UNIVERSITÉ DE LORRAINE

ensgsi

Ecole Nationale Supérieure
en Génie des Systèmes et de l'Innovation

Competency-based Education:

Issues and Implications for the training quality

Feedback from an experiment

Valérie RAULT - March 13, 2019

SUMMARY

- A COMPETENCY-BASED APPROACH: THE ORIGINS
- DESIGN OF THE JOB AND COMPETENCY FRAMEWORK (JCF)
- ACTORS AND UTILISATIONS OF THE JCF
  - FROM JCF TO TRAINING PROGRAM: EXAMPLES
- COMPETENCY-BASED APPROACH AS A SUPPORT FOR THE CONTINUOUS IMPROVEMENT OF TRAINING SYSTEM

Engineering school created in 1993, with 2 main lines:

- built competencies inside the training -> use of project based learning
- new type of engineers, thinking and acting in systemic way, integrating many competencies domains

Practically, difficulties appears soon:

- no other references for external actors (future students, companies, colleagues…) for understand what we wanted to do

  \+ heterogeneous vocabulary inside the conception's team of the cursus, for explaining our common vision
- difficulties to express what students can do, facing projects subjects given by enterprises, and to evaluate results of projects activities (which criteria ?)

NEED FOR A STABILIZED COMMUNICATION UPON THE TARGET OF THE TRAINING, FOR INTERNAL AS EXTERNAL STAKEHOLDERS

Design of the Job and Competency Framework (JCF)

Professional world (large groups, SMEs, employers' organisations)

Alumni of our Engineering Degree in one year

Research Lab on Innovation processess

Vision and values of the training team

Prospective studies on the evolution of engineering professions

short and long term vision of professional needs

Job framework

- **Typical missions of Systems and Innovation Engineers**
  = generic fields of activity

+

Overall competences

expressing the process of reflection and action to be conduct in the fields of activities

First version in 1997

Second version in 2015

DESIGN OF THE JOB AND COMPETENCY FRAMEWORK (JCF)

Exercised afterwards with different degrees according to the jobs held

TYPICAL MISSIONS

M1 PROJECT MANAGEMENT FOR A SPECIFIC GOAL

M2 CONTROLLING INDUSTRIAL ORGANISATIONS

M3 LEADING THE PRODUCT/MARKET/TECHNOLOGICAL SYSTEMS ASPECTS OF INNOVATIVE PROJECTS

M4 HUMAN DEVELOPMENT

M5 ANALYSIS AND MANAGEMENT OF ECOSYSTEMS

M6 DEVELOPMENT OF AN INNOVATION CULTURE AND STRATEGY

GUIDE THE CONTENT OF THE TRAINING: KNOWLEDGE, METHODS, TOOLS...

OVERALL COMPETENCES

SYSTEMIC INNOVATION:
multi-dimensional integration of parameters of a situation

DESIGN AND LEADING projects in complex environments: requiring a multi-disciplinary skills integration

Manage COLLABORATIVE INNOVATION and guide relevant organizational and Individual CHANGES

GUIDE TEACHING METHODS: INTEGRATION (NOT JUXTAPOSITION) OF THE CONTENTS IN ACTIVE PEDAGOGIES

ACTORS AND UTILISATIONS OF THE JCF

FOR THE STUDENTS: -> gives meaning to learning and teaching content -> helps to develop the professional project

FOR THE FACULTY MEMBERS : -> orient their teachings according to the competency target
-> develop cross-collaborations between them (courses with "several voices")

FOR THE SCHOOL DIRECTION BOARD: -> positioning and strategic orientation of training
-> global management and monitoring of the training process

FOR THE LABOUR MARKET RECRUITERS: -> readability of the specificities of the training, expressed with professional terms which are familiars for them

FOR THE SCHOOL'S INDUSTRIAL PARTNERS: -> sizing (theme, expectations) of projects given to students
-> as examiners in projects and internships: knowledge of the requirements in terms of competencies

TRAINING ACCREDITATION

French Committee
on engineering degree

INTERNATIONAL LABELS

- International Association for Management of Technology
- International Council on Systems Engineering

POSITIONING IN THE ENVIRONMENT OF HIGHER EDUCATION

- European Qualification Framework
- CDIO Syllabus (MIT)

