Discrete 3D surfaces of revolution

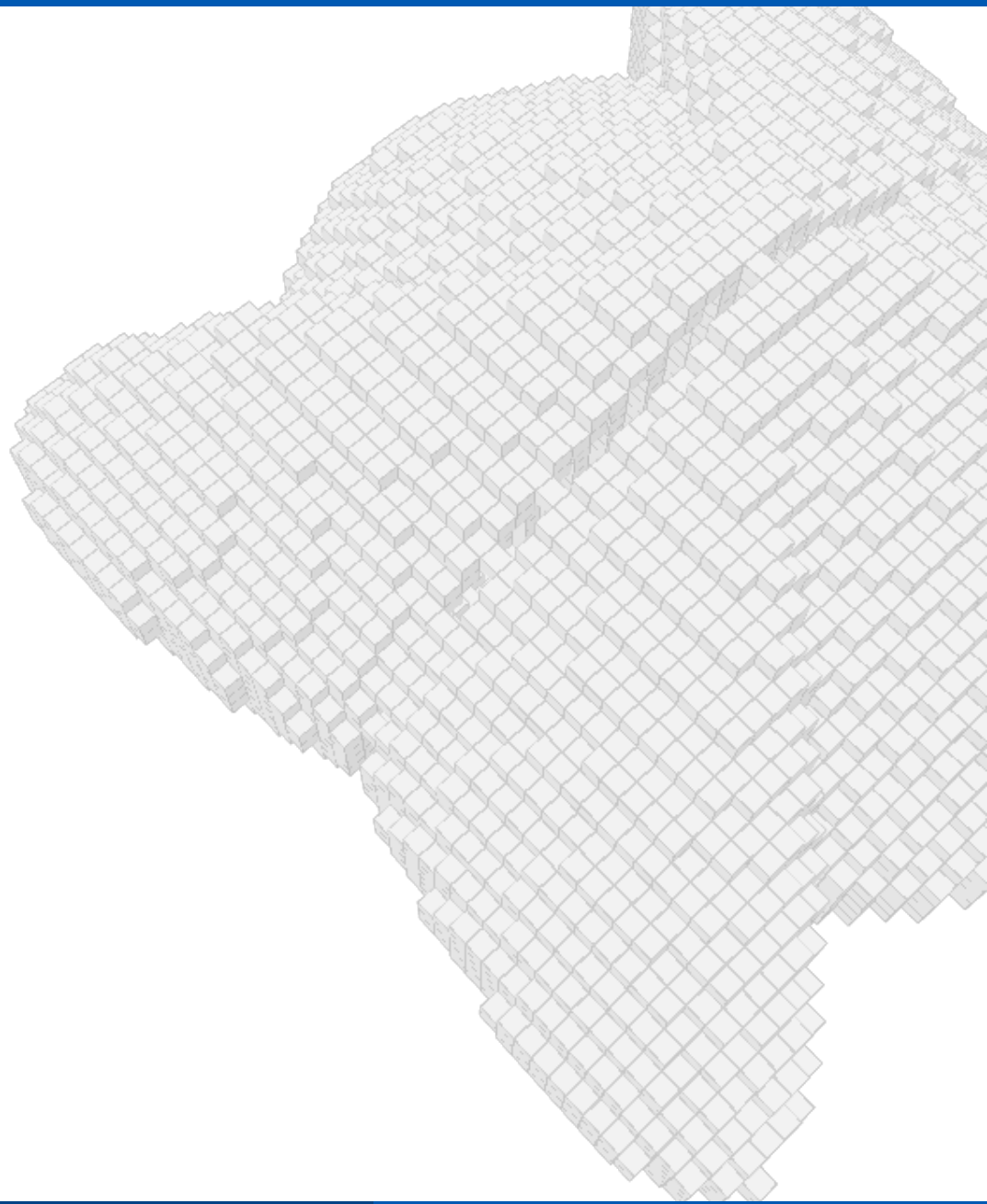
Final presentation

Zied Ben Othmane
Thomas Benoist
Adrien Bisutti
Lydie Richaume

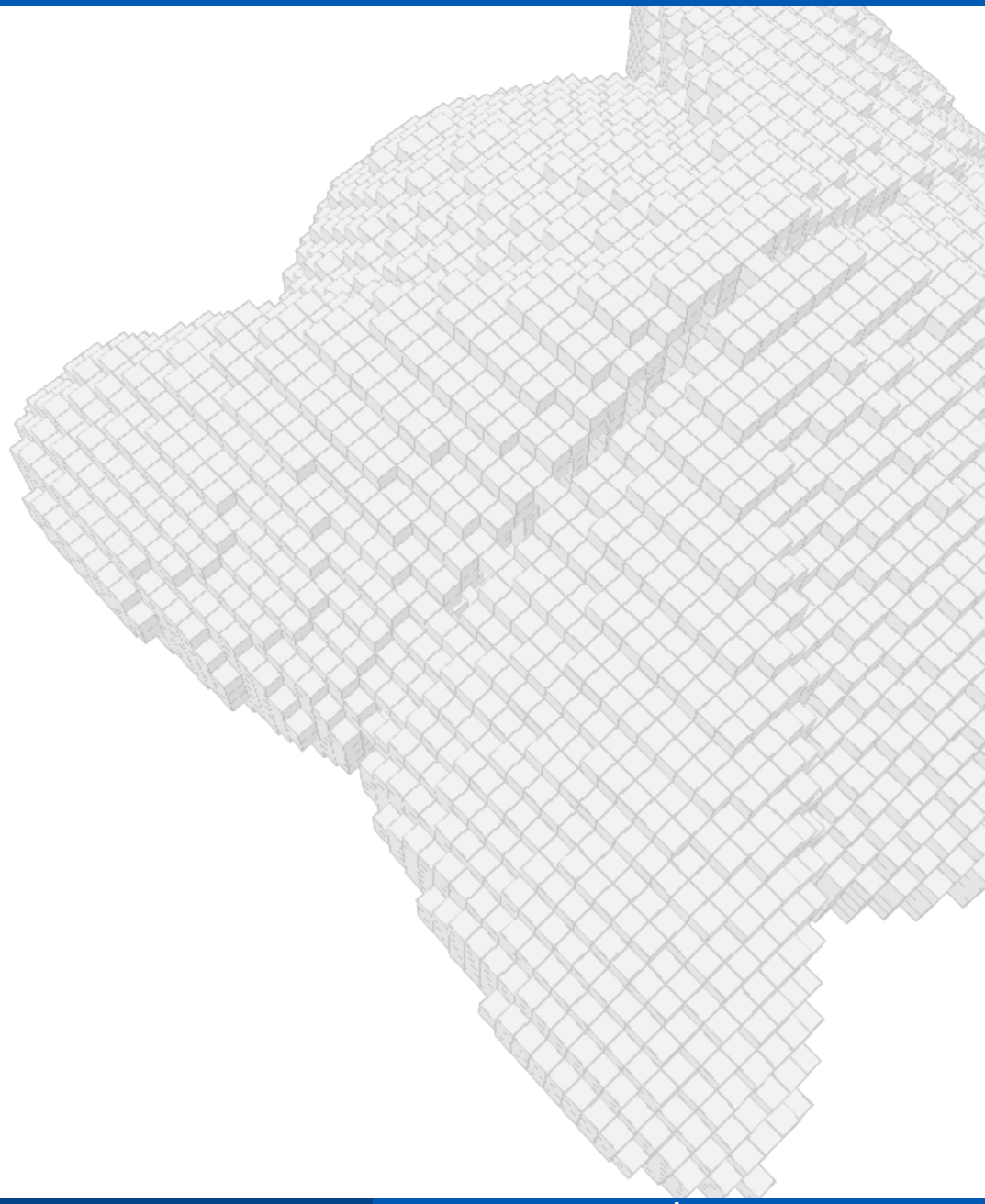
University of Poitiers

March 21st, 2016

Outline



Outline

