Welcome to MSc. KIMP

Design & Manufacturing

Descriptions, explanations and expectations of the KIMP_DM Master of Science

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4th October 2021

Arts et Métiers Sciences et Technologies

ARTS ET MÉTIERS
IN FIGURES

11
SITES
all around France dedicated to research and teaching

220
PHD STUDENTS
registered in our doctoral school focused on engineering

1
BACHELOR IN TECHNOLOGY

6000
STUDENTS
all programs combined

14
LABORATORIES
and research teams

11
ENGINEERING PROGRAMS

1100
STAFF
teaching, research, technical & administrative

7 MILLIONS €
of revenues in
CONTINOUS EDUCATION

+20
MASTER OF SCIENCE

15 MILLIONS €
in revenues generated by contracts with industry

2000
STUDENTS
in continuous education programs

17
SPECIALIZED MASTERS ©

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ARTS ET MÉTIERS
A UNIQUE NETWORK

8 Campus Arts et Métiers dedicated to teaching and research

3 Institutes dedicated to only research

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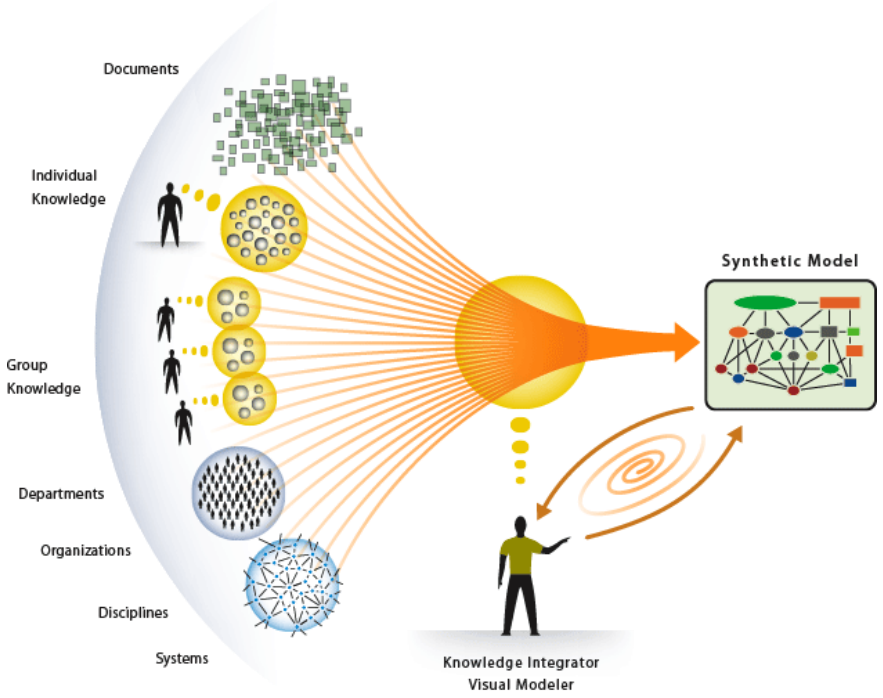
K.I.M.P.
KNOWLEDGE INTEGRATION

Why Knowledge Integration ?!

The aim of Design is to manage (during creative and decision phases) all constraints, Knowledge and information involved on both the Product to design and its manufacturing process.

With this global view, the goal is to design **not a local good solution** (the best if we consider only one expertise) **but the global one** (the best compromise).



www.idiagram.com

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KIMP TRACKS
3 TRACKS, 3 CAMPUSES, 1 GOAL

The international Master of Science KIMP is proposed in three Arts et Métiers campuses. Each of them proposes a specific track :

Agile **P**roduction **S**ystem - Adel OLABI
To be able to design and integrate agile (flexible and rapid) production systems for modern and competitive production industries

CII (Integrated Design and Innovation) - Ali SIADAT
To be able to manage production systems by modeling them, their products, company and resources. Courses taught **in French**.

Design and **M**anufacturing - Alain ETIENNE
To be able to apply integrated design and manufacturing, concurrent engineering, computer aided design, computer aided manufacturing and computer aided engineering concepts

… but 4 scientific modules (core courses) are common to these 3 tracks.