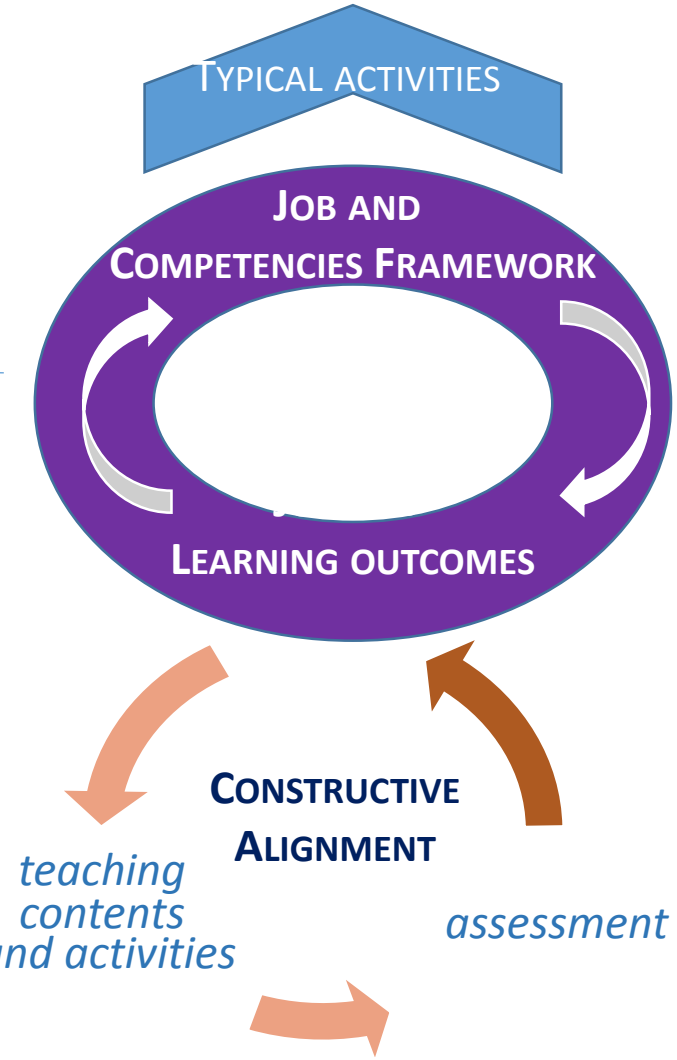
……

FROM JCF TO THE TRAINING PROGRAM

- **CONSISTENCY AND ROBUSTNESS OF THE SYSTEM**
- **COLLABORATIVE WORK**

OUTPUTS OF THE TRAINING CURSUS

TRAINING SYSTEM



Contributions missions/jobs

MISSIONS of JCF

JOBS	C10	C11	C12	C20	C21	…
A1						
A2						
A3						
A4						
B1						
B2						
…..						

professionalization trajectories

Contributions courses/missions

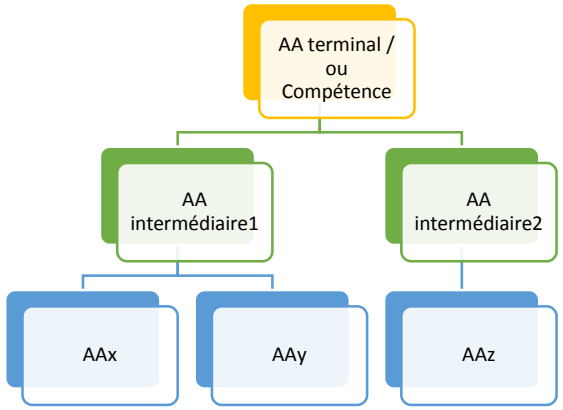
MISSIONS of JCF

COURSES

RESSOURCES		C10	C11	C12	C20	C21	…
UE1	Cours 1	AA		AA		AA	
	Cours 2		AA	AA			
	Atelier				AA	AA	AA
	Projet	AA	AA	AA			AA
UE2	Cours X						
	Cours Y						
	….						
	……..						

