledge Worker mean?

Round 2

Reset the Stopwatch

Start Round 2: start the stopwatch

When a participant has finished, they need to record their time and then count the number of paper pieces produced.

When all are done, record the results on a flipchart or whiteboard (Results).

Discuss the results and reflect back to real life challenges of interruptions.

2.4. Results

In Table 2.1 you can see example information written on a standard form used in the game for recording the results (e.g. can be plotted to a whiteboard).

Table 2.1. Example: Standard forms used in the game for recording the results

Name	Round 1 Time	Quantity	Interruptions	Round 2 Time	Quantity	Interruptions
N.N.	3,31	Job 1: 13/15 Job 2: 17/15	2	1,39	Job 1: 15/15 Job 2: 15/15	0
N.N.	4,10	Job 1: 14/15 Job 2: 15/15	1	1,24	Job 1: 15/15 Job 2: 15/15	0

2.5. Lesson learned

After the game the participants will be involved in a discussion in which each person will reflect on the knowledge and office work productivity challenges (wastes) and how to focus more on the value adding work.

3. Lean tools implementation in knowledge work on the example of the analysis of a planning processes

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3.1. Why are the problems analysed in the game important?

The game, on the basis of the planning of the manufacturing processes, presents important problems which can appear in any kind of organization, not only in manufacturing companies.

- When there is a delay in the product/service delivery to a client everybody usually blames a production/execution department,
- Some people don't realize how much waste a business process (a planning process) can cause for other departments of a company,
- Some people don't realize how much one employee's work can influence the work of other employees,
- Some people mostly think about their own benefits (own goals) without taking into consideration the goals of the whole company.

In order to present these problems, a planning process was chosen as a process which exists in any company and is easy to understand for anybody who works in any organization.

3.2. Organization of the course day

The day of the course is organized as follows:

1. Before the game, the participants should attend the tablet course explaining lean tools which can be implemented in office and knowledge work (see Tablet course, Chapter 3.1. Review of lean tools used in office and knowledge work and Chapter 3.4 presenting A3 Report in details).
2. Then, the course participants will play the game.
3. The game consists of 4 steps:

   STEP 1 – Playing the game according to the established rules.

   STEP 2 – The problems analysis with the use of A3 report; implementation of Hoshin Kanri to obtain improvements. Here, the participants will discuss the identified problems and the noticed kinds of wastes. In brainstorming some improvements can be proposed as well as

lean tools, which can be implemented to improve the planning process, will be discussed. Hoshin Kanri, as one of the tools, is recommended to be implemented. The game participants create A3 report, in which they will present the identified problems, the analyses and the proposed solutions.

STEP 3 – Playing the game according to the new rules.

STEP 4 – Results assessment.

4. Finally, the day should be summarized by a teacher / trainer underlining the learned lesson.

3.3. Participants and duration

The game should be played by teams of 4 people. 3 or 4 teams can play the game at the same time. It will create competitiveness between the teams. The goal set for the teams is to obtain the lowest cost of manufacturing. The team which will achieve the lowest costs is a winner.

The duration of the game is max 4 hours, together with a discussion, A3 report preparation and the assessment of improvements.

3.4. Real problems in planning of manufacturing processes

The presented problems were adopted to a manufacturing planning process and can be described as follows. Clients expect from a supplier that the ordered products will meet their requirements concerning quality as well as a delivery time. Therefore, planning of manufacturing processes is crucial to ensure clients' satisfaction. Depending on the size of the company and the realized manufacturing processes, the companies use different tools to support their planning process. However, it is always difficult to meet all the requirements at minimal costs. There are different reasons of that, such as internal and external constrains or lack of knowledge, or tools which could support the employees responsible for a planning process. Thus, companies try to optimize the plan to meet the requirements and to minimize the costs however they can. In the game presented in this chapter, a planning process is simulated. The participants of the game are motivated to identify wastes in the planning process as well as the wastes which are caused by an improperly prepared plan or the lack of optimization.

3.5. Description of a case study company

The problems concerning a planning process are presented on the basis of a case study. The case study company manufactures kitchen fronts. They offer fronts having different profiles and different colours (Fig. 3.1). The real conditions were simplified to present the problem in the time short enough. Therefore, only 3 profiles and 3 colours were taken into consideration.

Fig. 3.1. Profiles and colours of kitchen fronts

3.6. The goal of the game

The main goals are:

- Learning how to apply lean tools in knowledge work,
- Identification of the dependency between different work stands and steps of a process.

Additional goals for a team are:

- Identification of the wastes in a planning process,
- Identification of possibilities of time waste minimization,
- Identification of possibilities of cost minimization,
- Identification of possibilities of profit maximization.

3.7. The input competences needed to play the game

The participants should attend the tablet course which explains lean tools that can be implemented in office and knowledge work before participating in the game.

However, teachers / trainers have to know lean tools and understand how they can be implemented in different situations. Game participants should be motivated to use A3 report and Hoshin Kanri strategy. Nonetheless, they can also propose to implement other tools in order to improve the process, and a teacher / trainer should be open for other solutions.

3.8. The competences received by the game participants

By playing the game, the participants will acquire the following competences:

- They will know what kind of wastes can appear in a planning process,
- They will understand how the wrong planning process can influence other wastes in a company,
- They will know what kind of lean tools can be used to analyse the planning process and to improve its performance,
- They will know how to apply A3 report to analyse a problem,
- They will know how to implement Hoshin Kanri to a limited extent.

After the game the participants should realize that:

- An individual interest of an employee should be related to the business interest of a company (Hoshin Kanri),
- Individual costs calculation for a single point in the system without taking into account next steps in the process can increase total costs (Lean Accounting).
- The lack of communication and feedback between people responsible for a planning process can increase the costs of a manufacturing process (Communication problems),
- Wrong planning rules can increase manufacturing costs (Planning rules).

3.9. Organization of the game

In order to manufacture a kitchen front, it is necessary to perform the following processes: a cutting process, a milling process and a laminating process. Each manufacturing process takes one day, therefore, it is possible to realize a client's order in three days. However, a planning process has a great influence on the clients' orders realization on time.

In the game, four people work on four work stands realizing the tasks concerning a planning process and clients' orders realization monitoring:

- Work stand 1 – Orders reception, completion and shipping.
- Work stand 2 – Cutting process planning.
- Work stand 3 – Milling process planning.
- Work stand 4 – Laminating process planning.

The information flow concerning a planning process is presented in Fig. 3.2.

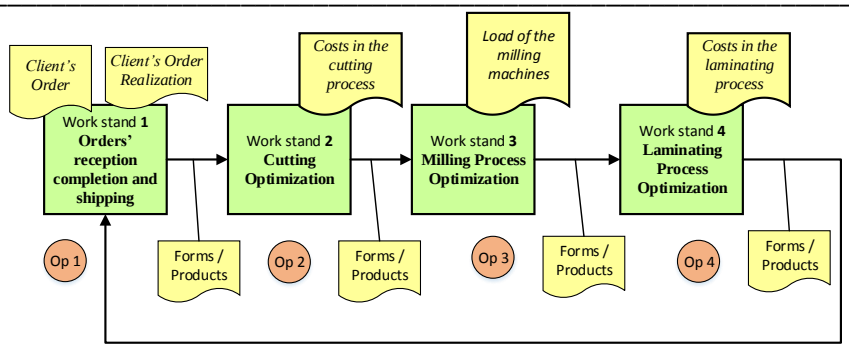


Fig. 3.2. The information flow in a planning process

Each person has his/her own responsibilities:

- An employee on the Work stand 1 is responsible for shipping ready products to clients on time.
- An employee on the Work stand 2 is responsible for planning a cutting process to get the lowest costs of material.
- An employee on the Work stand 3 is responsible for planning a milling process to complete all the required products.
- An employee on the Work stand 4 is responsible for planning a laminating process to get the lowest costs of material.

The employees bonuses depend on the quality of a planning process (work stands 2, 3, 4) and delivering the products to clients on time (work stand 1).

3.10. Materials and forms necessary to play the game

To play the game the following materials are needed:

- One blue piece of paper (A4) to represent a wooden board on which the formats will be arranged.
- Two pieces of papers to represent what kind of profiles can be manufactured on each milling machine (Fig. 3.3).
- Two pink ½ A4 sheets of paper to represent a laminate sheet on which the formats will be arranged.
- Two green ½ A4 sheets of paper to represent a laminate sheet on which the formats will be arranged.
- Two yellow ½ red A4 sheets of paper to represent a laminate sheet on which the formats will be arranged.
- A blue marker.
- A red marker.
- A green marker.
- 4 pens.

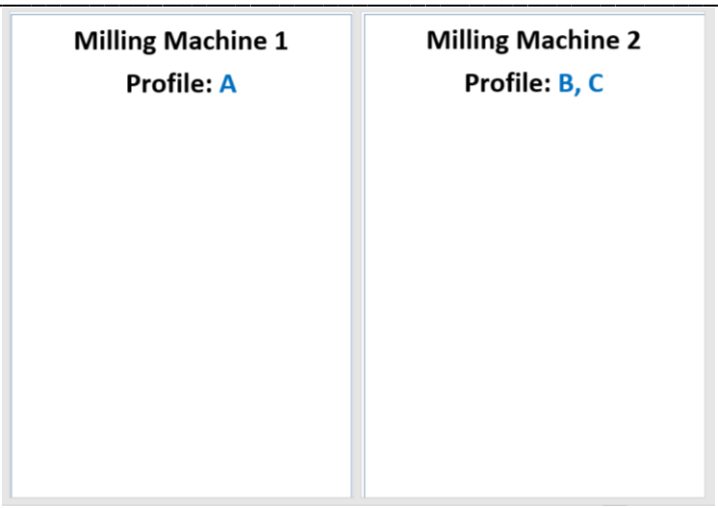


Fig. 3.3. Information about profiles which can be manufactured on each milling machine

To play the game the following forms are needed:

- A set of clients' orders for 5 days.
- A set of formats containing data concerning the ordered products.
- A form for a cutting process.
- A form for a milling process.
- A form for a laminating process.
- A form for orders completions and shipment.
- A form to present the game results.

3.11. The course of the game

Clients' orders (Fig. 3.4) come to the 1st work stand. The orders contain such information as: a day of the order receiving, the client, the size of the format, the profile of the format, the colour of the front, the number of pieces and the deadline.

DAY 1					
Client	**Size**	**Profile**	**Color**	**Number of pieces**	**Deadline**
C-1	70	A	P	2	4 days
	50	A	Y	3	
	70	C	P	2	

Fig. 3.4. The client's order – an example

An employee working on the 1st work stand transfers the formats (Fig. 3.5) representing the products which are ordered by the clients to the 2nd work stand. The formats present information concerning the products which have to be realized, in particular: the day of order receiving, client, profile of the format, colour of the front, size of the format and number of days in which the front has

to be manufactured. The profile of the format will be taken into consideration in the planning process of a milling process to decide on which milling machine the process can be realized. Three profiles can be manufactured: A, B and C. The colour of the front will be taken into consideration in the planning process of a laminating process to decide which colour of laminate will be used in the process. Three colours can be used: P – pink, G – green and Y – yellow.