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KIMP

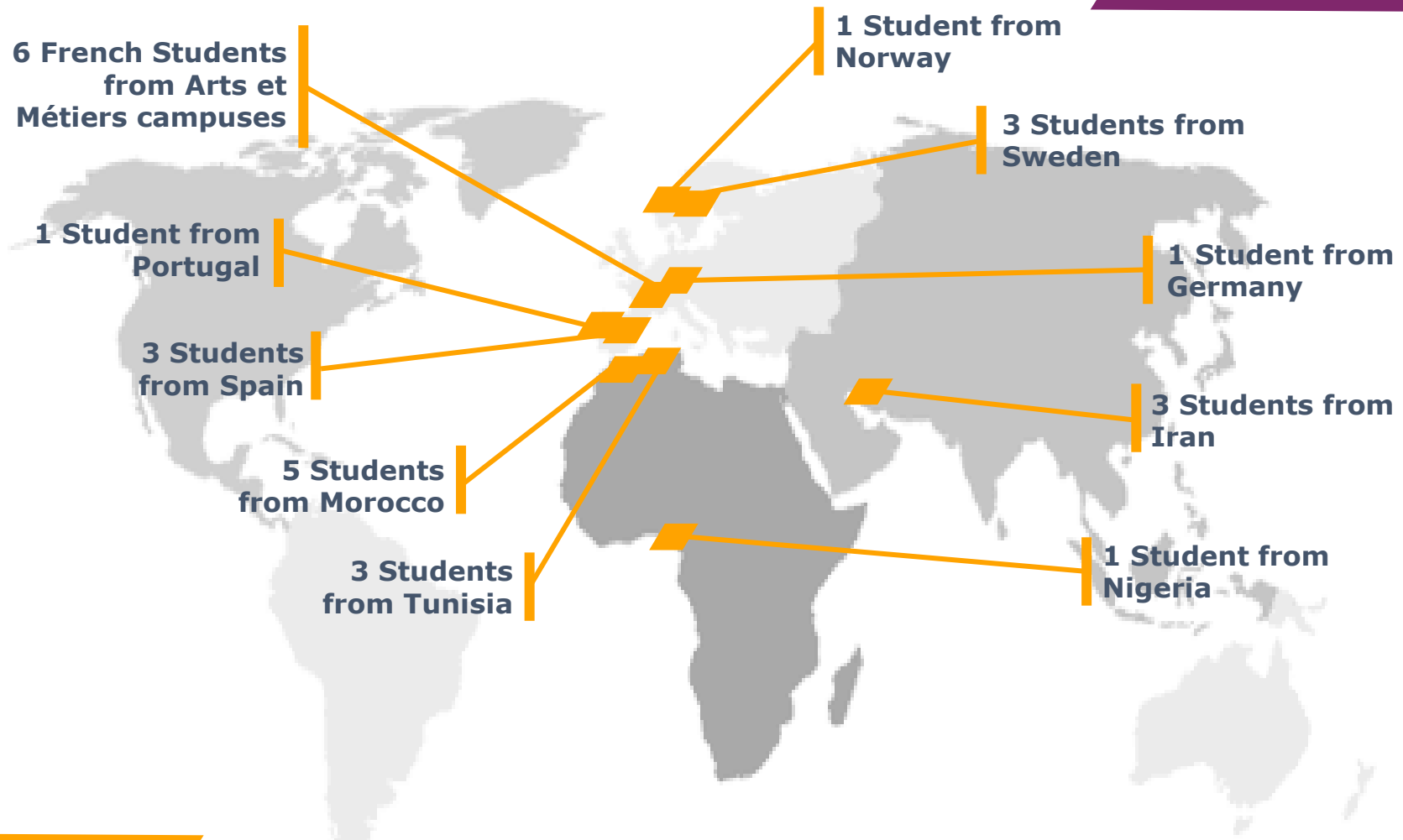
DOUBLE DEGREES

Thanks to the teaching language, KIMP MSc. eases the international relationships through double degree programs with:

- **Swedish** Universities (KTH)
- **German** University - Karlsruhe In Technology
- **Danish** University - DTU
- **North Africa** Schools of Engineering (Morocco, Tunisia)
- **Iranian** University - (University of Tehran + Iran University of Science and Technology, Sharif University of technology and others in perspectives)

… and several exchanges through ERAMUS and Campus France programs

2021 SCHOOL YEAR
27 STUDENTS



=> Enjoy all these cultures to **share** and avoid staying in national groups !

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2021 SCHOOL YEAR
17 TEACHERS

A. OLABI
N. KLEMENT
A. QUENEHEN

M. LASSAGNE
J. CAMARERO
K. SANTIC
S. GARBAYA

L. LANGLOIS
L. HOMRI
A. ETIENNE

J.R. CHARDONNET
F. MERIENNE
F. ABABSA

Y. LEDOUX
N. PERRY

J.P. PERNOT

=> They make long trips to teach KIMP courses, **avoid being late**…

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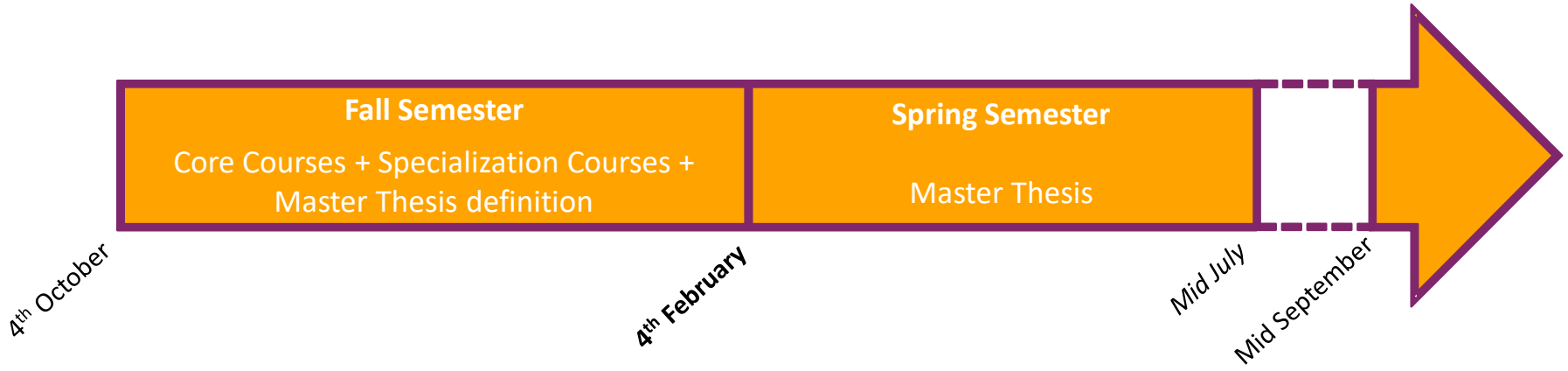
2021 SCHOOL YEAR
COURSES TIMELINE



The Master year is divided into two main semesters:

- ✓ The **Fall Semester** (from October to end of January) is dedicated to courses, which are split into 3 main categories:
  - ➢ Scientific courses
  - ➢ Professional courses
  - ➢ Culture and language courses and ATHENS Program

- ✓ The **Spring Semester** is dedicated to the Master Thesis. It ends with the Master Thesis defense. You have the choice between two defense dates.