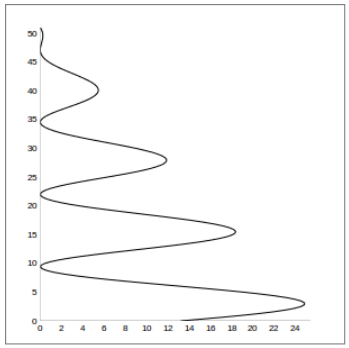


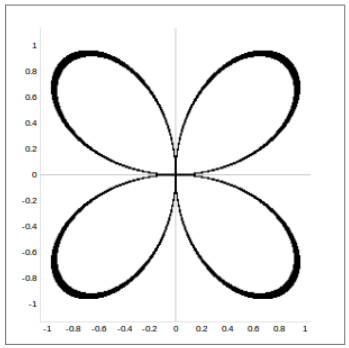
Collaborators and clients

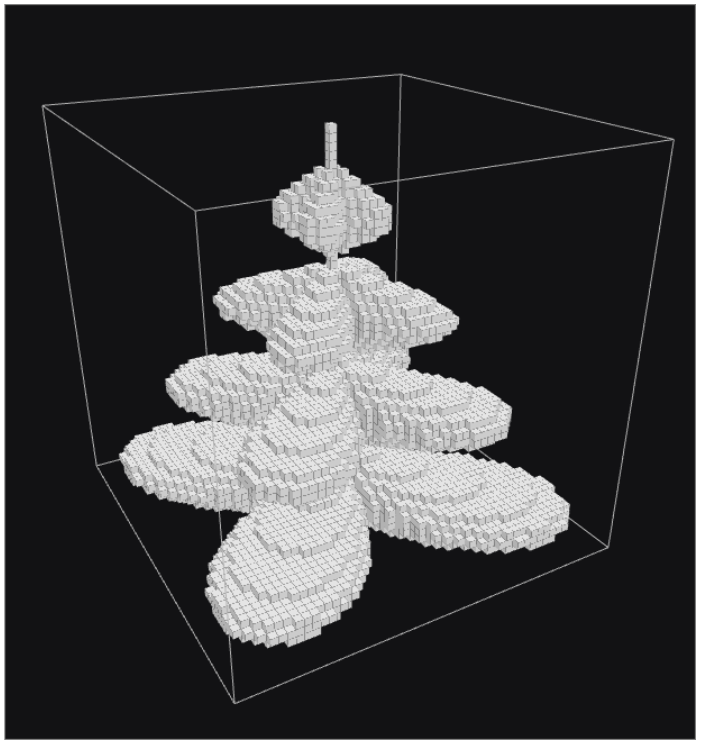
- Clients :
  - Éric ANDRES (Professor and former director of XLIM-SIC department)
  - Gaëlle LARGETEAU-SKAPIN (University lecturer, Discrete geometry)
- Exemple of final user :
  - Aurélie MOURIER (Artist)
- Pedagogic Supervisor :
  - Philippe MESEURE (Professor, Computer Graphics)

Context

- Éric Andres and Gaëlle Largeteau-Skapin developed a new algorithm to model discrete surfaces of revolution.