The "Xs" are originally put in all formats. From Fig. 3.5 we can see that in four days the order has to be completed. However, to complete the whole manufacturing process we only need three days: one day for a cutting process (blue square), one day for a milling process (red square) and one day for a laminating process (green square).

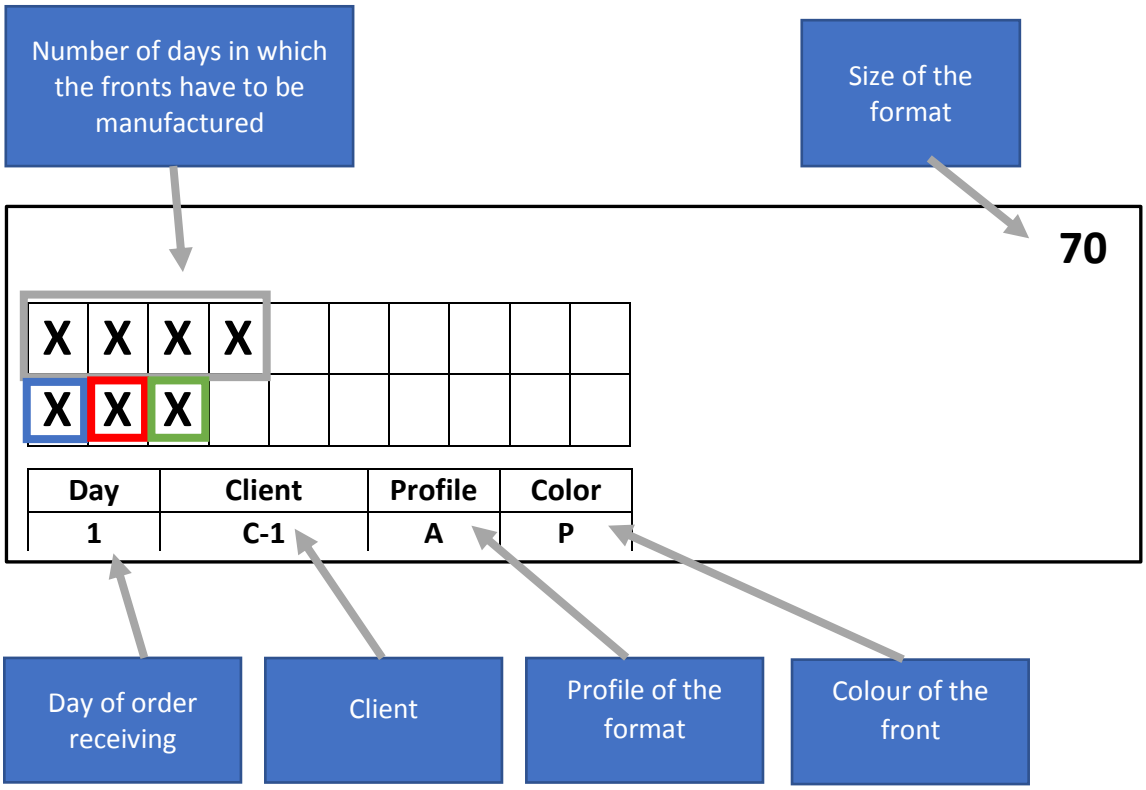


Fig. 3.5. The format – an example

On the basis of the received information (formats), the employee working on the 2nd work stand optimizes the cutting process.

The capacity of the cutting machine is 600 cm^2 (A4 sheet of paper). The employee has to plan what and how it will be cut. The fronts will be cut from one wooden board (Fig. 3.6). The employee has to take into consideration the capacity of the cutting machine as well as the priorities of orders realization.

The bonus of the employee depends on how much material waste will be produced in the cutting process.

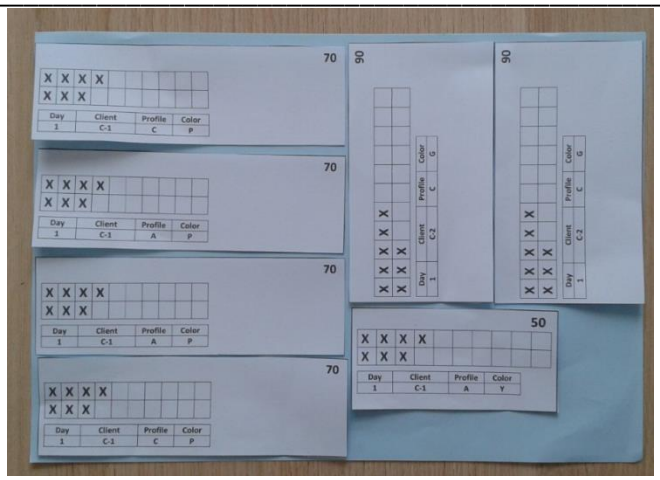


Fig. 3.6. The optimization of the cutting process – an example of formats arrangement on the wooden board (A4 card)

In the case if a format can't be realized on a certain day because of the lack of the capacity, the format has to wait till the next day. This information has to be registered on the format by putting blue „C" for each day of delay in this process (Fig. 3.7). It means that if an employee who plans the cutting process has no capacity to plan the manufacturing process of a product on a certain day, he/she has to put blue "C" on the format representing the product and leave the format on his/her own work stand to plan it the next day. The employee transfers the rest of the formats to the 3rd work stand.

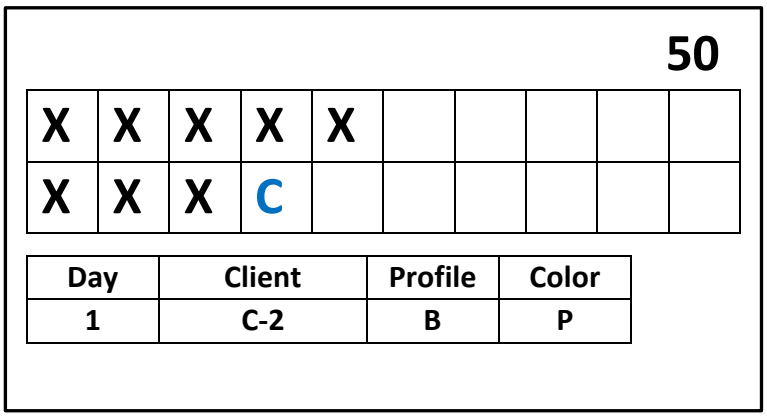


Fig. 3.7. The format – an example of delay registration

On the 3rd work stand an employee optimizes the milling process. In the process, two milling machines are used. The capacity of each machine is 300 cm^2. The total capacity of the milling process is 600 cm^2. On each of the machines different kinds of profiles can be realized (Fig. 3.8), i.e. on the milling machine 1 only profile A can be manufactured, and on the milling machine 2 profiles B and C can be manufactured. The employee has to plan what will be processed on which milling machine.

The bonus of the employee depends on the orders realization.

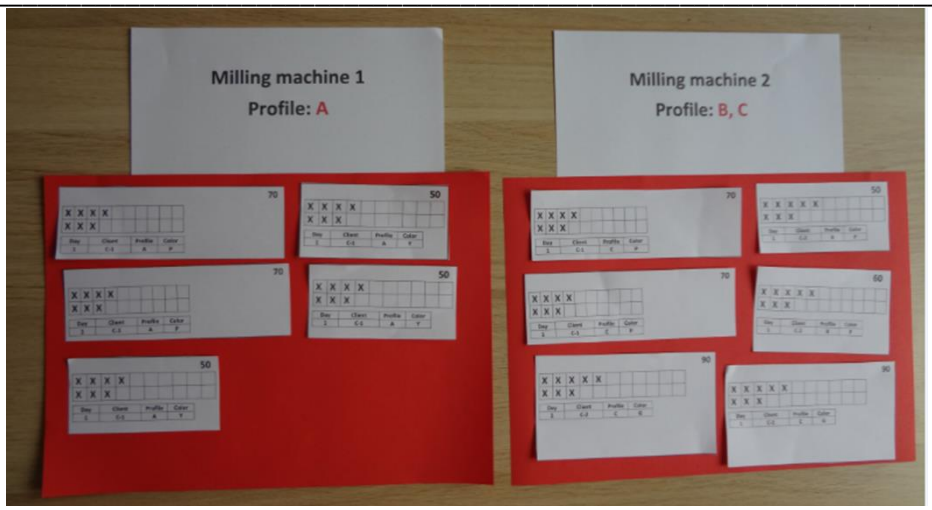


Fig. 3.8. The format – an example of delay registration

In the case if a format can't be realized on a certain day because of the lack of capacity, it has to wait till the next day. This information has to be registered on the format by putting red „M" for each day of delay in this process (Fig. 3.9). The employee transfers the rest of the formats to the 4th work stand.

The employee can also decide to work overtime if it is necessary. The overtime work (the second shift) is connected with additional costs. One shift of overtime equals 600 Euro per machine.

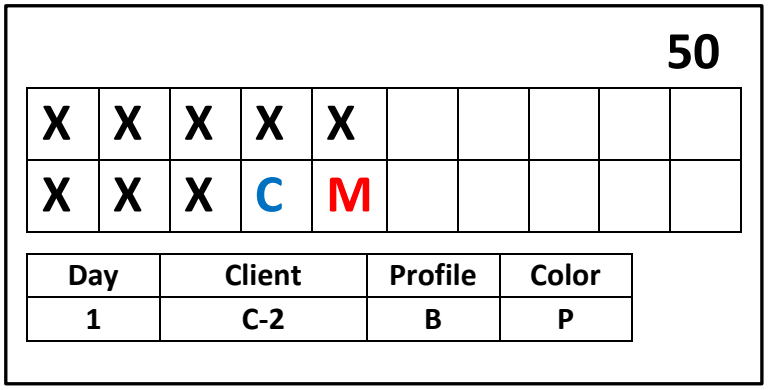


Fig. 3.9. The format – an example of delay registration

On the 4th work stand an employee optimizes the laminating process. The capacity of the laminating process is 2 laminate sheets per day (Fig. 3.10). One sheet equals 300 cm^2 (1/2 A4). The total capacity of the laminating process is 600 cm^2.

The employee has to plan what will be laminated taking into consideration the colour of the laminate. Three colours of laminates are used: green (G), pink (P) and yellow (Y). The employee has to decide which colours will be realized on the day. Additionally, the employee has to take into consideration the deadline of the orders realization.

The bonus of the employee depends on how much material waste will be produced in a laminating process.

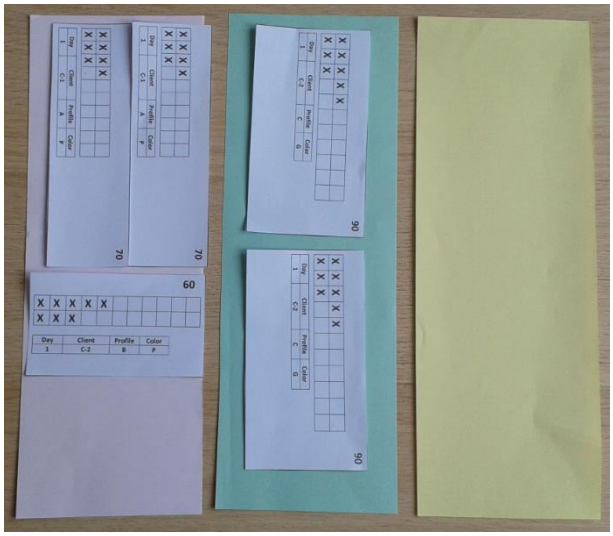


Fig. 3.10. An example of formats arrangement optimization in planning of laminating process

In the case if a format can't be realized on a certain day because of the lack of capacity, it has to wait till the next day. This information has to be registered on the format by putting green „L", which means "delay" in this process. In the presented example (Fig. 3.11), we can see one blue „C", one red „M" and one green „L", what means that this format had to wait in each process for one day. Totally, it was three days. This caused one day of delay in the client's order realization.

