ScilabTec 2012

Set of Tools for Space Flight Dynamics Mission Analysis

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- What kind of activities ?
- What tools are necessary ?
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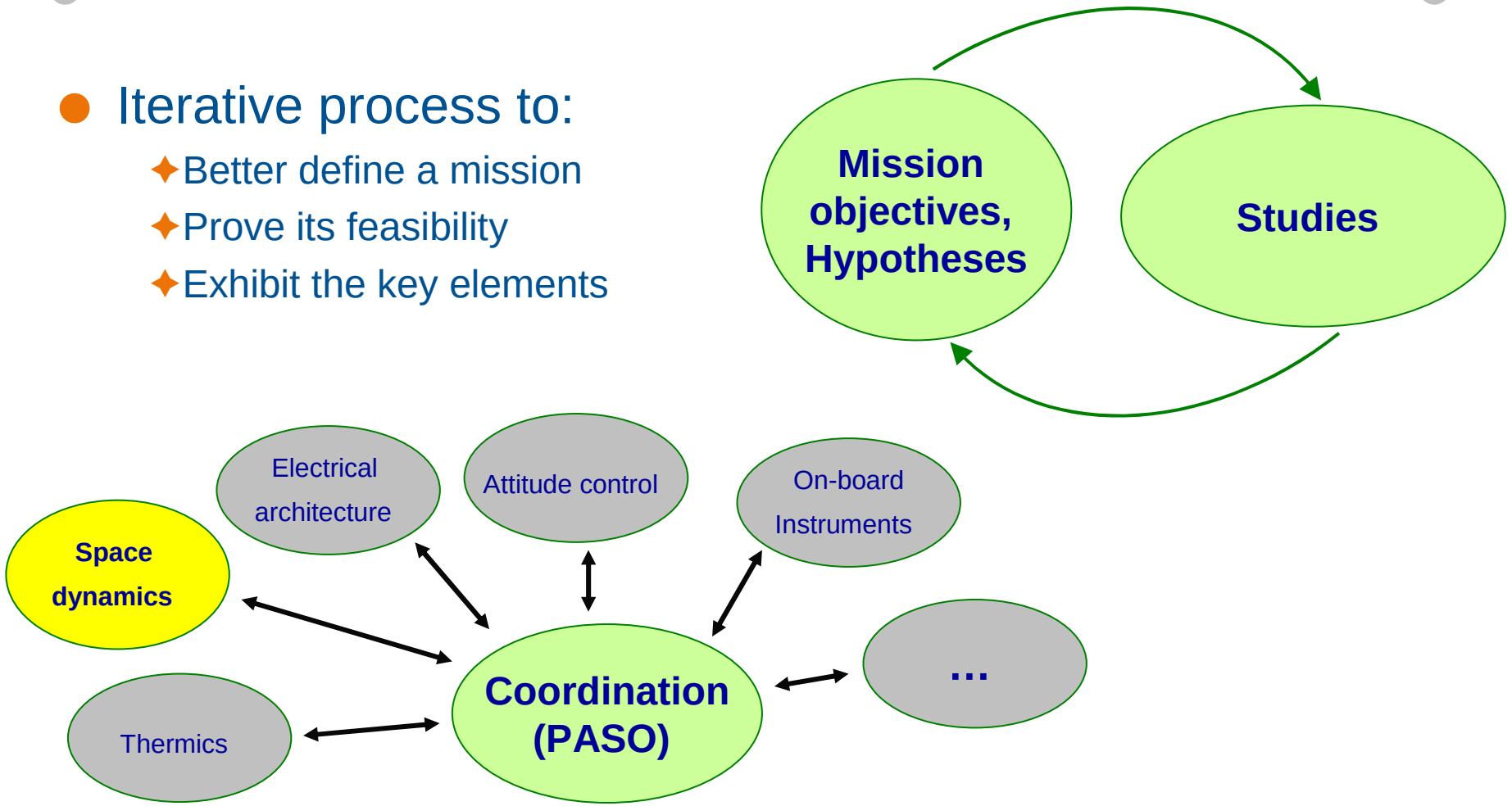
Introduction: what is mission analysis ? (mission analysis for early phases)

- Iterative process to:
  - ✦Better define a mission
  - ✦Prove its feasibility
  - ✦Exhibit the key elements



At CNES mission analyses are carried out within a dedicated structure:

PASO(*) = Concurrent Design Facility

(*) Plateau d'Architecture des Systèmes Orbitaux

Concrete example

- Mission analysis: lots of aspects to deal with
  => lots of small tools rather than one big (irrealistic) one

Example: Suppose you define an observation mission...