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Fall Semester

Courses, Schedule, Terms…

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FALL SEMESTER
CORE COURSES

The first quarter is composed by courses common to all KIMP tracks:

- ✓ **Scientific courses (core courses):**
  - ✓ **UE1** - Methods, models for the integration of both product and manufacturing process parameters — L. LANGLOIS
  - ✓ **UE2** - Tools for integration – Rules based approach from AI — A. ETIENNE
  - ✓ **UE3** - Modeling and control of mechatronics devices — A. OLABI
  - ✓ **UE4** - Manufacturing process management — N. KLEMENT, A. QUENEHEN
- ✓ **Professional course:**
  - ✓ **UE5** - Literature Review — S. GARBAYA
- ✓ **Culture and Languages courses:**
  - ✓ **UEL** - French language and culture — K. SENTIC, J. CAMARERO
  - ✓ **UEL** - English language class for French native speakers — K. SENTIC, J. CAMARERO

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FALL SEMESTER
SPECIALIZATION COURSES

The second quarter is composed by courses specific to each track. KIMP_DM track specialization courses are:

- ✓ **Scientific courses:**
  - ✓ **UE21** - Sustainable engineering — N. PERRY
  - ✓ **UE22** - Robust Design and Big Data — Y. LEDOUX, L. HOMRI
  - ✓ **UE23** - Geometrical product representation for CAD and CAM — J.P. PERNOT
  - ✓ **UE24** - Digital mock-up and virtual environments — J.R. CHARDONNET, S. GARBAYA, F. MERIENNE
- ✓ **Professional course (shared):**
  - ✓ **UE25** - Decision and risk analysis — M. LASSAGNE
- ✓ **Master Thesis Proposal definition**
- ✓ **ATHENS Program**: No KIMP course planned to help student to participate to this program which is mandatory !

FALL SEMESTER
COMMON TERMS

Each module is evaluated by the teachers.

They are totally **free** to choose the way to evaluate you and the number of assessments needed. Evaluation can be oral defenses, reports, projects, exams…

The learning outcomes sheets detail the terms of each course and their objectives.

Penalties can be applied if you don't respect deadlines, terms or if your work **is not personal (plagiarism, copy/paste…)**.

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FALL SEMESTER
COURSES ORGANISATION

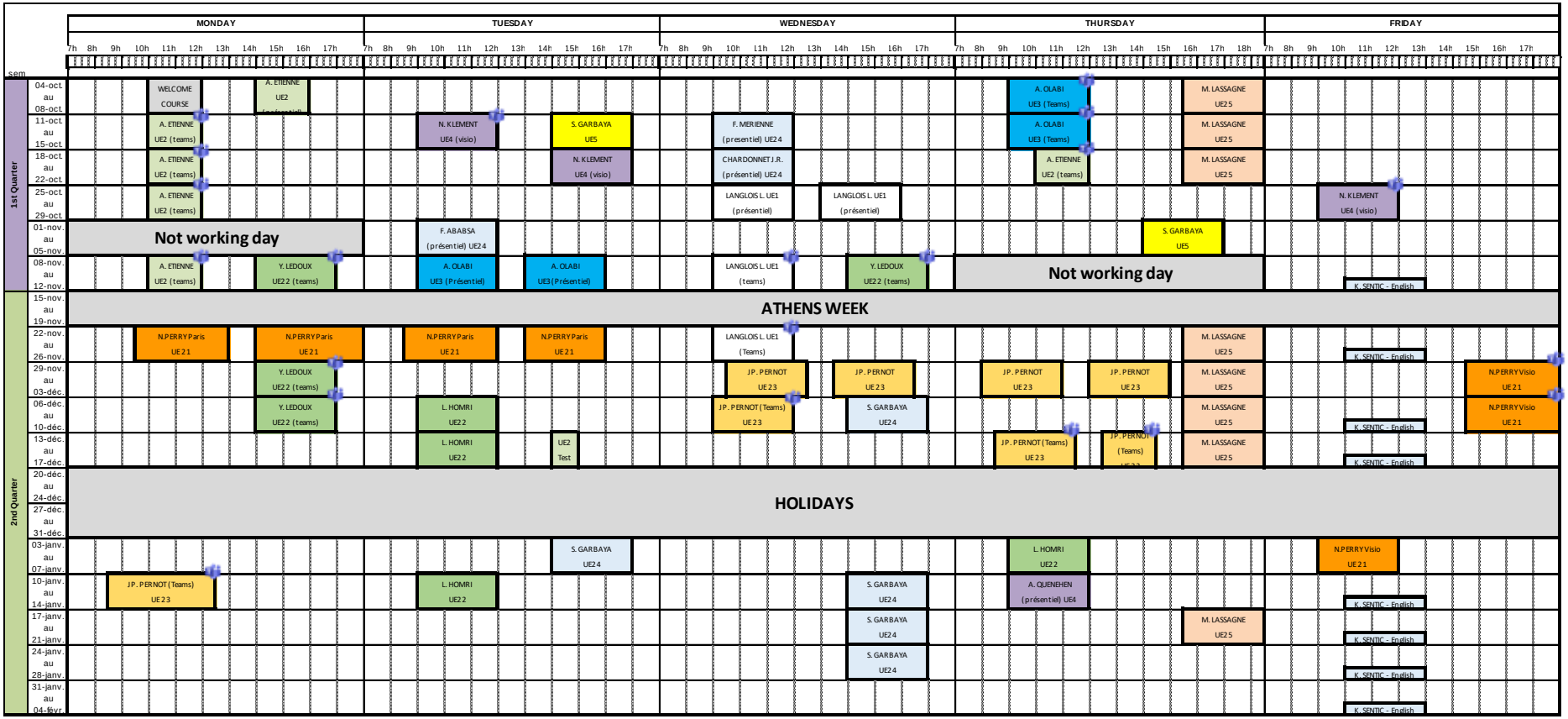
The COVID and previous confinement impacted the manner the courses were taught. The choice was given to the teachers (who came across France and prefer splitting their course on shorter sessions) to organize their course in the manner they consider the best.