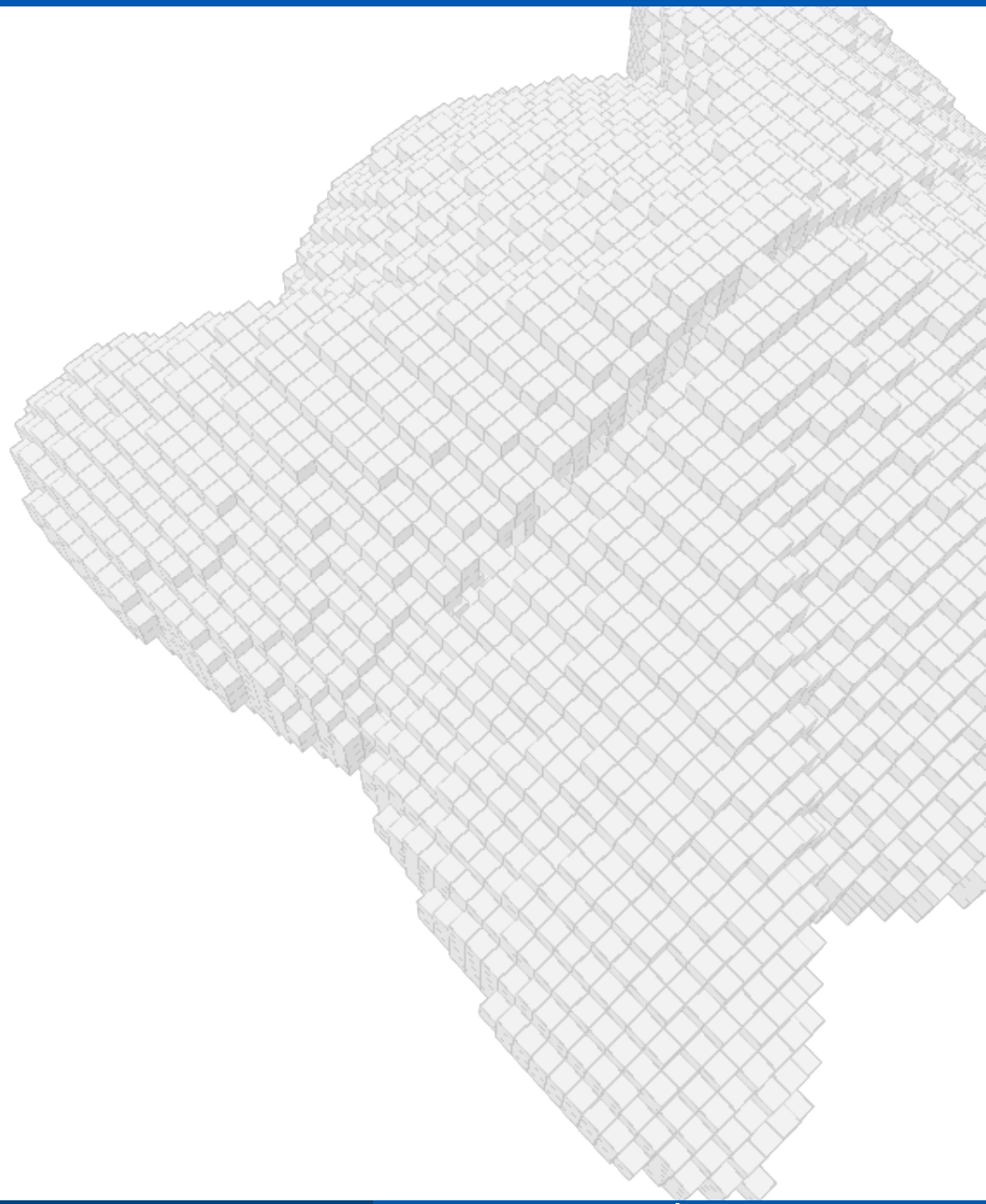


- Display the result with Mathematica
- Need a tool usable by everyone and everywhere

Objectives

- Surfaces visualization tool
  - 3D, slices visualization
  - Choose the generatrix and directrix
  - Export the results
- Algorithm to generate surfaces of revolution
  - Provided by the clients
  - Possible evolution of the algorithm