- ✦What orbit (low altitude, circular, geostationary ?)
- ✦Lighting characteristics ? Eclipses ? ...
- ✦One satellite or many ?
- ✦Coverage => how often is each location on Earth seen ?
- ✦Orbit control : what type ?
- ✦What orbit correction cost ? (=> impact of hypotheses on solar activity, available fuel...)
- ✦Monitoring from Earth: how many ground stations ...
- ✦Etc...

Types of activities, and how to answer …

- Completely new study **Weeks or months**
  - ✦*Develop specific tools,*
  - ✦*Reuse (partly) some other ones*
- Recurrent study **Weeks or days**
  - ✦*Reuse tools, but in practice there is always something different => some adaptations are often (always) required (varying parameters, adjusting plots...)*
- Anything in-between …
- Quick analysis **Days or hours**
  - ✦*No time for heavy (risky) developments (essential tools must be available)*
- Immediate answers **Hours or minutes**

➡ **Various activities ⇔**
Various possibilities on how to answer

The « big » question…

What kind of tools do we need ?

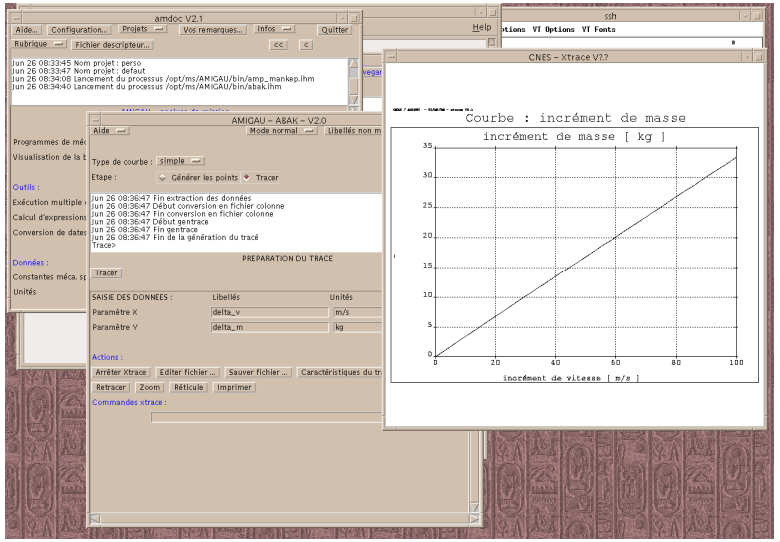
- Scilab (we think) is part of the answer (from experience)
  - ✦Scilab is particularly well adapted to studies, analyses
  - ✦CelestLab (« our » toolbox) is also part of the answer

  But that's not sufficient...

Some time ago, we didn't use Scilab:

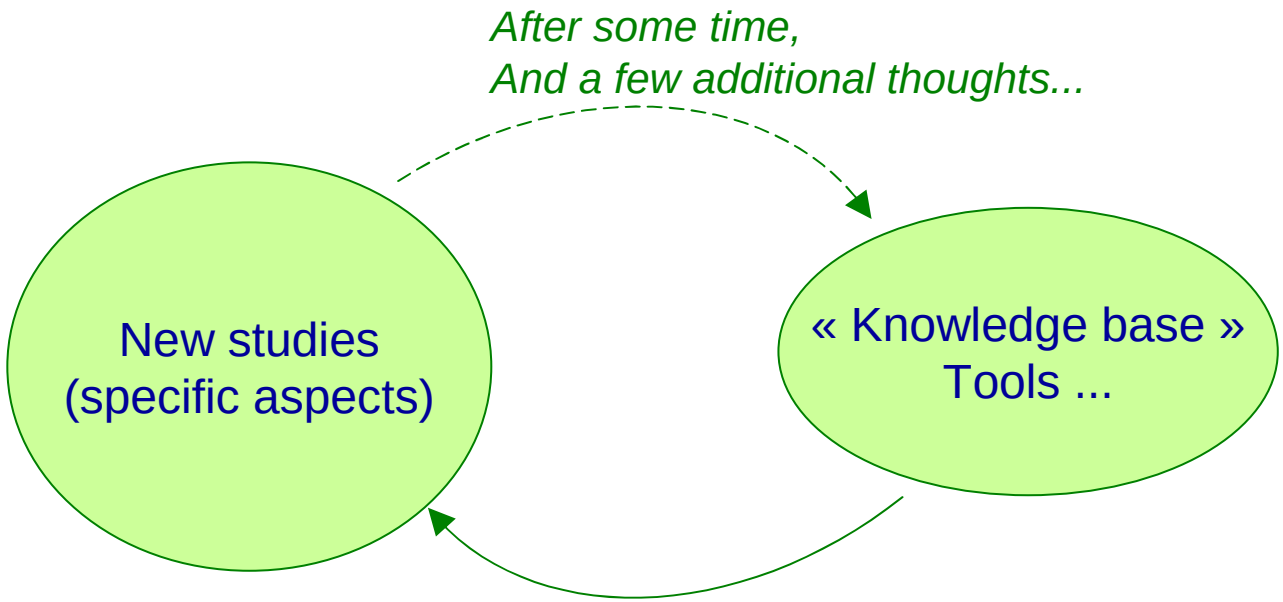
We had unix-based solutions, with compiled program, shell scripts, data exchanges using files, dedicated libraries for I/O …

… It worked but was not as flexible as we might have wished.