The course can be taught:

- ✓ **Face to face session in campus Arts et Métiers of Paris**
- ✓ **Synchronous remote manner**: TEAMS video-conference system
- ✓ **Asynchronous remote manner**: Moodle system (called SAVOIR in Arts et Métiers) => All the KIMP structure is available in this webpage. Since this structure is new, they will be complete in time.

FALL SEMESTER
SCHEDULE V2021.1.0

Can be modified



The tests are not yet planned => They'll be proposed all along the semester

The up-to-date version (with the classroom) is available in schedule Website : https://lise.ensam.eu by selecting "*Mon planning*". The planning is available when your registration is complete.

FALL SEMESTER
EVALUATIONS & VALIDATION

The validation rules are:

- ✓ For scientific modules:
  - ✓ **Each scientific module must be <u>greater than 10</u>** (new validation condition from the school head)**,**
  - ✓ **For ranking, the semester mark considers only the scientific courses weighted by their ECTS credits.**

- ✓ For professional (and language) modules:
  - ✓ **The marks of each professional module must be greater than 10.** These marks are not considered in the scientific average (nor in the ranking)
  - ✓ For ATHENS program the ECTS grade must be greater than D : A, B, C, D, **E, F**

During the second semester, revalidation works are proposed: don't spoil this second chance, there is no third one…

Only the first try is considered for both year average and ranking.

Spring Semester

Master Thesis – Definition, Proposal, Schedule

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SPRING SEMESTER
MASTER THESIS - DEFINITION

"The master thesis must be an **original work** on an extended analysis of a research & development project, with **well-defined aims** and well-identified **contribution**"

Consequently, a master thesis…

- is not a company placements, nor job-shadowing…
- is not compatible with multiple missions projects…
- cannot be **only an application** of well-known technics or methodologies (even on a new case or new product)

+ is defined with a scientific issue
+ is supported by a set of scientific references (articles, conferences…)
+ aims at enriching the scientific community (personal contribution and novelty)

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SPRING SEMESTER
MASTER THESIS - TERMS

A KIMP Master Thesis…

- ✓ takes at least 4 consecutive months
- ✓ can be performed in a Laboratory (of Arts et Métiers ones or not) or in a Company (mainly in R&D departments French or not).
- ✓ cannot be performed in a student room… The aim is to discover and participate to research and professional lives!
- ✓ is directed and supported by at least an ENSAM Associate Professor (or full professor). I select them regarding the topics of your Master Thesis (that takes time to make a match).
- ✓ **can be performed not necessary in the city of your 1st semester => take this into consideration for any subscriptions**

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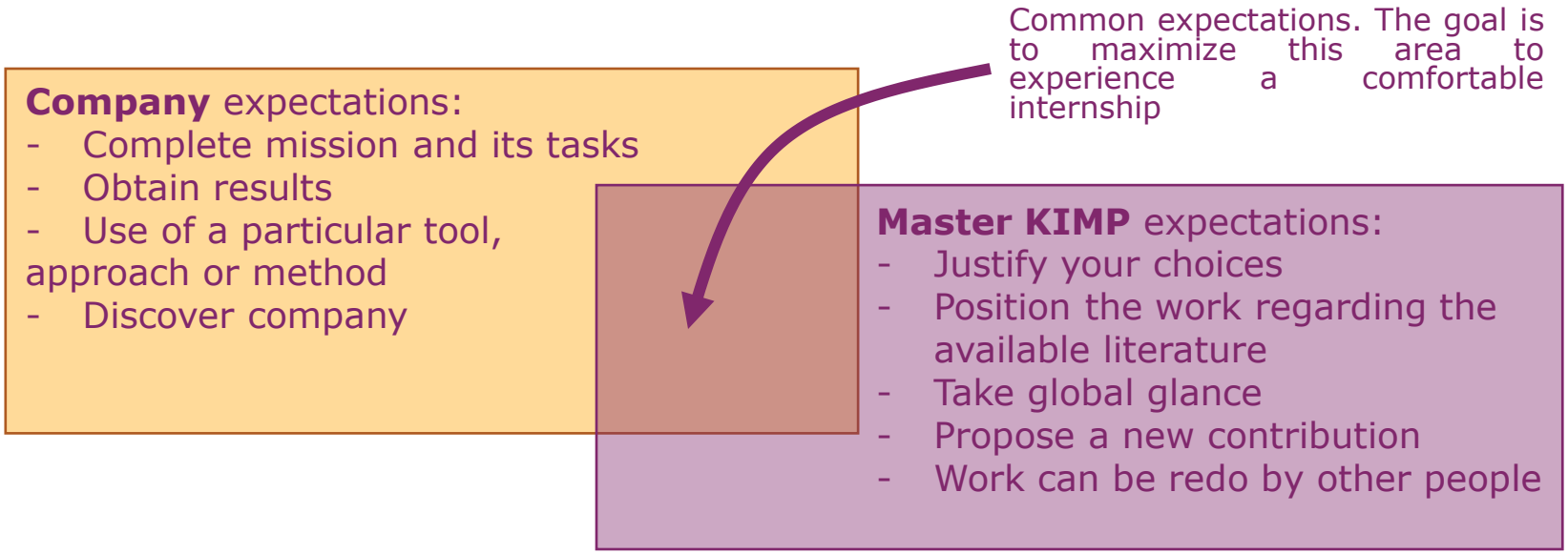
MASTER THESIS
MULTIPLE **EXPECTATIONS**

If you plan to make your Master Thesis in a company, who may consider that their expectations can differ from the ones of a Master Thesis:



The goal of the proposal is **to check** that the **work expected by the company is not too far** from the one needed to validate a **Master Thesis** work!