The information about realized formats has to be transferred to the 1st work stand.

50

X	X	X	X	X					
X	X	X	C	M	L				

Day	Client	Profile	Color
1	C-2	B	P

Fig. 3.11. The format – an example of delay registration

Finally, on the 1st work stand an employee completes the finished formats and he/she checks whether the orders are realized on time.

3.12. The game documentation

The employees register the data concerning each process.

- An employee on the Work stand 2 registers material used for products realization as well as material waste and calculates the costs of waste (Fig. 3.12).
- An employee on the Work stand 3 registers machines utilization and the costs connected with a milling process (Fig. 3.13).
- An employee on the Work stand 4 registers laminate used for products realization as well as material waste and calculates the costs of waste (Fig. 3.14).
- An employee on the Work stand 1 registers orders realization and connected costs (Fig. 3.15).

CUTTING PROCESS
600 cm² per a day
1 cm² = 1 EURO

Day	Material used	Waste	Costs
1			
2			
3			
4			
5			
6			
7			
8			
		Total cost	

Fig. 3.12. The form used by an employee on the work stand 2

MILLING PROCESS

2 x 300 cm² per a day

1 cm² = 2 EURO

1 cm² = 4 EURO in additional shift

	Milling machine 1 Profile: A		Milling machine 2 Profile: B, C	
Day	Real machine load	COST First shift Additional shift (if any)	Real machine load	COST First shift Additional shift (if any)
1				
2				
3				
4				
5				
6				
7				
8				
First shift			First shift	
Additional shift			Additional shift	
Total cost				

Fig. 3.13. The form used by an employee on the work stand 3

LAMINATING PROCESS

2 x 300 cm² per a day

1 cm² = 3 EURO

Day	Material used	Waste	Costs
1			
2			
3			
4			
5			
6			
7			
8			
		Total cost	

Fig. 3.14. The form used by an employee on the work stand 4

Erasmus+

ORDERS COMPLETIONS AND SHIPMENT

Client number	Work in Process Number of pieces			Total number of days of delay	Cost of delay 1day = 500 Euro
	C	M	L		
C-1					
C-2					
C-3					
C-4					
C-5					
C-6					
C-7					
C-8					
C-9					
C-10					
Sum of work in process	Σ =	Σ =	Σ =	Total cost	
Cost of Work in process (1 piece = 50 Euro)					

Fig. 3.15. The form used by an employee on the work stand 1

The forms should be available for people during the game.

The following examples present how to fill the forms.

In the picture presented in Fig. 3.16, you can see 7 formats which were placed on a sheet of paper, representing a wooden board. Summarize fields of all formats, that is 70+70+70+70+90+90+50, and what gives 510 cm^2. Because one piece of a wooden board has 600 cm^2, the waste will be 90 cm^2. Then, fill the form as presented on the left.

Erasmus+

CUTTING PROCESS
600 cm² per a day
1 cm² = 1 EURO

Day	Material used	Waste	Costs
1	510	90	90
2			
3			

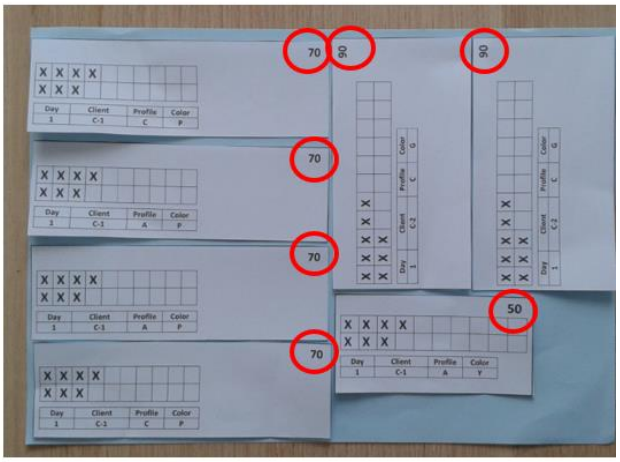


Fig. 3.16. An example of a form filled on the work stand 2

The employee on the work stand 3 can decide to work overtime if it is necessary. The overtime work (an additional shift) is connected with additional costs. On a regular shift, 1 cm^2 costs 2 Euro. In overtime, 1 cm^2 costs 4 Euro.

The employee has to assess the real load of machines and register this information on the form presented in Fig. 3.17 for each day. On the presented example you can see that the first machine is loaded with 290 cm^2, what means that it will work on one shift only. Therefore, the cost will be 580 Euro. On the second machine we have 430 cm^2, what means that the machine will have to work on the second shift. Therefore, the costs will be 600 Euro per the first shift, that is 300 cm^2 multiplied by 2 Euro, and 520 Euro per the second shift, that is 130 cm^2 multiplied by 4 Euro. This information should be written on the form.

Erasmus+

MILLING PROCESS
2 x 300 cm² per a day
1 cm² = 2 EURO
1 cm² = 4 EURO in additional shift

	Milling machine 1 Profile: A		Milling machine 2 Profile: B, C	
Day	Real machine load	Cost	Real machine load	Cost
1	290	580	430	600+520 = 1120
2				
3				
4				
5				
Total cost				

Machines loading

Fulfill the form

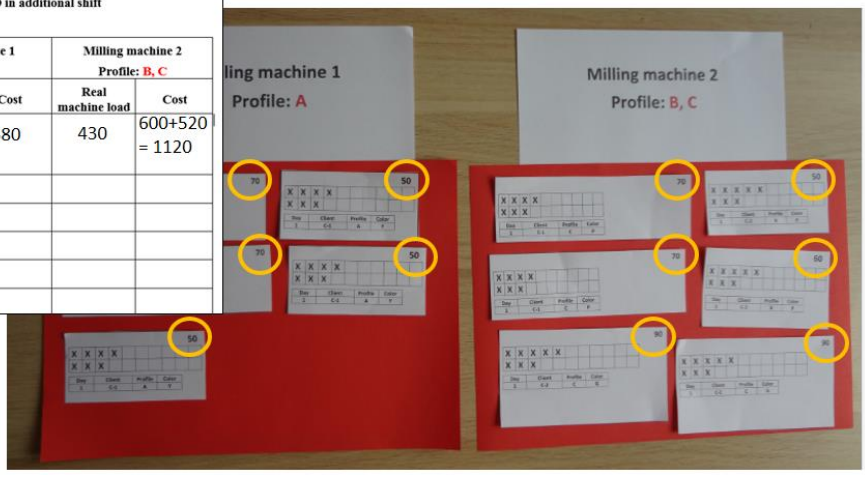


Fig. 3.17. An example of a form filled on the work stand 3

For the laminating process each day material waste is registered on the form (Fig. 3.18). In the case presented in Fig. 3.18, 380 cm^2 was used. Because two sheets of 300 cm^2 were used, the waste equals 220 cm^2, what costs 660 Euro.

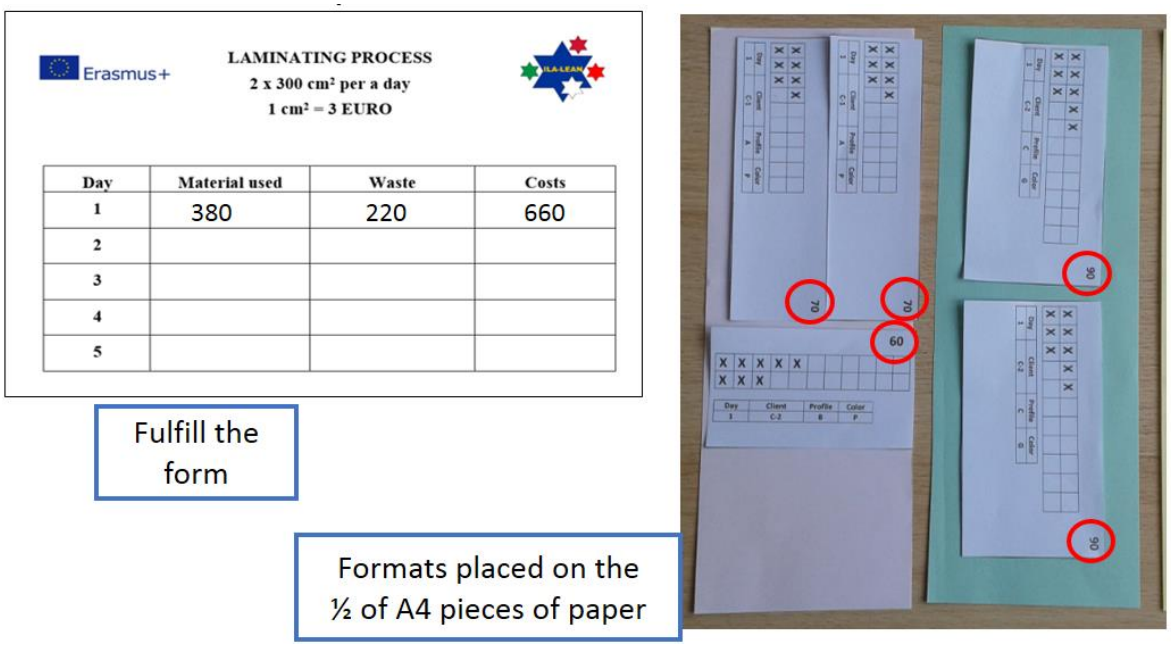
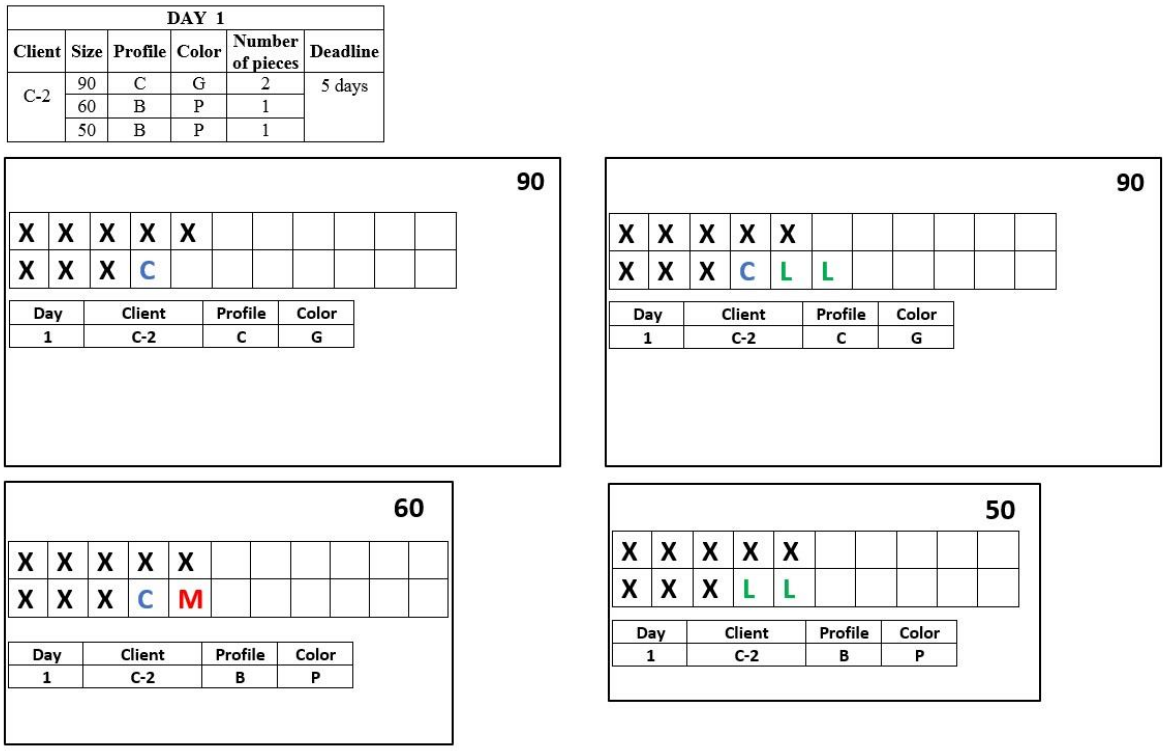