Let’s try to start from high level requirements...

- Simplify recurrent (or nearly recurrent) studies
- Spent time on more advanced and innovative ones
- Capitalize on what has been done



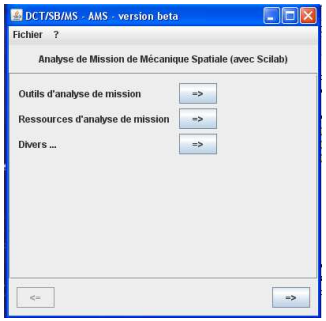
So what ?

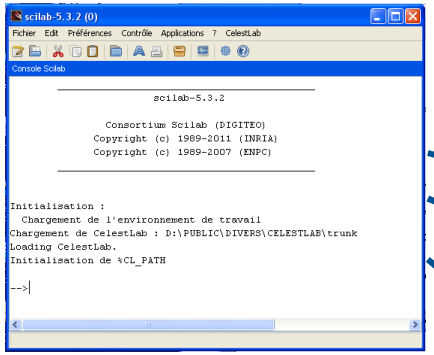
What tools for mission analysis ?

- The answer is less obvious than it seems:
  - **Flexibility is required**
    - What exactly does « flexibility » means?
  - **« Reference » tools are needed**
    - => validated, trustworthy (not always the time or the possibility to check the results)
  - **Having libraries only is not sufficient**
    - Tools (« scripts ») based on libraries are necessary
- More concretely, we would like something ….
  - As **easy to use** as the CelestLab « demotool »,
    - => Immediate answers
  - but that could handle more **complicated tasks**, with more complex data,
  - that would enable **easy code adaptations**,
  - that would be compatible with the « **standard** » (everyday) **use of Scilab**

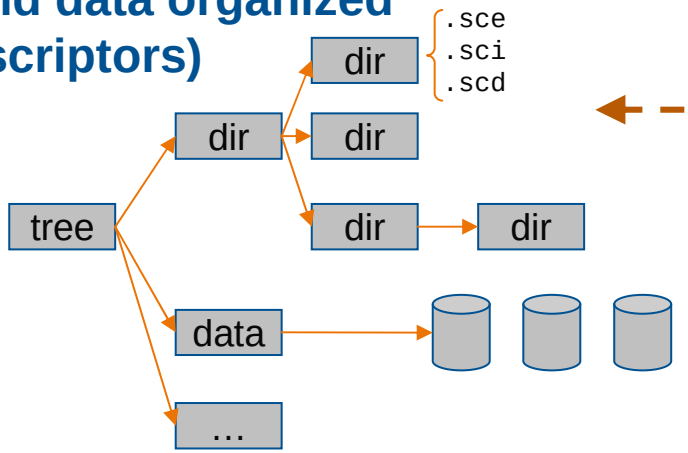
Our solution …

Simple « navigator » (java)





Tools (sce, sci…) and data organized in directories (+ Descriptors)



(read only)

Low level lib.

Higher level lib.
(+ interfaces with C, Fortran, Java)

Scilab « extension »
Functionalities for an easier use of the tools

Feedback

User area …

- Demo ...

  - Illustrates in a simple case how the tools can be used and customized.

  - Shows one more complex example in which the results are used as inputs to a 3D simulation based on Celestia.

A few concluding remarks

- Simple architecture, but (very) efficient
  - Several independent parts and not a large program => easy to manage
  - Consistent
  - Many aspects are generic (navigator, scilab extension => don't need to be changed very often)
  - Interface with other langages: powerful ; Java / JIMS: very promising

  => It's clear that studies are done much more efficiently

- Possibility to make the « scilab extension » an external module

- Minor work remaining on the design (scilab « scripts »)
  - How to make them simple, « well » written, easily adaptable, with the best possible interface (input parameters ...)

    => « good practice » rules in the future

For more information...

- For more information on CelestLab:
  - http://www.scilab.org/products/modules/pem/celestlab
  - **http://atoms.scilab.org/toolboxes/celestlab**
  - http://mailinglists.scilab.org