Learning outcomes at the intersection

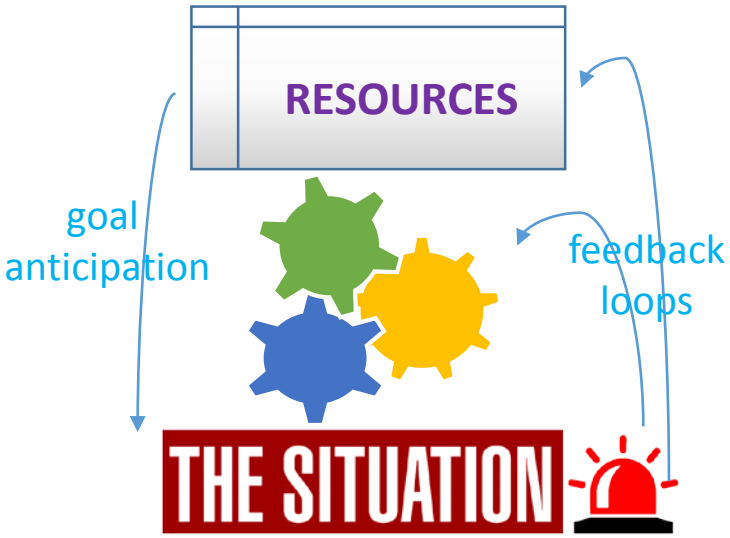
Hierarchical order and sequencing of Learning outcomes



COMPETENCY BASED APPROACH: IMPLICATIONS ON TEACHING METHODS

A DEFINITION

complex know-how to act, based on
the effective mobilization and combination of
a variety of internal and external resources
within a family of situations



competencies are built in a situation,
constantly adjusted to it,
and cannot be considered as
a transferable "stock"

THE NEED TO USE ACTIVE PEDAGOGIES

60% of the cursus

PROJECT-BASED LEARNING
-> long-term, interdisciplinary projects
-> short-term, in a subject area, or crossing several

PROBLEM-BASED LEARNING

FLIPPED CLASSROOM

SIMULATIONS, CASE STUDIES

ESCAPE GAME

SELF-DIRECTED LEARNING
for developing "learning to learn" as a key competence

Implementing of a project-based and skill assessment pedagogy in a mechatronics course

Mechatronics course syllabus

third year,
20 weeks,
60 hours

Introduction and project presentation

Lectures

Pair work lab session

Electronic design (open-source)

Project work

Project prototypes: travelling funfair

Demoniac rolling

Duck fishing

Lorraine Fab-Living Lab

3D printers

3D scanner

Laser cutters

Arduino kits

COMPETENCY BASED APPROACH: EXAMPLE 1

M3: "Design an innovative product, service or process"

10 learning outcomes

L.O.	Statement
1	I am able to describe a kinematic chain
2	I am able to imagine a simple mechanism and to dimension it
3	I am able to design a part in SolidWorks
4	I am able to make an assembly in SolidWorks
5	I am able to perform a simulation in SolidWorks
6	I am able to realize a part on the laser cutter
7	I am able to realize a part in 3D printing
8	I am able to design and realize a simple Arduino-based electronic circuit
9	I am able to design and realize an Arduino-based control circuit for my mechanism
10	I am able to realize a complete mechatronic prototype and do it work

4 mastery levels

Score	0	1	2	3
Mastery Level	I have no mastery	I master a few basics	I have a good mastery of the basic concepts in the module	I have a very good mastery and I feel able to apply my skills in other projects

ASSESSMENT PROCESS

Pre-course skills self-evaluation (individual)

Skill based final exam (individual)