Fig. 3.18. An example of a form filled on the work stand 4

On the work stand 1 an employee is responsible for sending realized products to clients. Fig. 3.19 presents an order of Client C-2 who ordered four products. The products should be delivered within 5 days. However, as we can see, it was impossible because one product (90) stayed in the process one day longer. Therefore, we fill the form concerning orders completions and shipment, as you can see in Fig. 3.20. We put 1 day of delay, what will cost 500 Euro.



DAY 1					
Client	Size	Profile	Color	Number of pieces	Deadline
C-2	90	C	G	2	5 days
	60	B	P	1	
	50	B	P	1	

Fig. 3.19. A client's order and formats which went through the process

As you can see from Fig. 3.20, three products stayed in the cutting process one day longer (C), so we put 3 in the form. One product stayed one day longer in the milling process (M), so we put 1, and two products stayed two days longer in the laminating process (L) so we put 4 in the form. Because the cost of work in process is 50 Euro per piece a day, we can calculate the cost of work in process for all the parts which stayed in the process longer and, then, we calculate the total cost connected with the cost of delay and the cost of work in process.

Erasmus+

ORDERS COMPLETIONS AND SHIPMENT

Client number	Work in Process (number of pieces x number of days)			Number of days of delay	Cost of delay 1day = 500 Euro
	C	M	L		
C-1	1	0	1	0	0
C-2	3	1	4	1	500
Sum of work in process	Σ = 4	Σ = 1	Σ = 5	Total cost	1000
Cost of Work in process (1 piece = 50 Euro)	200	50	250		

Fig. 3.20. An example of a form fulfilled on the work stand 1

With this form, the game participants will realize that it is necessary to plan processes and such way to ensure that no delays will appear, because delays cause costs.

Step 1

In the first step of the game, the participant plans manufacturing processes on the basis of orders received. 5 days work is simulated in this step.

Step 2

After 5 days of work, each work stand assesses the costs.

The game participants have to make an adequate analysis to answer the questions:

- Why were the costs of the processes so high?
- Why didn't the clients receive the products on time?
- What can be done to improve the planning process?

After the game, the results table is filled (Fig. 3.21). The costs obtained by each team are assessed.

RESULTS TABLE

	Team 1	Team 2	Team 3	Team 4
Cost of waste in cutting process				
Cost of additional shift in milling process				
Cost of waste in laminating process				
Cost of Work in Process				
Cost of delayed deliveries				
Total costs				

Fig. 3.21. A results table

Then, the game participants choose adequate lean tools to perform a necessary analysis and implement the chosen lean tools to improve the process.

It is recommended to implement **A3 report** for performing the analysis and **Hoshin Kanri** for improvement.

The winner is this team which will be able to achieve the best improvement. The improvements are assessed on the basis of costs.

To analyze the problems, the team will use A3 report and questions presented in Fig. 3.22. An empty form is delivered to each team as well (Fig. 3.23).

A3 REPORT

Title: What do you want to write about?	**An owner of the problem:** / **Date:**
1. Problem description Why do you want to write about this problem?	**5. Proposed countermeasures** What do you propose to implement to achieve the goal(s)? How the proposed solutions can influence on the source causes of the problem and can change the current situation to achieve the future state?
2. Current situation What is a current situation? Use visual tools to present the current situation (schemes, flowcharts, pictures, diagrams, VSM, spaghetti diagram etc.)	**6. Plan** What we have to do? What is a deadline? Who will be responsible for the activities? How much it will cost? You can use Gant chart, table or other visual tool.
3. Goal(s), indicators The goal(s) should be SMART (Specific, Measurable, Achievable, Realistic, Time-bound) Indicators should give the possibility to assess improvements in the future	**7. Further improvement** What kind of problems can appear (risk analysis)? Use PDCA to plan further improvement. Assess what was achieved?
4. Analysis What are the source causes of the problems? Use a tool which will help you to find the causes of the problem (5xWhy?, Ishikawa diagram, interrelationship diagram, brainstorming, etc..)	

Fig. 3.22. A3 report with questions which should be asked

A3 REPORT

Title: What do you want to write about?	**An owner of the problem:** / **Date:**
1. Problem description	**5. Proposed countermeasures**
2. Current situation	**6. Plan**
3. Goal(s), indicators	
4. Analysis	**7. Further improvement**

Fig. 3.23. An empty form of A3 report

Step 3

When the analysis is performed, improvements are proposed and A3 report is prepared by the teams that implement the improvements and play the game again. After that, they assess the results. The winner is the team which has the lowest costs and was able to achieve the biggest improvement.

3.13. The lesson learned

The implementation of lean tools in a process analysis and for the process improvement can bring real benefits.

A3 report is an easy and structured way for a problem analysis.

The implementation of Hoshin Kanri can improve the performance of a company, because an individual interest of an employee is related to the business interest of the company.

In a planning process, the following wastes can be identified:

- Material waste because of a wrong planning process – a lack of the communication and feedback between people realizing the planning process can decrease the costs of a manufacturing process.
- Long lead time because of the wrong prioritization – wrong planning rules can increase the costs concerning delivery delays.
- Low profit – individual costs calculation for a single point in the system without taking into account next steps in the process can increase the total costs and decrease the profit.

4. Process mapping in office and knowledge work

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4.1. Office and knowledge work processes

As in production processes, the office and knowledge work processes are prone to wastes occurrence which can seriously undermine the overall efficiency of companies. Therefore, the need for a fundamental tool arises if the intention is to conduct not only a detailed analysis of a process, but also the development of improvement proposals: an adequate tool for process mapping. By "adequate" one can refer to the characteristics such as (mainly): simplicity of construction, high representativeness and easiness of interpretation. Thus, the main objective of this course is to make the participants aware of the importance of process mapping during the first phase in the improvement of office and knowledge work processes. The other objective is to present an adequate graphical tool to do the process mapping.

4.2. Organization of the course day

The participants will attend the tablet course TC3.3: Process Mapping in Office and Knowledge Work. This course will begin with an introduction to Lean fundamentals, namely: lean principles, value stream and waste. Then, a more detailed content about wastes in office is addressed. Particularities of process mapping in production and process mapping in office and knowledge work are explained next. The course will finish with the presentation of a tool for the process mapping in office and knowledge work.

4.3. Partner Company involved

The office and knowledge work process, used in the game inherent to this course, is based on a real process, concerning the development of a new product, provided by the Latino Group Company. Latino Group is a Portuguese textile company, originally specializing in the manufacturing of uniforms and tactical equipment for the militarized armed forces as well as of professional workwear. As it is constantly involved in the development of new products, the company is an excellent source in terms of processes of office and knowledge work.

4.4. Game on process mapping in office and knowledge work (hands-on session)

The main purpose of the game is to teach participants (trainees) how to map a process of office and knowledge work using a specific tool, analyse that map in order to identify wastes and other improvement opportunities, and to devise possible improvement solutions, in order to increase the process performance, e.g. in terms of time spent. As previously stated, the process to be mapped is about a new product development in the Latino Group Company.

The game involves a formal competition in the 1st stage: the goal of the participant teams is to be the fastest team to provide the correct map and to calculate the lead-time and the value-added time of the process. In fact, the goal of the competition is to promote the coordination/communication between team participants (e.g. regarding information gathering), so they can understand and complete the process mapping. The other two stages, especially the 3rd stage, due to their nature, do not consider a formal competition between the teams.

4.4.1. Contextualization

To contextualize the game, one should consider the following brief description of the entire process of a new product development. When the company receives a consultation from a customer, the following steps are conducted:

1. Based on the product specifications provided by the customer, the company prepares and sends a proposal with costs and delivery time.
2. When the customer accepts the proposal, the company designs the product, produces a sample and sends it to the customer.
3. When the customer approves the product sample, the company starts the production.

The process to be mapped in the game is the one corresponding to step 2, as represented in Fig. 4.1.

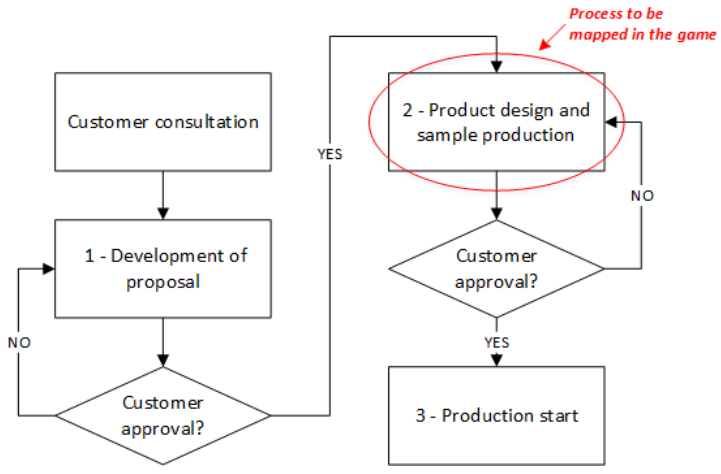

Fig. 4.1. Contextualization for the process mapping game

The game involves 2 (or more) teams (see section 4.4.2). The fastest team to map the process and calculate the corresponding lead-time and value-added time, is the winner. After this stage, the

teams will analyse the process map to identify improvement opportunities and propose possible solutions.

4.4.2. Participants and duration

Regarding the number of participants, consider the following recommendations:

- The minimum number of participants is 8 (2 teams of 4). Each team needs 4 participants because each one will assume one of the 4 specific roles.
- It is possible to conduct the game with fewer participants (e.g. 2 teams, each one with 2 participants), but then they must take on different roles and the duration of the game is likely to increase.
- It also possible to conduct the game with more participants (e.g. 2 teams, each one with 6 participants), but then some of them must share the same role.
- If more than 12 participants are involved, then teams of 4 should be created. However, one should keep in mind that each team needs a large whiteboard or flip chart paper sheets to stick on the wall.