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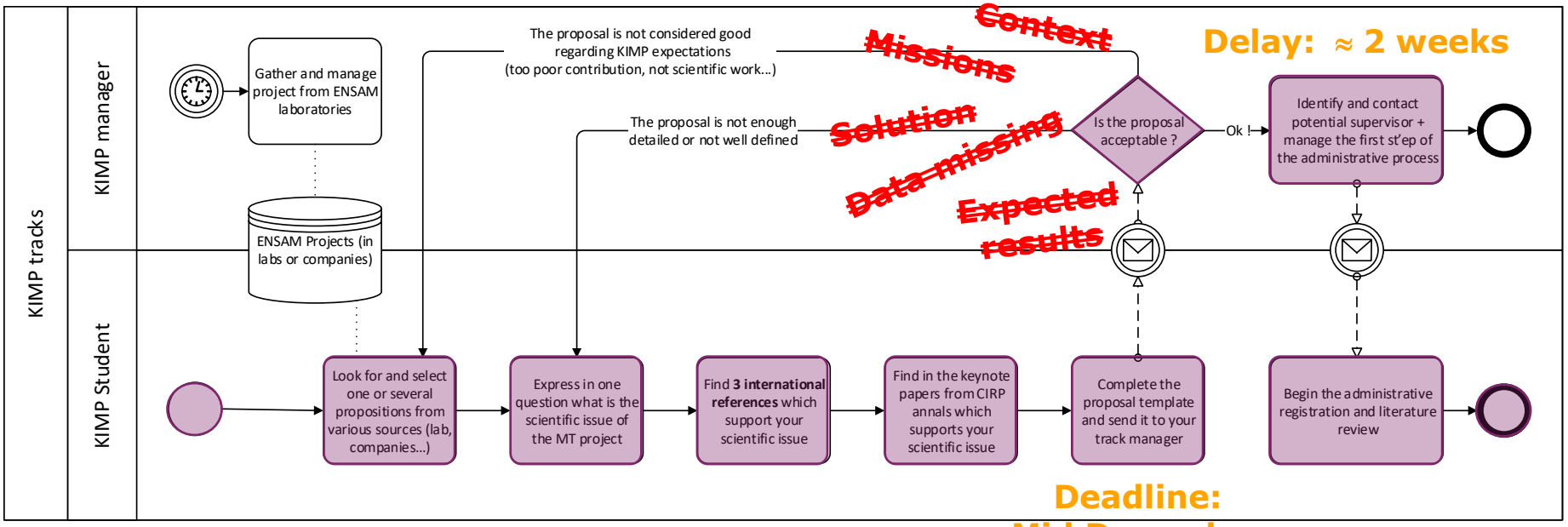
MASTER THESIS
PROPOSAL'S PROCESS

Before working at full time on your Master thesis project, you have firstly to define it by underlining **what is the scientific issue you try to solve**. To do so, this process must be followed:



The sooner is the better !

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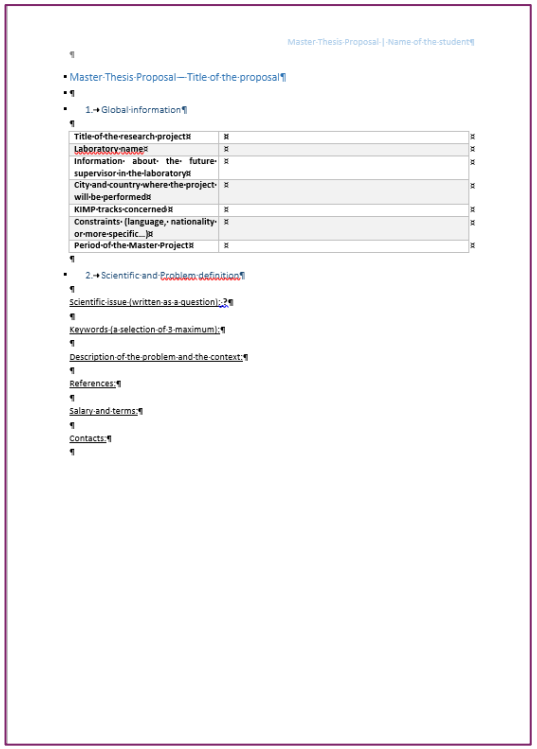
MASTER THESIS
PROPOSAL - CONTENT

Fulfil all the data required (a template is available on the website) and mail them to me.

- Global information
  - Student's name
  - Title of the research project
  - Company or Laboratory
  - Information of your future supervisor in the company/laboratory (First name, last name, email address, City and country where the project will be performed…)
- Scientific and Problem definition:
  - Scientific issue (problematic) written **as a question**
  - Domains of this project and related keywords
  - 3 Articles related to the scientific issue (not the domain of this project, but linked to the problem you aim to solve)
  - 1 Article of the Annals of CIRP related to your problematic
  - For each article explain the reason why you selected it and how it is useful for your work.
  - Expected contributions (methodology, tool, new approach…)


Master-Thesis-Proposal-|-Name-of-the-student¶

¶

- Master-Thesis-Proposal—Title-of-the-proposal¶
- ¶
- 1.→Global-information¶

¶

Title-of-the-research-project¤	¤
Laboratory-name¤	¤
Information- about- the- future-supervisor-in-the-laboratory¤	¤
City-and-country-where-the-project-will-be-performed¤	¤
KIMP-tracks-concerned¤	¤
Constraints- (language,- nationality-or-more-specific…)¤	¤
Period-of-the-Master-Project¤	¤

¶

- 2.→Scientific-and-Problem-definition¶

¶

Scientific-issue-(written-as-a-question):-?¶

¶

Keywords-(a-selection-of-3-maximum):¶

¶

Description-of-the-problem-and-the-context:¶

¶

References:¶

¶

Salary-and-terms:¶

¶

Contacts:¶

¶

Analyzed for the validation of your MT

You can add to this proposal the project statement proposed by the company or the laboratory.
If this project is one of them proposed by KIMP Master, you don't have to write any thesis proposal.