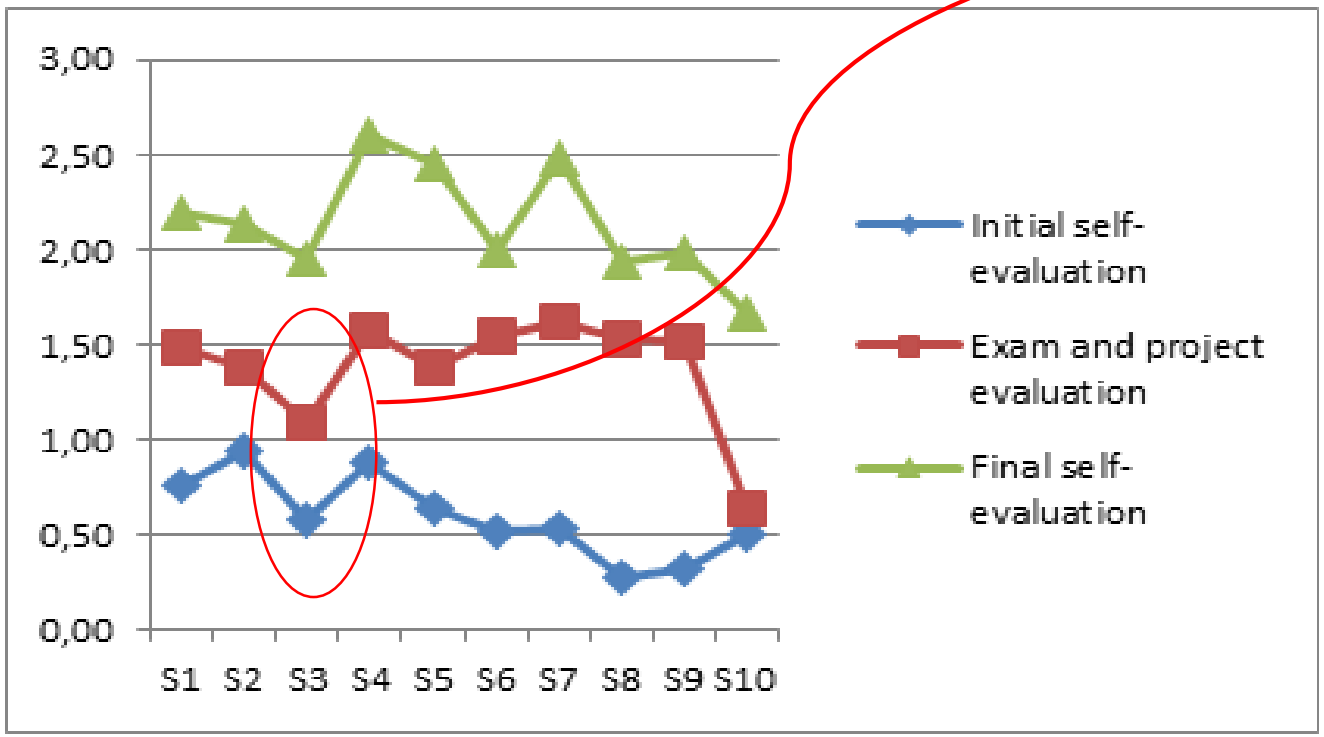
Project evaluation (group)

Post-course skills self-evaluation (individual)

COMPETENCY BASED APPROACH: EXAMPLE 1

Results of the assessment process: an evaluation sheet for each student, measuring the evolution for the 10 learning outcomes

Student's skill average scores



Overall average gain is 1.55

Feedback loop for the teachers team: for change something in the teaching to better develop this learning outcome

The Competency-based approach helps to improve the teaching at a fine-grained level

COMPETENCY-BASED APPROACH: EXAMPLE 2

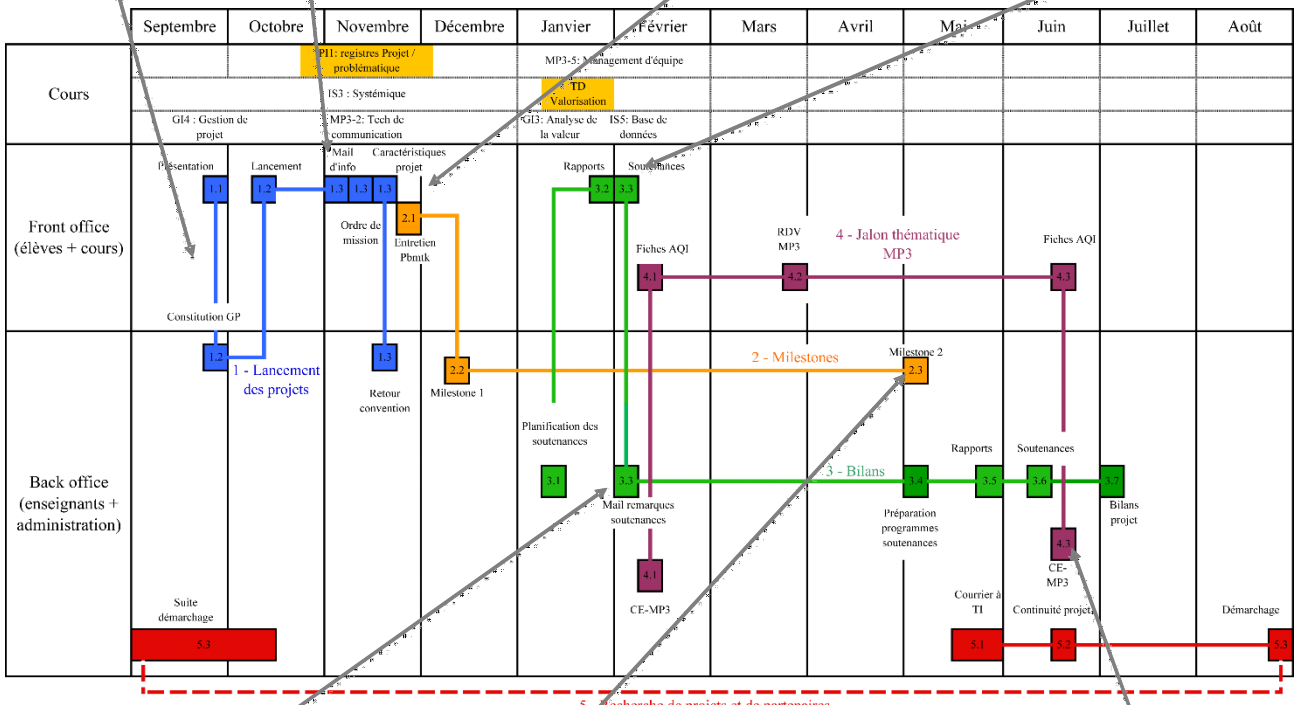
MONITORING PROCESS
LONG-TERM PROJECTS 3rd Year