The duration of the game is 2 hours (max.)

4.4.3. Required competences (input competences)

No special competences are required for the participants of this game (e.g. no previous knowledge, in terms of industrial engineering in general or even in process mapping in particular, is needed). Basically, anyone professionally involved in some kind of a process (understanding thus what a process is and that its execution may involve several people) is able to participate. As mentioned in section 4.1, one of the key aspects of the developed tool is the simplicity of the mapping construction. In any case, if necessary, a brief explanation of what a process is can be easily provided by the facilitator in the preparation stage of the game.

4.4.4. Developed competences (output competences)

The involvement in the game allows participants to develop a set of competences, not only technical but also transversal. The main technical competences are the ability to:

(i) map a process of office and knowledge work (based on a set of distributed information, purposely contradictory/incomplete) by using a specific tool (based on a graphical language with a reduced set of symbols) and
(ii) identify wastes in the process mapped.

Although to the less extent, it is also expected that the participants will be able to propose improvements to the analysed process in order to reduce wastes and to increase the process performance.

In terms of transversal competences, the nature of the game clearly potentiates the development of skills such as:

(i) teamwork,
(ii) communication,
(iii) leadership and even, eventually, conflict management.

4.4.5. Materials

To conduct the game, the following materials / equipment are necessary (per team):

- A large whiteboard or flip chart paper sheets and scotch tape (to stick on the wall),
- A set of 2 whiteboard markers (black or blue and red),
- A set of 4 marker pens (medium tip, black or blue),
- Two sets of post-its (100x75mm, yellow), and,
- A set of information cards.

4.4.6. Documents

The process to be mapped by each team is described in a set of information cards, each one corresponding to a particular actor in the process (role), namely:

- Department of Operations and Planning (DOP),
- Product Manager (PM),
- Warehouse Manager (WM), and,
- Technical Office (TO).

Thus, each card contains only a part of the necessary information. The original process provided by the partner company was simplified so its mapping became feasible in the period of time expected for the game. The cards with that information are presented in Figs 4.2 to 4.5.

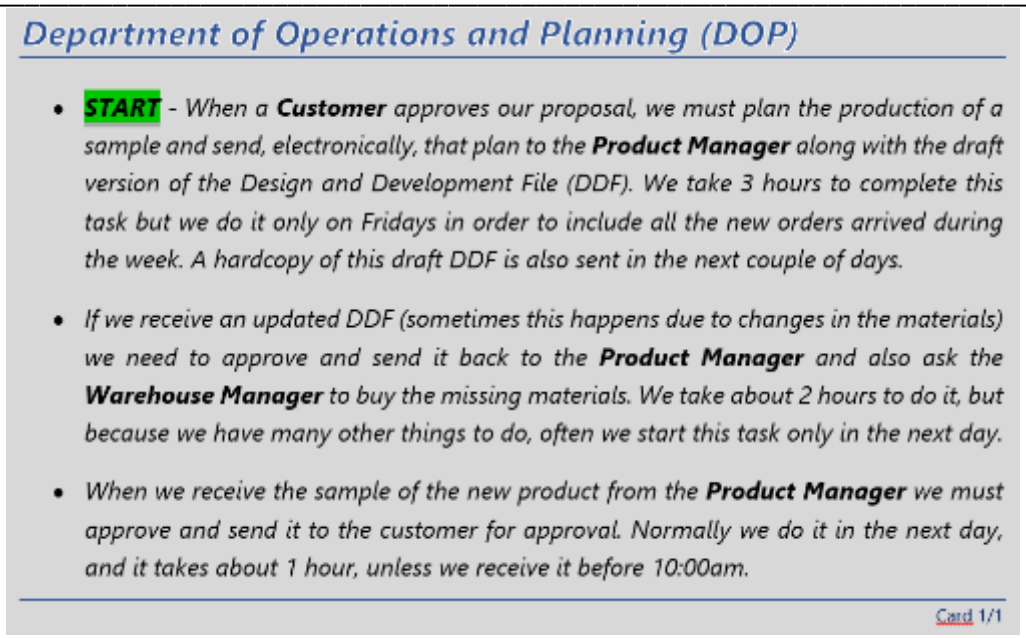

Fig. 4.2. Information card of the Department of Operations and Management (DOP)

One should note that the beginning of the process is labelled with "START" (Fig. 4.2).

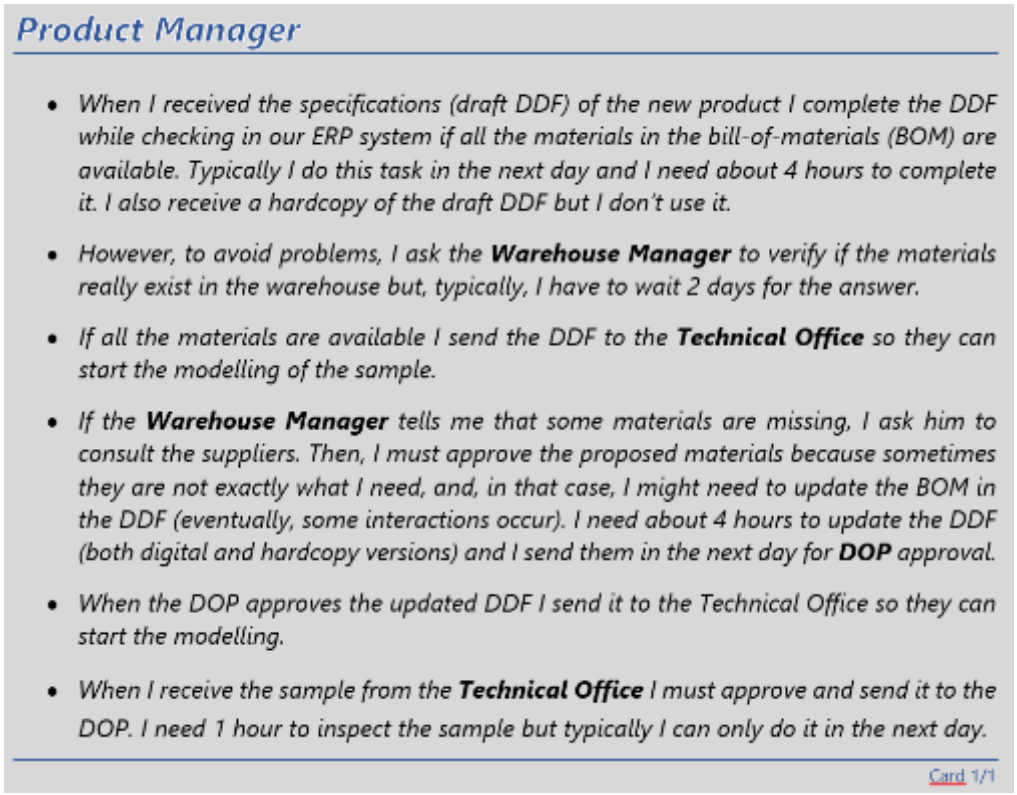

Fig. 4.3. Information card of the Product Manager

In the 2nd item of the Product Manager information card (Fig. 4.3) the excerpt "… I ask the Warehouse Manager… but, typically, I have to wait 2 days for the answer" contradicts the information provided in the 1st item of the Warehouse Manager information card (Fig. 4.4).

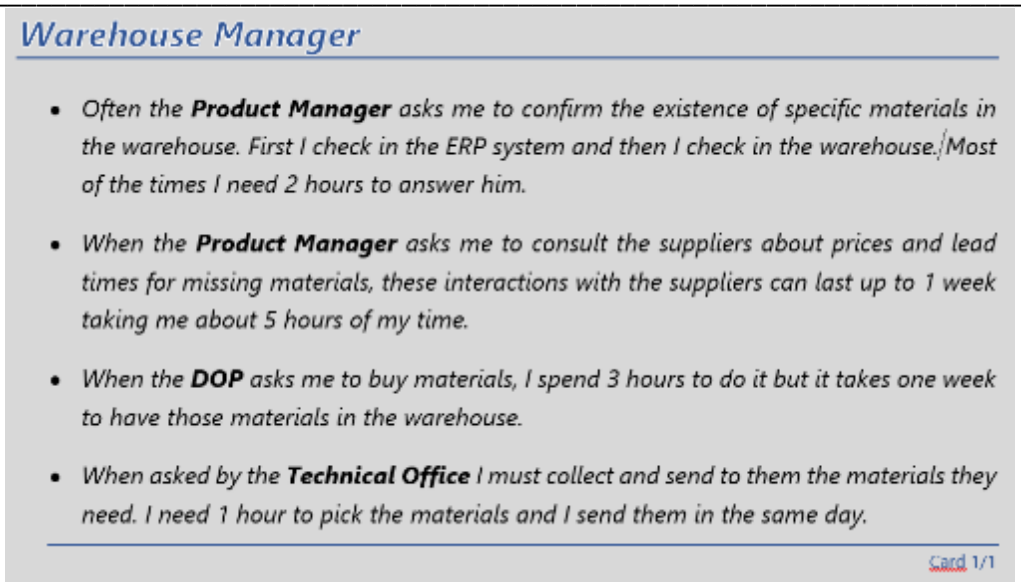

Fig. 4.4. Information card of the Warehouse Manager

The inclusion of the contradictory information is intentional, so the teams face this problem that usually happens in real situations. In the context of the game, one should consider that the Warehouse Manager needs 2 days to answer to the request of the Product Manager (due to his other tasks), although only 2 hours of added value time are involved.

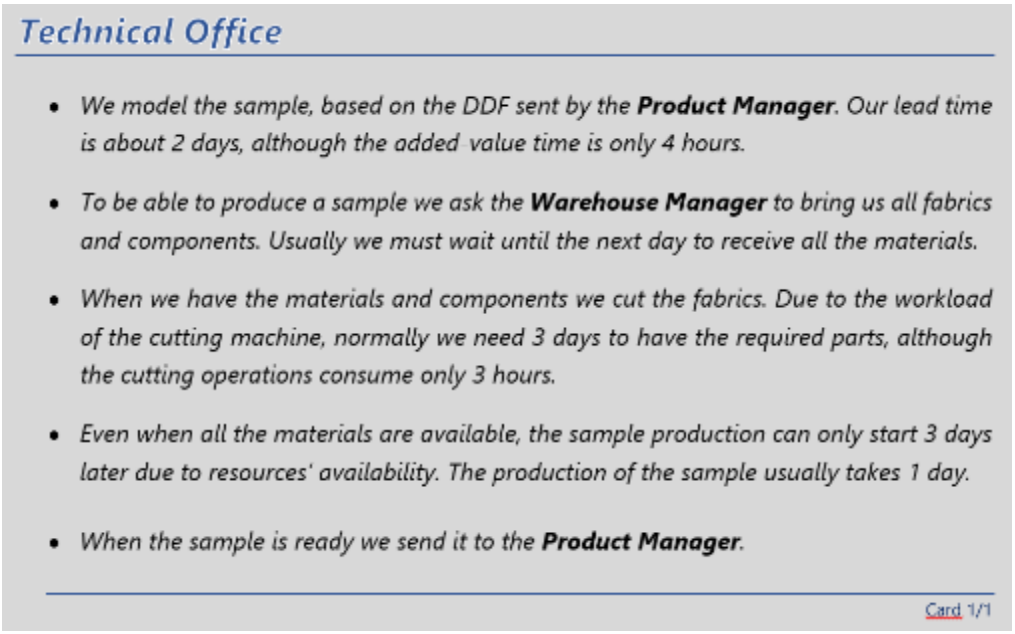

Fig. 4.5. Information card of the Technical Office

The 2nd item of Fig. 4.5 ("… Usually we must wait until the next day…") and the last item of Fig. 4.4 ("…and I send them on the same day") also reveal intentional contradictory information involving the Technical Office and the Warehouse Manager. For the game context, the worst case should be considered (1 day). Finally, this last information card (Fig. 4.5) also includes information that may be misinterpreted: the lead-time of the operation inherent to the 4th item (production of the sample) is 4 days and not 3 days as one might think at first.