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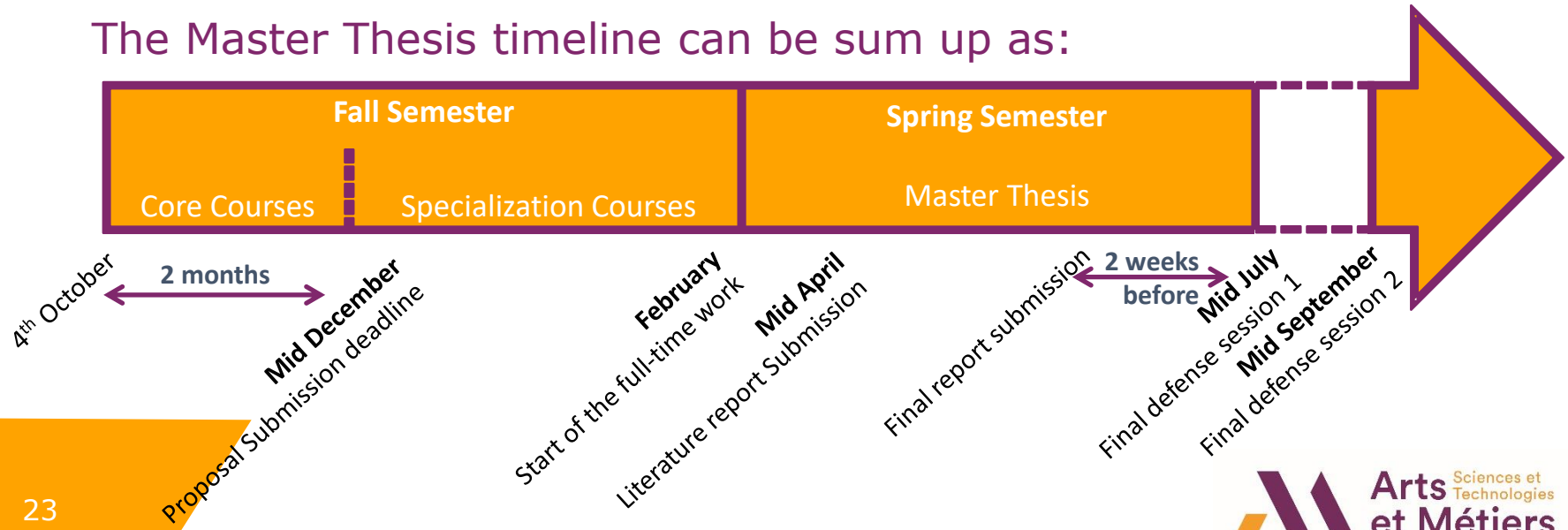
MASTER THESIS
SCHEDULE AND MILESTONES

The work performed during the Master Thesis is evaluated by:

- ✓ The **literature review** - 6 ECTS
  - ✓ A report assessed by your supervisor
- ✓ The Master Thesis works - 24 ECTS
  - ✓ A **final report** assessed by a reviewer who is not your supervisor
  - ✓ A **final defense**, in front of a jury composed by at least three professors
  - ✓ An evaluation of the **work** carried out during the project, by your supervisors

The Master Thesis timeline can be sum up as:



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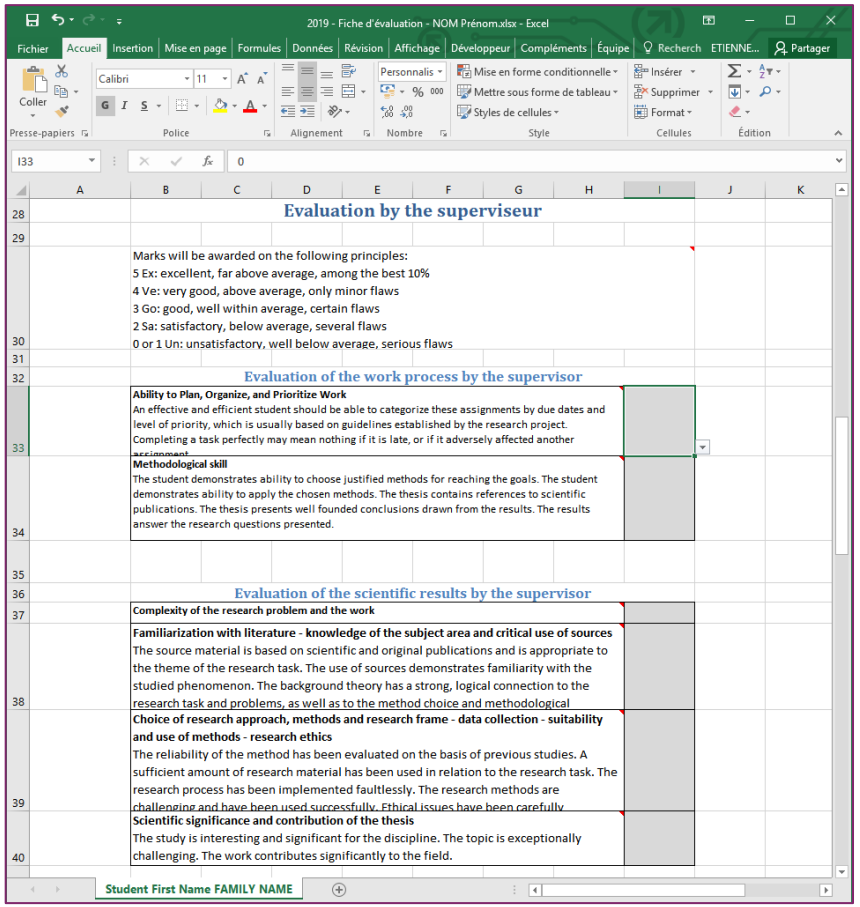
MASTER THESIS
EVALUATION CRITERIA