Lancement des sujets et désignation des acteurs concernés

Les premiers jalons:
Garantie du bon démarrage du projet

Entretien «Problématique» :
Compréhension du contexte, appropriation et reformulation de la demande

Bilan intermédiaire : vérification de la compréhension du contexte et de la demande ; des méthodologies et outils employés ; du pla n d'action proposé ; des résultats intermédiaires et futurs



Mail de retour / soutenance intermédiaire:
démarche d'amélioration de la conduite du projet ; assurance de la prise en compte des remarques du jury

Valorisation du projet:
- valorisation des résultats dans l'entreprise
- valorisation des perspectives du projet
- valorisation du bilan financier (gains et dépenses liés au développement du projet)

Fiches *AQI* & CE *MP3* (Commission d'Évaluation du Pôle Management, Projet Professionnel et Personnel) :
- intégration de l'étud iant dans une démarche d'identification et d'amélioration de ses aptitudes managériales ;
- assimilation du contexte professionnel comme terrain d'exploitation privilégié des notions abordées dans les ateliers du Pôle*MP3* ;
- évaluation des compétences managériales et du développement personnel de chaque étudiant via les fiches *AQI* (Appréciation Qualitative Individuelle)

Learning outcomes :

Understanding of the company's context (internal and external)

Problematization process: appropriation and reformulation of the request

definition and implementation of an approach based on referenced tools and methods