The next sections will provide the facilitator (trainer) with the necessary information to conduct the game.

Preparation Stage: Introduction and definition of teams and roles

The facilitator of the session (a trainer) should briefly describe the game and its main purpose, using a small set of slides to contextualize the game. Then, the facilitator should define a number of teams according to the number of participants. Unless necessary, the facilitator should not interfere in the teams formation. Next, each team should organize its space with a whiteboard (or flip chart paper sheets taped to the wall) and the rest of the materials, except the information cards. Finally, each member of each team should choose his role.

Step 1: Process mapping

The 1st stage – process mapping - is expected to be the longest in the session. Each participant will have an access only to the specific knowledge indispensable for his/her own role, represented in the corresponding information card. Thus, the "overall picture" is distributed. Naturally, mapping of the entire process implies gathering information from all the people involved in the process.

The facilitator delivers the information cards to the participants of each team, according to the defined roles. Each participant should read his/her information card in order to clearly identify:

- His/her intervention in the process (i.e. what tasks are to be done),
- Who he/she has to interact with (i.e. who gives inputs and who receives the outputs of the executed tasks).

The facilitator should indicate that the process starts in the Department of Operations and Planning (DOP) so the participant playing that role becomes aware of that fact.

It is expected that one of the participants will take the lead of the mapping process, although the facilitator should not provide any previous information about this additional role – the purpose is to expose the participants to a real problem that often occurs when a process mapping session is conducted in a company: no one wants to lead a task (construct the mapping on the whiteboard or similar).

As already mentioned, the set of information cards contains contradictory information (e.g. about the lead-time of an operation). Obviously, the goal is to make participants realize that they cannot complete the process mapping due to these problems (which occur in real scenarios). This will lead to a discussion and deadlock. At this point, the facilitator should intervene and provide the correct information so the mapping can be completed (see section 4.4.6).

The whiteboard should be divided into five horizontal cells (Fig. 4.6), one for a customer and the remaining for each of the actors.

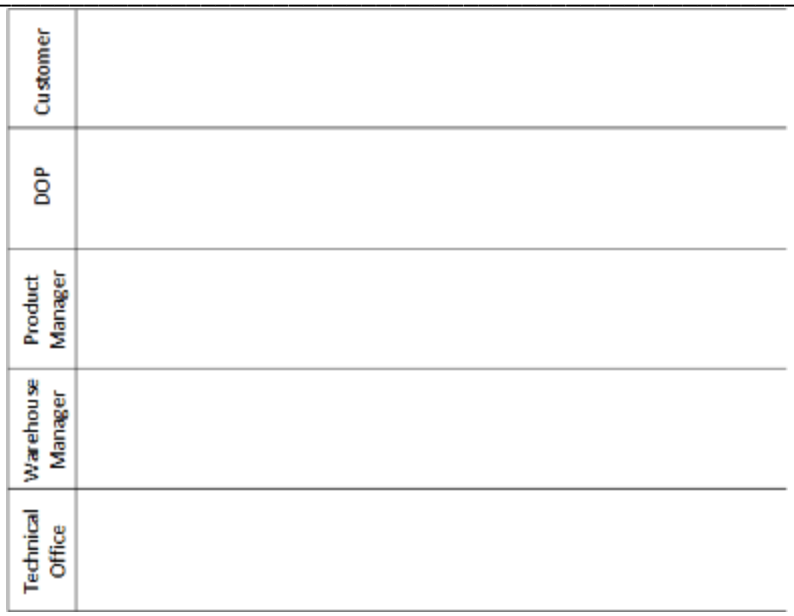

Fig. 4.6. Cells for the process mapping

The process mapping is iteratively constructed on the whiteboard (or similar) using the post-its. Starting by the DOP participant (beginning of the process), each participant should:

- Write a short description of one's tasks on a post-it,
- Deliver the post-it to the participant in charge of constructing the map (if someone has assumed that leader role) or simply stick the post-it on the whiteboard, in the cell corresponding to his/her role,
- Represent with arrows (using a whiteboard marker) interactions with the participants he/she is involved with (inputs and outputs), or ask a team leader to do that (if present).
- Discuss/interact with the team in order to clarify all the aspects of the process.

An example of a task description on a post-it can be seen in Fig. 4.7.

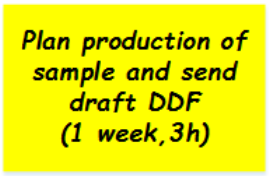

Fig. 4.7. An example of a task

In the provided example (Fig 4.7), the lead-time and the value added time were included on the post-it. However, the facilitator should not give this tip to the teams. Eventually, they will feel that need. As mentioned, the operations (post-its) are placed in the corresponding cells (Fig. 4.6) and they are connected with lines (drawn with whiteboard markers) which represent an information flow. In order to map decisions, another post-it - the "decision element" is used (Fig. 4.8).

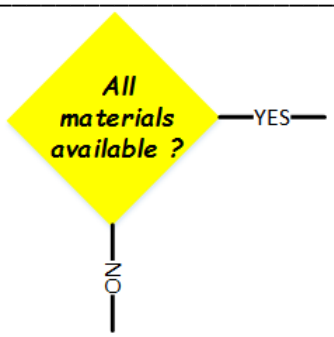

Fig. 4.8. An example of a decision

At the bottom of the map, the "timeline" should be drawn (by a team leader, if present) according to the provided information. An example can be seen in Fig. 4.9.

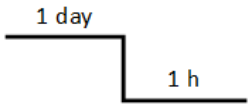

Fig. 4.9. Example of excerpt of timeline

The upper part of the line represents the lead time of the task and the bottom part the added-value time.

A possible solution for the process map inherent to this game is represented in Fig. 4.10. The whole map is also attached to the manual (Attachment 1). The solution is not unique in terms of mapping (e.g. may depend on the level of operations aggregation/disaggregation assumed by each team), but it is unique in terms of the lead-time and added-value time of the entire process. The lead-time of the process is **32 days** and the added-value time is **41h**. The team that first indicates these values, after concluding the mapping (correctly), will be the winner.

Step 2: Identification of wastes / improvement opportunities

At this stage, the facilitator should promote the analysis and the discussion of the developed map – a current state map. The participants should analyse the process and identify the existing waste (i.e. redundant processes, long lead times and long processing times). The places where these problems occur should be tagged with red circles/ellipses, which in fact identify improvement opportunities. For this current-state map, at least the following problems could be identified:

1. The hardcopy of the Design and Development File (DDF) sent by the Department of Operations and Planning is not necessary (waste).
2. Both the Product Manager and Warehouse Manager check the existence of materials in the ERP system (redundant processes).
3. A sample of a product is approved by the Product Manager and by the Department of Operations and Planning (redundant processes) as well.

4. The modelling of a sample (digital task) is executed only when all the materials are available (waiting).

The places where these problems occur should be tagged on the current state map (Fig. 4.11) with red circles/ellipses which in fact identify improvement opportunities. In this case, the tagged operations should be:

1. Plan the production of a sample and send a draft DDF,
2. Complete DDF and check materials in ERP,
3. Check materials and inform,
4. Model the sample, and,
5. Approve and send the sample (both at DOP and PM).

Eventually, the teams may identify additional problems.