The Master Thesis evaluation is performed by a set of public criteria gathered into an Excel sheet.

This table is easily available for students who wants to know exactly what are the criteria used to evaluate their Master Thesis. In addition, this help you to know what are the expectation of a Master Thesis.



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MASTER THESIS
FINAL REPORT

MSc. KIMP Design and Manufacturing Annals – (2020)

KIMP Design and Manufacturing Annals

Program website: https://arbeitmetiers.fr/

Data-Driven Tolerance Allocation: a new approach based on Decision Tree and Monte Carlo simulation

Seyed MohammadReza MIRAFZAL[1,2], Lazhar HOMRI[1], Jean-Yves DANTAN[1]

[1]Arts et Metiers Institute of Technology, Université de Lorraine, LCFC, HESAM Université, F-57070 Metz, France
[2]Iran University of Science and Technology, Industrial engineering department, Tehran, Iran

Nowadays, regarding the growth of manufacturing technology, data stores and produces more in the manufacturing processes. Machine learning algorithms play an essential role in manufacturing changes in manufacturing natures' changes to become more autonomous and more advanced. Moreover, product quality and manufacturing cost would become more crucial in the manufacturing processes. The design step will help the manufacturer produce a qualitative and costless product when tolerance allocation gets attention. The manufacturer considers loose tolerances to reduce cost, but designers prefer tight tolerances for a high-quality product. In this paper, machine learning knowledge is considered to deal with tolerance allocation. Therefore, a new approach based on the decision tree technique and Monte Carlo simulation is proposed and then applied to a Jansen case study.

Tolerance Allocation, Tolerance Analysis, Machine Learning, Deep Learning, Monte Carlo, Design, Quality in Manufacturing.

1. Introduction

With the advancement of technology in production, the details can be examined to increase quality and functionality. Increasing competition between large industries and maintaining quality with scraps in production and consumption becomes significant, leading manufacturers to avoid warranty returns [1]. Also, data are easily generated and stored to be used for quality review and increasing productivity through technology advancement.

To balance quality and cost, the designing process could be considered as an essential issue. The quality level of a part would be satisfied due to the haphazard part deviations' limit; designers specify and allocate tolerances to consider those limits [2]. The tolerancing process can profoundly impact the quality, the cost of the product, and the scrap rate. Designers want tight tolerances to assure product performance; manufacturers prefer loose tolerances to reduce cost. Tolerance design in the design stage can provide a prediction about product quality [1]. Tolerance Specification, Tolerance Allocation, Tolerance Synthesis, and Tolerance Analysis are four different tasks to be considered [2]. Assigning and distributing the tolerance values is a simple definition of tolerance allocation [2]. Therefore, tolerance allocation would be critical to balance cost and quality due to increased product functionality and profitability [2, 3]. To estimate the quality of the tolerance allocation phase, tolerance analysis would be determined [1]. Tolerance analysis corresponds to calculating the probability of having the defect in the assembly processes. Tolerance synthesis aims to find the most relevant tolerances and re-allocate the analyzed tolerances for each part, which helps tolerance allocation obtain the required quality [4]. In the tolerance analysis phase, components are known for the model, and tolerance analysis aims to assess assembly tolerance. In the tolerance allocation, assembly features and tolerances are known for the model, and the component's tolerances are calculated [5]. Figure 3 (a) illustrated the difference between tolerance analysis and allocation.

Figure 1. Tolerance Analysis vs. Tolerance Allocation [5]

Therefore, the design tolerance process can be defined as a sequence of instructions containing tolerance allocation, tolerance analysis, and tolerance synthesis.

As mentioned before, due to technology's progress, outcome data for each manufacturing process would be stored more. Using this data would be able to predict product features as a design feature. In this article, the new approach extracts rules from the decision tree result to identify new tolerances. This approach helps to solve non-linear and complex problems. Section 2 describes a short review of tolerance analysis and discusses three main issues in tolerance analysis. Section 3 demonstrates tolerance allocation's role and reviews the current approach in tolerance allocation. The problem statement has been considered in section 4. In this section new approach has been proposed and compared with the current approaches. Section 5 talks about research methodology and clarifies the main contribution of this article. Also, a brief review of the machine learning tasks has been contemplated. Section 6 brings a JANSEN linkage case study and applies the methodology to the case. Then, in this section, results are demonstrated and show that the article's methodology applies to non-linear and complex problems. Finally, section 7 gives a conclusion about this article.

2. Statistical tolerance analysis – a short review

Generally, tolerance makes the manufacturer ensure that the assembly process's functionality is proper by studying the defect probability of variations in the part's geometry and positioning [3, 6]. There are two procedures to apply tolerance analysis: the worst-case and statistical tolerance analysis [3, 7, 8]. The worst-case method considers the worst possible tolerances initially and tries to optimize and examine based on these tolerances. It can lead to unrealistic results, notwithstanding the unrealistic and

Since last school year, the final report of Master Thesis is written as a conference article (about 6 pages, double column).