Declination of an action plan

Analysis and evaluation of results

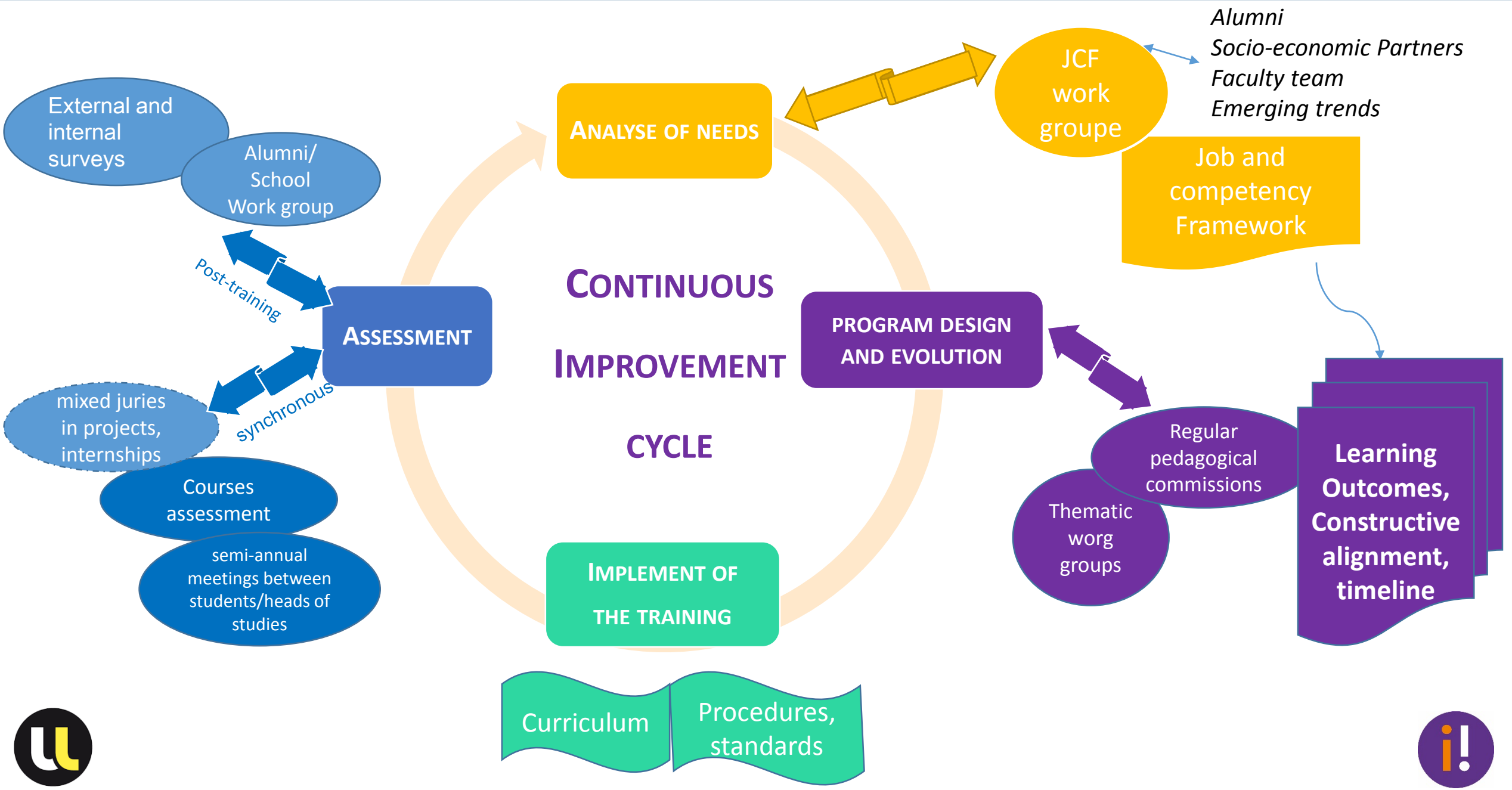
Proposals for improvements and perspectives for the company

Experiment with learning to work in a team, including team leadership and sharing tasks and responsibilities

At the individual level, experiment the paths of personal development and managerial skills identified during the activities of the MP3 teaching unit, evaluate their impact and adapt their role and actions in the project accordingly.

UNIVERSITÉ DE LORRAINE

COMPETENCY BASED APPROACH AND TRAINING QUALITY DEPLOYMENT



CONCLUSION

The coherence of the entire training system requires reference documents and processes,
and a lot of places and time for exchanges between internal and external stakeholders.

BUT THE MOST ESSENTIAL, AND PERHAPS THE MOST DIFFICULT, IS THE CHANGING ROLE OF THE TEACHER:

- Contributing to the construction of competences requires the development of pedagogical methods **going towards the active pedagogies.**

- As competency requires to mobilize components coming from different disciplinary fields, teachers have to learn to work together, to link their interventions or to conceive common interventions:
and so, they have to **learn to go outside of their familiar reference framework**.

- Contributing to the construction of competences is not teach the student on “how to act”, but teach him to “learn to act”: **develop student reflexivity skills is on the heart of deep learning**,
-> teachers are no longer only transmitters of knowledge,
but above all they become **guides or coaches on a trajectory of competence development**

TO EVOLVE HIS CONCEPTIONS, TO LEAVE HIS USUAL FRAME, TO EXPERIMENT (by giving the right to the error),
TO HAVE CONFIDENCE IN ONESELF AND IN OTHERS, TO HELP DEVELOP THE SKILLS OF COLLEAGUES ... ..

THESE ARE SKILLS OF THE INNOVATOR, APPLICABLE TO OUR TEACHING ROLE !!!