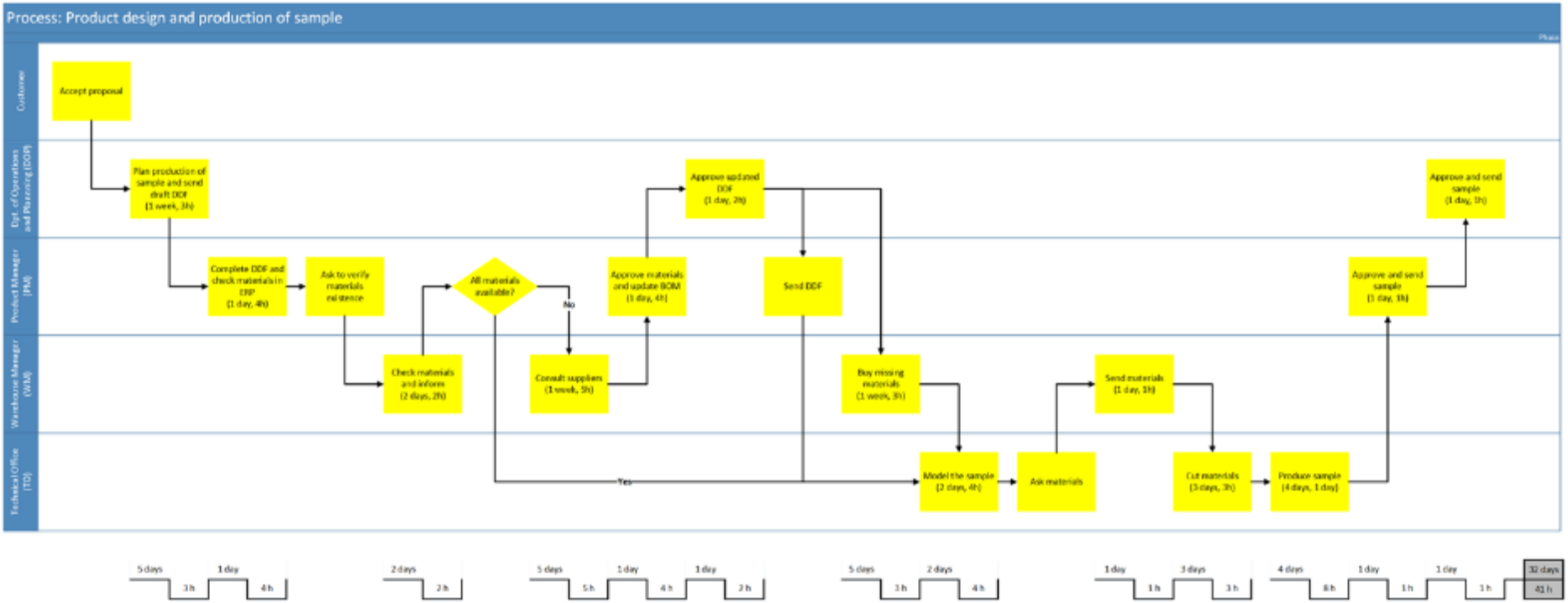

Fig. 4.10. A current state map

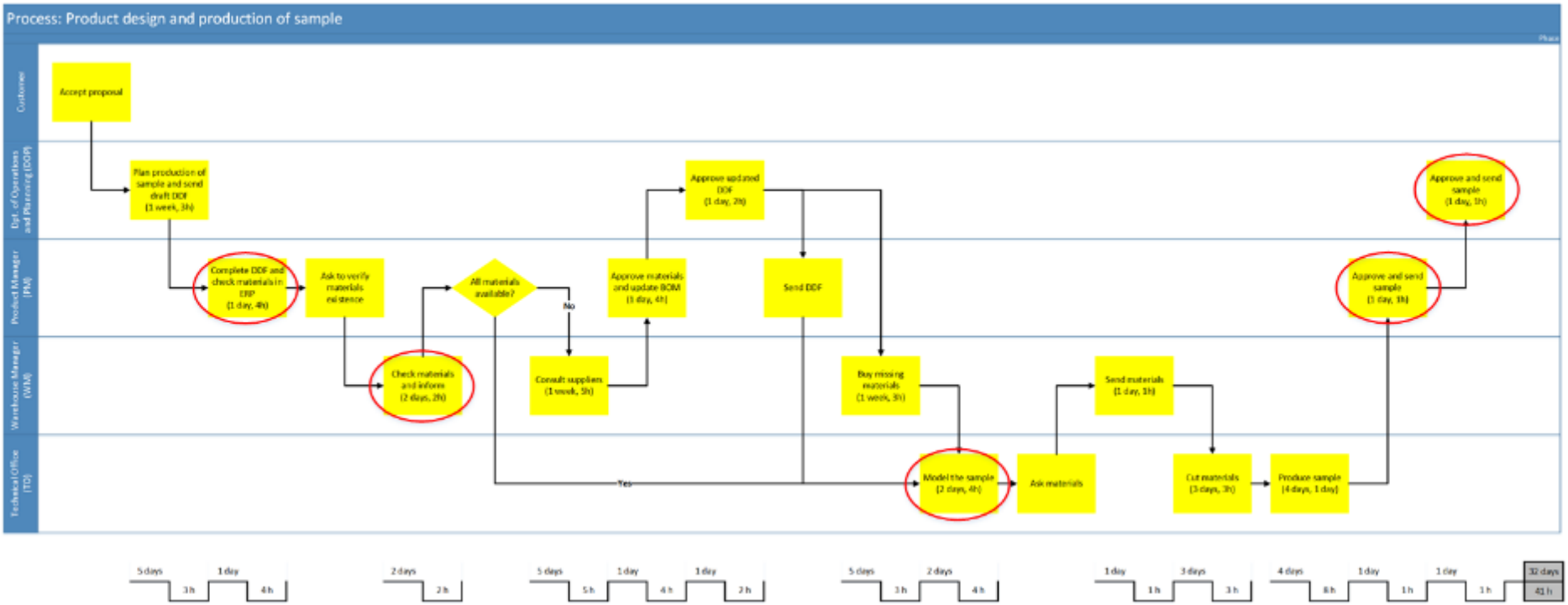

Fig. 4.11. Identification of some improvement opportunities on the current state map

Step 3: Presentation/discussion of improvement proposals

At this final stage, the facilitator should promote the development of certain improvement proposals and, eventually (depends on the available time), ask the participants to change the current process map accordingly (in fact it will be a "future state" map). In this case, some improvement proposals could be:

1. Eliminate the hardcopy of the Design and Development File (DDF) sent by the Department of Operations and Planning to the Product Manager.
2. Only the Product Manager should check the existence of materials in the ERP system. Additionally, standard procedures to update the ERP system (in terms of inventory inputs and outputs) should be implemented in the warehouse (e.g. involving a bar-code and/or RFID systems). If the ERP system has accurate data, then the operation "Check materials and inform" performed by the Warehouse Manager can be eliminated.
3. Define a standard procedure to inspect and approve a product sample (e.g. by including a checklist of inspection points) and assign this task only to the Product Manager.
4. The modelling of a sample (a digital task) can be started when the Product Manager completes the DDF.

In order to conclude the session, the facilitator should ask the participants to summarize the lessons learned as well as to provide feedback, namely in terms of advantages and drawbacks of the game and improvement ideas.

5. Use of Kanban Philosophy in Knowledge Work

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Salte AS

5.1. Background and Motivation of Developing the Game

Engineering companies normally do not put as much consideration on work-in-process (WIP) as manufacturing companies. They normally engage in a knowledge type of work, where WIP is physically and financially invisible. The invisibility of WIP makes most engineering companies not even realize of the presence of work queues. The concept of kanban, which has gained popularity since the introduction of Toyota Production System (TPS), has been proven to enable the management of queues to limit WIP. However, this concept is also not prominent in an engineering type of activities and projects due to the belief that kanban is applicable only in a repetitive type of production, such as manufacturing. This game is developed to serve two key purposes: to apply the importance of managing WIP in knowledge work as well as to communicate the possibility of applying kanban in engineering tasks.

5.2. Learning Outcomes

After playing this game, the participants are expected to:

- Learn the impact of batch processing and the importance of limiting WIP
- Learn the concept of kanban and how to apply it in knowledge work
- Learn the importance of visualizing a process, especially in knowledge work where most of tasks are physically invisible.

5.3. Game Overview

This game is adapted from getKanban board game developed for a software industry. Considering similar characteristics between a software industry and other engineering activities, it is believed that getKanban board game could be modified to be adapted to other engineering activities circumstances. As engineering activities are broad and varied, there is a need to select one particular engineering area to focus on. The Risk-Based Inspection (RBI) assessment and control, which is one of the most important engineering activities in process engineering, especially in an oil and gas industry, is selected for developing the game.

Brief Overview of Risk-Based Inspection Assessment

Before going to the game basics, a brief overview of RBI assessment will be provided in this section. This will be the foundation that develops the elements as well as the rules of the game.

RBI is a methodology used to optimize the inspection activities in process plants. Numerous equipment and piping in industrial plants make it uneconomic for the plant owner to do a rigorous level of inspection and maintenance for all equipment and piping. RBI uses risk assessment tools to assess the risk of each piece of equipment and piping, and rank them based on the assessed risk. Items with a high level of risk will be prioritized more for inspection and maintenance than the lower risk items. The priority is in terms of the frequency of inspection and the rigorousness of the inspection technique. Higher risk items will receive more frequent inspection and/or more rigorous inspection techniques. The main steps of RBI assessment are shown in Fig. 5.1.

Fig. 5.1. Key Steps of RBI Assessment

Normally, RBI assessment is conducted by an engineering company appointed by a plant owner. A team of engineers, comprising of RBI engineers and material/corrosion engineers, is typically employed. The process plant usually comprises of several units. Each of them shall be assessed by the RBI team. For instance, an offshore oil and gas processing plant might consist of wellheads & manifolds unit, separation & stabilization unit, crude handling unit, etc. Every unit will undergo the RBI assessment independently by following the key steps shown in Fig. 5.1.

The Game Background and Objectives

A company, ABX Engineering Inc., provides an integrity management service for an oil and gas industry. The oil and gas company, DCK Exploration & Production, hires ABX Engineering to conduct a Risk-Based Inspection (RBI) analysis for one of their offshore platforms. The main objective of the game is to complete the project in as minimum time as possible.

Game Apparatus

The game adopts the elements of a board game, which consists of: (1) a board, (2) cards, (3) a dice, and (4) players. Each of them will be discussed individually as follows:

The Board

The board is shown in Fig. 5.2. The board has five columns, each of them represents the main steps of conducting an RBI assessment. The first three columns/steps have two sub-columns, which are in-progress and complete. The game will move from left to right.

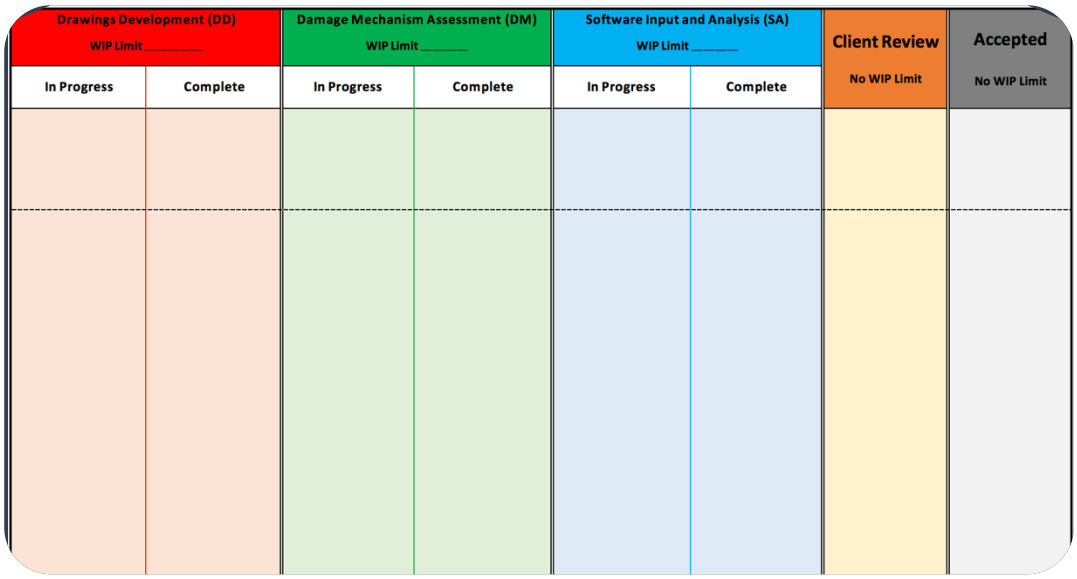

Fig. 5.1. The Board

A Dice

A dice represent engineers in the RBI team. One engineer is represented by a dice. The colours indicate their specialization. A Red dice represents corrosion/material engineers while a blue dice represents an RBI engineer. An RBI engineer can do the task in all three steps (i.e. Drawings Development, Damage Mechanism Assessment, and Software Input and Analysis), while a corrosion/material engineer can only do Drawings Development and Damage Mechanism Assessment tasks. The number of dice to be played with can be adjusted, depending on the available play time and the desired complexity of the game.

In this game, each dice is thrown once in a turn and the turn symbolizes a week of the project. In other words, when all dice have already been thrown once, that means a week of the project has been spent by the RBI team. All dice must be assigned to the specific unit card before being thrown. Once assigned, dice may be rolled in any order. Multiple dice could not be assigned to a single unit.

Cards

There are two types of cards: the *unit cards* and the *event cards*. The unit cards are a type of cards that will move on the board. Unit cards are the actual work that need to be done by the RBI team, with each card representing an individual unit of a processing plant (see Fig. 5.3). As mentioned, the unit cards will move from the left- to the right-side of the board. There are three categories of unit cards:

- *Hydrocarbon units* – Indicated by red cards. These unit cards have a high priority, to be completed first.
- *Flare, drain and utilities* – Indicated by yellow cards. These unit cards have a medium priority.
- *Chemical injection and air system* – Indicated by green cards. These unit cards have a low priority.