The goal is to have a first experience of article writing that is a key activity of the researchers and to ease the valorization of the scientific work performed during the semester.

In 2020, 3 students' articles were selected and published in international conferences.

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MASTER THESIS
EXAMPLES - CLASS 2020-21

Several topics, in several domains (Design and Eco-design, Control, Management, Manufacturing, Supply Chain, aerospace, automotive, IT…):

- ✓ *Model of manufacturing process and improvement of digital continuity*
- ✓ *Generation and planning of unit packaging operations through a constraint satisfaction approach*
- ✓ *Implementation of computer vision*
- ✓ *Decontamination of demolition machines*
- ✓ *Optimization of curve rectification studies*
- ✓ *IOT and Reconfigurable Manufacturing Systems*
- ✓ *Data driven tolerance allocation*
- ✓ *New product industrialization and Industrial process optimization*
- ✓ *Proposing a data processing framework to build reliability and functional models in a new printer development project*
- ✓ *Green AI*
- ✓ *Investigation of the dynamic behavior of forging machines*
- ✓ *Models of Artificial Intelligence for the prediction and management of crisis situations in the context of factory 4.0*
- ✓ *Optimization of the process of modelling of industrial facilities*
- ✓ *Twin Heads Machine Optimization System Development*
- ✓ *Which environmental impact for boron mining in Turkey?*

These Master Thesis projects was carried out (in 2018):

- ✓ In Companies: **71%** (some of them were proposed by labs but the position was in a company)
- ✓ In Laboratories (in France or abroad): **29%**
- ✓ About 30 projects proposed by KIMP program (only **5** selected by KIMP_DM students)

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KIMP_DM
ECTS CREDITS

60 ECTS (European Credits Transfer System) are allocated:

Master of Science KIMP_DM **60 ECTS**	Fall semester **30 ECTS**	Professional courses	6 ECTS	1 ECTS	UE5 – Literature review
				1 ECTS	ATHENS Program
				2 ECTS	UEL – Language and culture
				2 ECTS	UE25 – Decision and risk analysis
		Science courses	24ECTS	2 ECTS	UE1 – Methods, models for the integration of product and manufacturing process
				2 ECTS	UE2 – Tools for integration - Generation of Machining process by using AI approaches
				2 ECTS	UE3 – Modeling and control of mechatronics devices
				2 ECTS	UE4 – Manufacturing process management
				4 ECTS	UE21 – Sustainable engineering
				4 ECTS	UE22 – Big Data & Robust design
				4 ECTS	UE23 – Geometric modeling for CAD/CAM
				4 ECTS	UE24 – Virtual reality & Prototyping
	Spring semester **30 ECTS**	Literature Review	6 ECTS		
		Master Thesis	24ECTS		Master Thesis Report
					Master Thesis Defense
					Master Thesis Work

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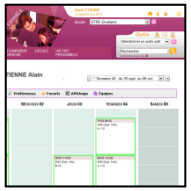
KIMP_DM
ONLINE RESOURCES



Your **schedule** is available at: https://lise.ensam.eu/
Your **mailbox** is available at: https://outlook.office.com/mail/ **Check them every day** since it is our only way to send you important information ! Please, from now, use this mailbox to contact me and our teachers. TEAMS meeting invitation will come on your mailbox

A **Moodle webpage, called SAVOIR** is used to store KIMP documents (courses materials, Master Thesis proposals, this presentation…). To access it, use your ENSAM login and password. Its address is : https://savoir.ensam.eu/moodle/course/index.php?categoryid=873

ScienceDirect (http://www.sciencedirect.com) is an online database of scientific articles. This website is a good first step for your literature review. Keynote papers of the CIRP Annals (needed for the Master Thesis proposal) are directly reachable by following this link: http://www.sciencedirect.com/science/journal/00078506

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FACING ISSUES OR QUESTIONS?
PEOPLE TO CONTACT

In order to improve your daily life in Paris, to have answers to your questions or to find a solution to your problems, please contact:

- ✓ For registration or administrative issues: **Guillaume JEANDENANS** (his office is in the school department area)
- ✓ For exchanges programs, and ATHENS program: **Delphine LUCHEZ** (her office is in the school department area)
- ✓ For KIMP_DM courses, schedule and organization issues: **Alain ETIENNE** (my office is in Metz ☺). You can contact me directly:
  - ✓ By email: alain.etienne@ensam.eu
  - ✓ By Teams: Send me an email first to plan an appointment.

If you have any doubt about who to contact, please contact me firstly: I will transfer your request to the right people, if need be.

NEXT STEPS
REGISTRATION SYNTHESIS

Regarding the registration review made last Friday, it seems that several registrations are still uncompleted. If you belong to this list, please contact Guillaume to update your files:

- ✓ Registration not started:
  - ✓ BEN MARZOUK Skander
  - ✓ BRUNS Jonas
- ✓ Some files are missing (or fee not yet paid):
  - ✓ ASADARAGHI Alireza
  - ✓ AZIZI Fatemeh
  - ✓ ESFAHANI Behdad
  - ✓ GIL DUTREY Carmen
  - ✓ PANTIN CARRO Julia
  - ✓ STOVNE Eivind Myklebust

KIMP_DM

NEXT STEPS…

Now: "Question and Answers" session if you have ones. We are at your disposal.

This afternoon at 2pm : First session of 2 hours of module UE2 with me.

From now: Register for ATHENS program (the mail you receive yesterday)

From now: Think about your Master Thesis Project : identify what are the topics you want to work in and have a look at companies and laboratories' propositions…

Any Question ?

alain.etienne@ensam.eu

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Sciences et Technologies