

Computational thinking

François Marechal

- Forget about...
 - listening religiously to your professor
 - take the exercise &... the correction and go home
 - Reproduce
- You are entering the Active learning world !
 - Theory is given on how to solve the problems => structure your reasoning
 - The project scenario is built to learn & apply the theory
 - A-G-I-R
 - Project steps are used to guide/inspire your reasoning
 - Problem solving : facing problems by solving problems
 - Example are given as an inspiration and to speed-up the application
- Computational thinking
 - Computer Aided Engineering
 - Professional tools : MS word and excel should not be the tools for your professional life

A for Analyse and Activate

Analyse consist in defining what are the expected results. Although most of the time intuitive, it is important to exchange on what you expect, defining the values your are looking for and the physical units associated. When using programming, it is also useful to use names and create your own project specific vocabulary, especially for acronyms abbreviation

A stands also for **Activation** as you have to decide the knowledge and the tools you need to activate (put in your toolbox) to realise the tasks. It is not forbidden to refresh knowledge or to acquire new knowledge to realize the task.

G for Generate

You are going to use different tools to generate results. It typically requires the

- formulation of the problem
- the definition of assumptions
- the collection of information (from knowledge data base)
- the definition of the degrees of freedom (decisions you need to make)
- the choice and the programming of a solving method
- the calculation realisation
- the extraction of the numerical results

I for interpret

Interpretation is the action of converting numerical results into meaningful information for the mission. This means:

- verifying the validity of the numerical results obtained
- the consistency with what was expected as defined in the Analyse phase
- verifying the validity and testing the sensitivity of the assumptions or of the data uncertainty
- testing the importance of the decision variables

R for reporting

Reporting of the results is the way to communicate not only the outcome of the mission but what you have learned. The report and the associated visual representation are targeting your teammates and classmates when you have realized a task or a broader audience (like your colleagues) so that if someone has the same task as yours, you will save their time. To validate the report, a critical review will be realised.

- **A : Analyse** : State the problem and Activate your knowledge

- Define the purpose of the calculations

- Define the level of details needed
- Identify your knowledge
- Identify the data you need (ref : Zotero)

=> we show you the way similar problems have been solved

- Activate the computational tools needed

- Python scripts - flowsheet simulation - CFD

=> be inspired by the examples

- Describe what you are looking for : for you and the others

```
M = [10,12,14] [kg/s] # flow of M entering the unit u  
for the state 1,2,3 measured in kg/s
```

=> be inspired by the examples reports

- **G :Generate** : Generate numbers by computer tools
 - Program the generation of numbers with comments and reporting
 - => duplicate and adapt the codes
 - => document and report your assumptions
 - => reference the data sources
 - Define the algorithms of the solving procedure
 - Structure => define functions and steps (data flow)
 - Solve
 - Extract numbers
 - Programming language are needed
 - => Python or R : elementary levels is required for manipulating data
 - => AMPL is used because it allows you to “think optimisation”

- **I : Interpret** the generated results
 - Transform numbers into engineering meaning :
 - Program the interpretation of the generated numbers
 - Graphs
 - Tables
 - Numbers

=> we use Quarto : reproducible science & open source
use Jupyter / Python or R scripting language

- Do not forget
 - Physical units
 - Axis titles
 - Captions
 - References

- **R : Report for the rest of the world and your peers (your boss)...**
 - Make a summary of your main results
 - highlight what is important in your findings
 - Make a documentation useful to the others
 - Allow others to reproduce your work : assumptions, limits, ...
 - Add references

- **Using computer softwares to solve engineering problems**
 - Finding and accessing data
 - search, find and cite your data sources
 - Programming calculations and reports
 - Variables with an engineering meaning
 - Variable = name + description + value + [physical units]
 - e,g, TempFlow1=25 #[C] temperature of the flow 1
 - Reproducible science
 - Use Professional tools
 - Developed by others but used by you
 - Reporting
 - Extracting data
 - Presenting data (graphs, tables)
 - Programming reports
 - Project notebook
 - Documenting the calculations
 - Reviewing (do I understand what I'm writing)