Each unit card has a number of white dots which represent the work required to complete the unit. The reversed triangles represent the work required to do rework, if necessary. After each throw of the dice, the white dots need to be crossed off in accordance to the number shown by the dice. The crossed off dots mean that some works have been done on that particular unit. The dots are arranged in three sections, representing Drawings Development (DD), Damage Mechanism Assessment (DM), and Software Input & Analysis (SA), which are the key steps in conducting an RBI assessment. When all the dots in a certain section have been crossed, it means that work in that particular step has been completed and the unit can be moved to the next step (see Fig. 5.4).

At the bottom of unit cards, there are three fields that are used to calculate lead time for each unit card. The lead time is the time needed by a card to travel across the board from Start (i.e. drawing a development step) to Accepted. Therefore, the players are required to record the time the unit card enters the board and the time unit card leaves the board.

Some rules regarding unit cards:

- Unit cards may be selected from the unit cards stack according to the priority order.
- Unit cards may be pulled across the board in any order.
- The selected column must be filled to its WIP limit in every week. If it is not possible to fil every column, the column with more upstream location is prioritized to be filled first.
- Unit cards may be moved downstream (as long as WIP limits are not exceeded) in order to make room upstream to pull other unit cards.

Meanwhile, the event cards contain some stories and instructions that shall be done by the players to the game. An example of an event card is shown in Fig. 5.5. The event card is picked up according to the schedule instructed on the back of the card.

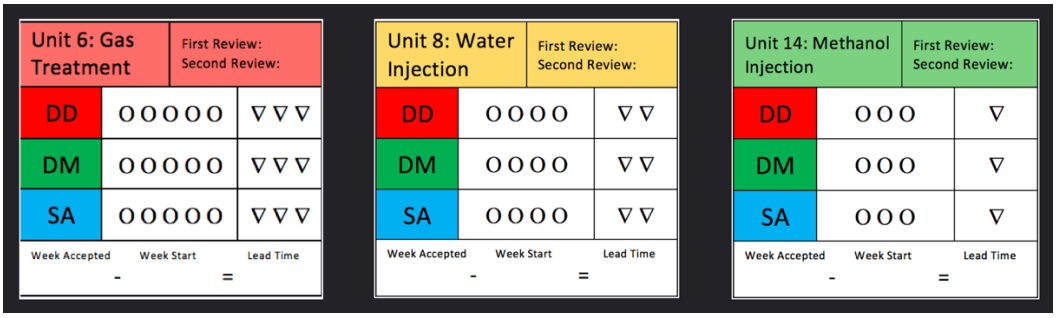

Fig. 5.3. Unit Cards

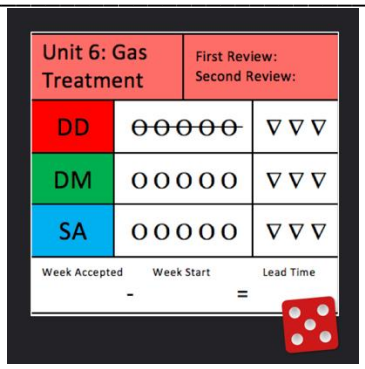

Fig. 5.4. After each throw of the dice, the white dots need to be crossed off in accordance to the number shown by the dice

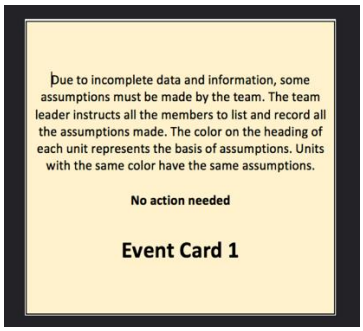

Fig. 5.5. An example of an event card

Players

In the game, there will be three players with different roles. They are a project manager, a resource tracker, and a work tracker. The project manager will be responsible for running the weekly steps. He/she will ensure that every step needed to be taken in every turn is done and every rule is obeyed. The weekly steps contain the following:

1. *Group meeting* – The project manager facilitates a "standup meeting" during which the team observes the state of work on the board, and briefly discusses the strategy for the day. The team decides the dice to assign for each unit and the units to pull if necessary.
2. *Play the board* – throw the dice, reduce work on assigned units by the face value the dice shows, take notes of any leftover work. Spread leftover work on other units, pull units to do so if necessary (ensure WIP limits are honoured). Repeat until all dice have been thrown for the week. Track the available time (i.e. the face value shown by the dice) and the used time (i.e. the face value used to reduce the work on the assigned unit) on the Resource Utilization Chart.
3. *Sanity check* – The project manager ensures WIP limits are honoured, and all unit cards are up to date: the week ready field is completed on all unit cards pulled onto the board; the week accepted and lead the time field is completed on all accepted cards.
4. *Track charts* – The project manager ensures that the chart tracker update their charts. Trackers complete charts: CFD at the end of every week; control the chart only if certain units have been accepted.

5. *Week complete* – Pickup the end of the week event card (if there is any). Read aloud, act if necessary and place the event card back at the deck. See the plan for an event card section for pick up scheduling.

The resource tracker has the responsibilities of filling in the resource utilization chart and lead the time distribution chart. Meanwhile, the work tracker is responsible for filling in the Cumulative Flow Diagram (CFD) and the control chart. The chart forms are presented in Fig. 5.6.

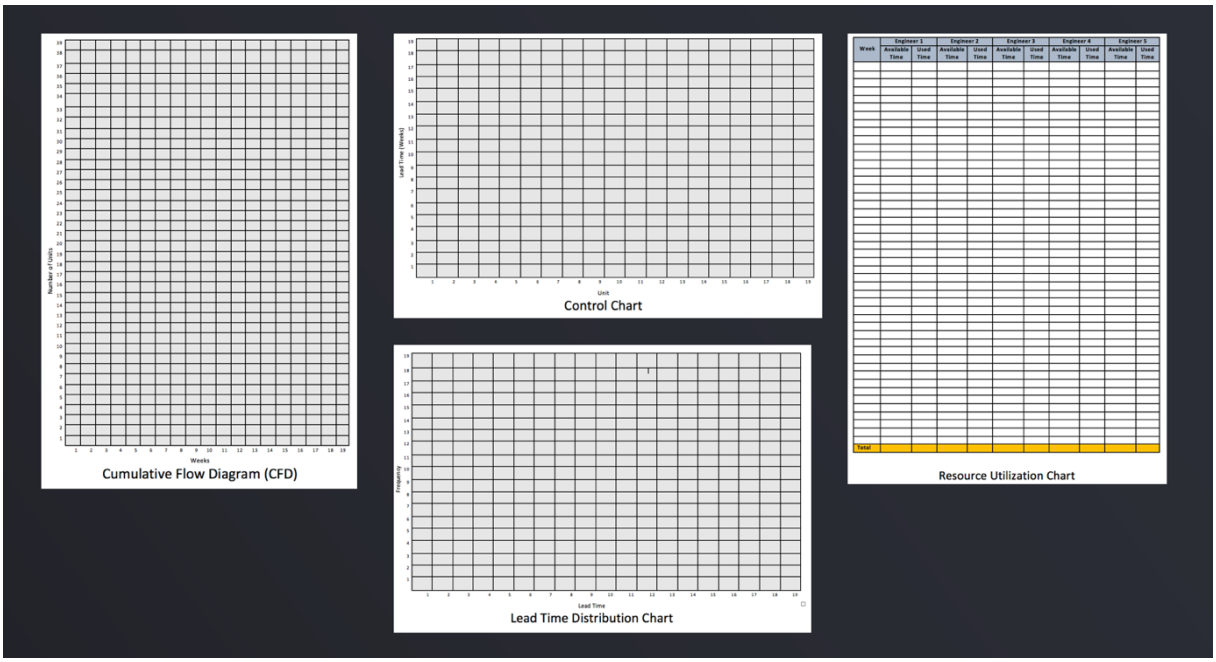

Fig. 5.6. Track Chart Forms

Game Set-Up

The initial set-up of the game is shown in Fig. 5.7. The WIP limits set at the top of each column apply across both in-progress and complete sub-column.

Game Mode

Two groups of players will play against each other. One group will constrain the WIP (i.e. the WIP is kept small), while the other team does not manage their WIP (i.e. the WIP is large). This is done in order to compare the performance of each other. Theoretically, the team with small WIP will finish the game first, followed by the other team.

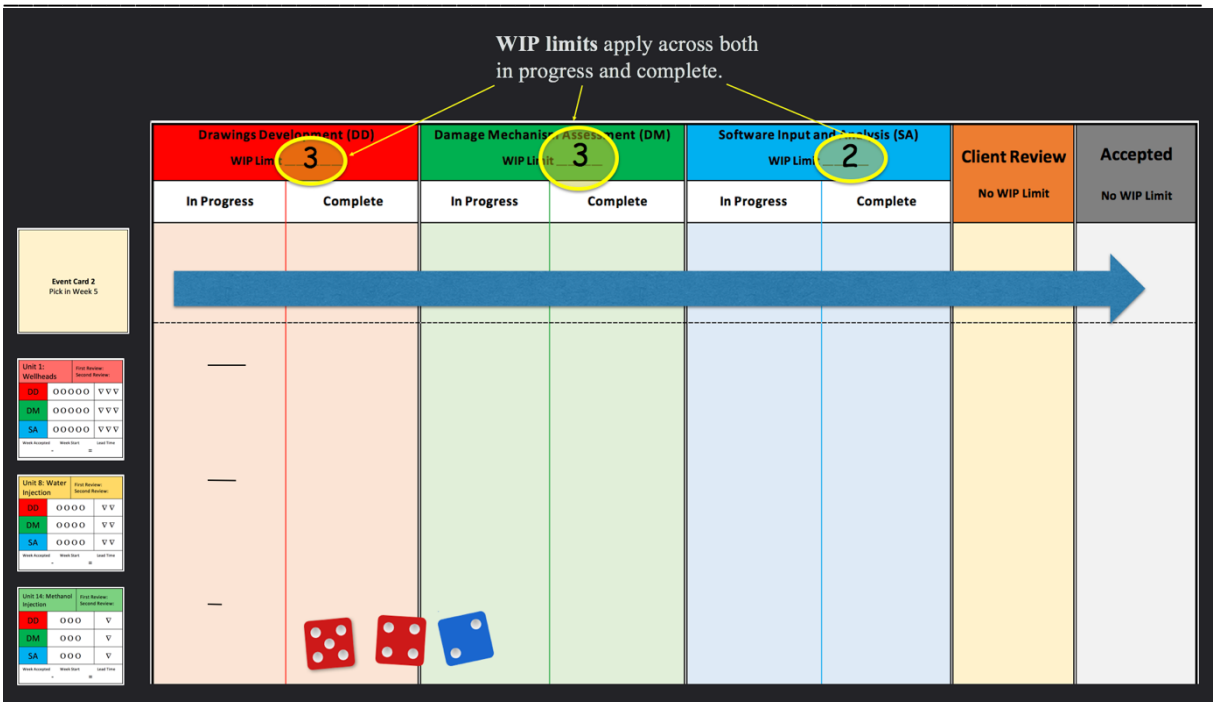

Fig. 5.7. The initial set-up of the game

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