Outline

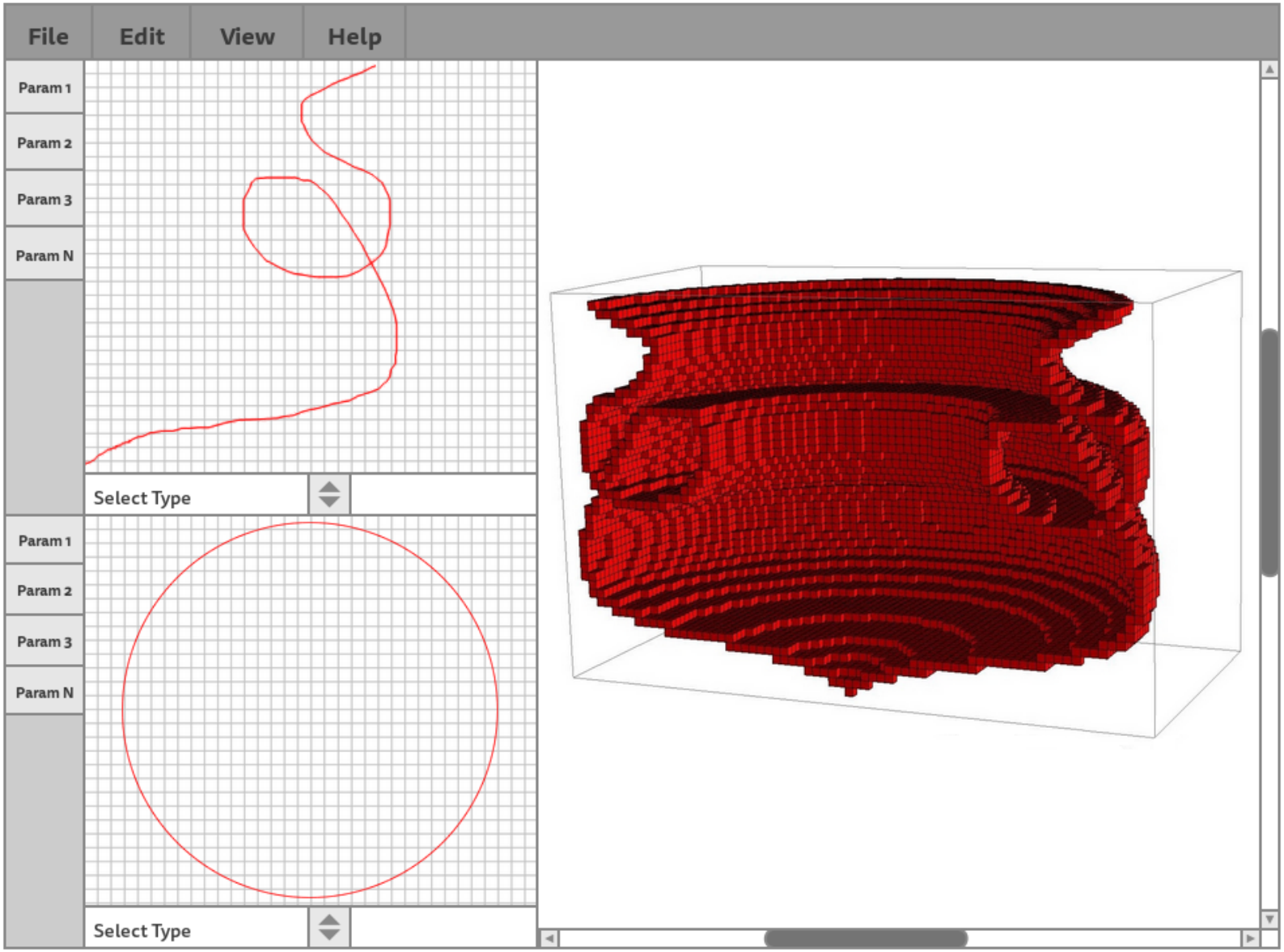


Technological choices

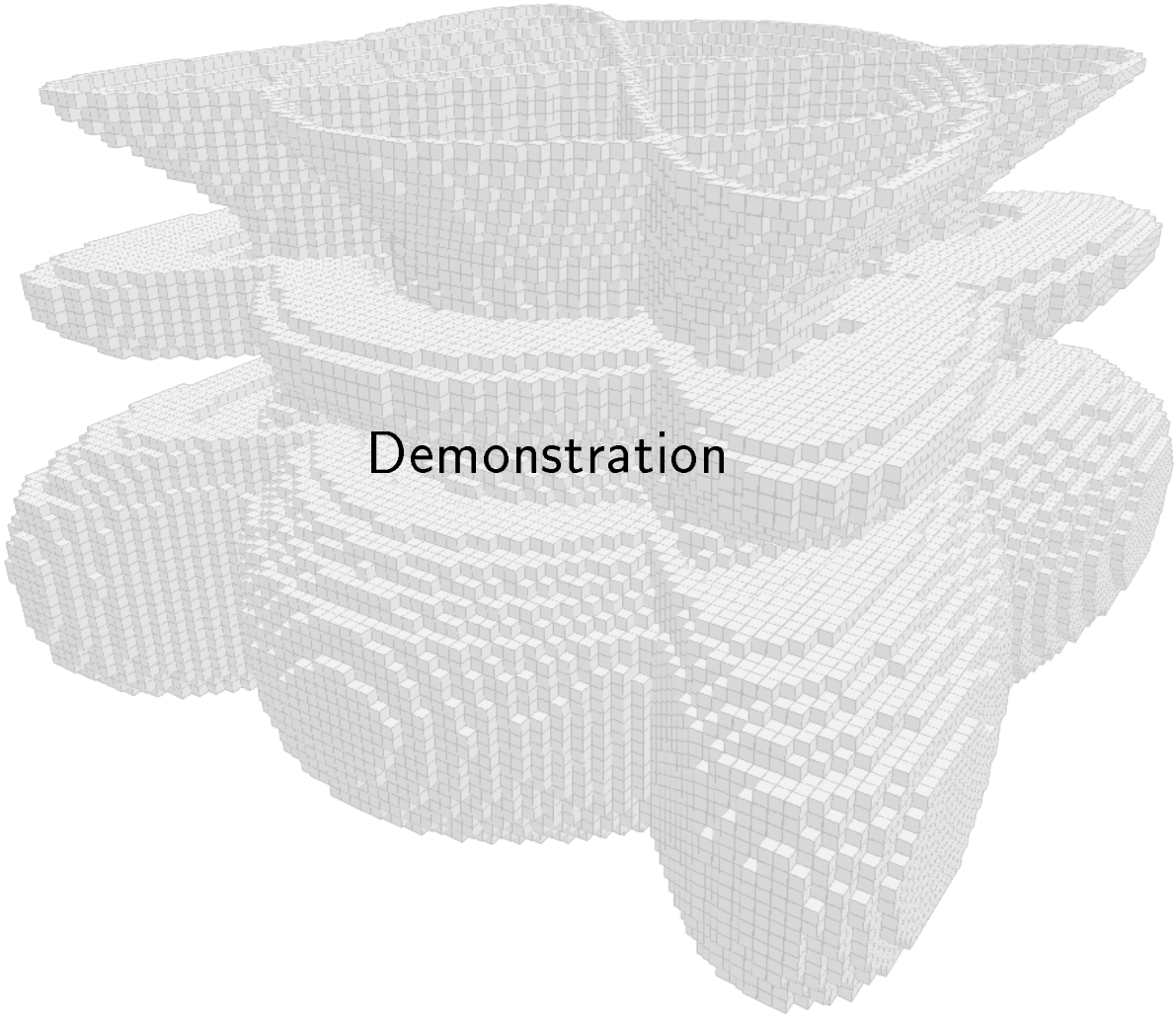
Tool usable by everyone and everywhere $\rightarrow$ web application

- Mathematica ?
  - Algorithm already implemented for Mathematica
  - Server application : difficult to set up a server from the university
  - Client application : user would have to install Mathematica (not free)
- Without Mathematica
  - Server application : security problems, data transfert
  - Client application : large quantity of computations $\rightarrow$ slow for computers with low capacities
- Choice : client application $\rightarrow$ HTML5/CSS, Javascript, WebGL

Prototype


File
Edit
View
Help
Param 1
Param 2
Param 3
Param N
Select Type
Param 1
Param 2
Param 3
Param N
Select Type

Demonstration



Technical aspect - 2D part

- Curves
  - Use MathJS
  - Two kind of definition : formula or freehand drawing
  - Formula : parse string $\rightarrow$ equation
  - Freehand drawing : retrieve points from HTML5 canvas
- Display
  - Explicit curve : easy to display
  - How to display implicit curves ?
  - Use functionPlot and HTML5 canvas
  - Formula curves : functionPlot $\rightarrow$ SVG
  - Freehand drawing : 2D rendering context on HTML5 canvas

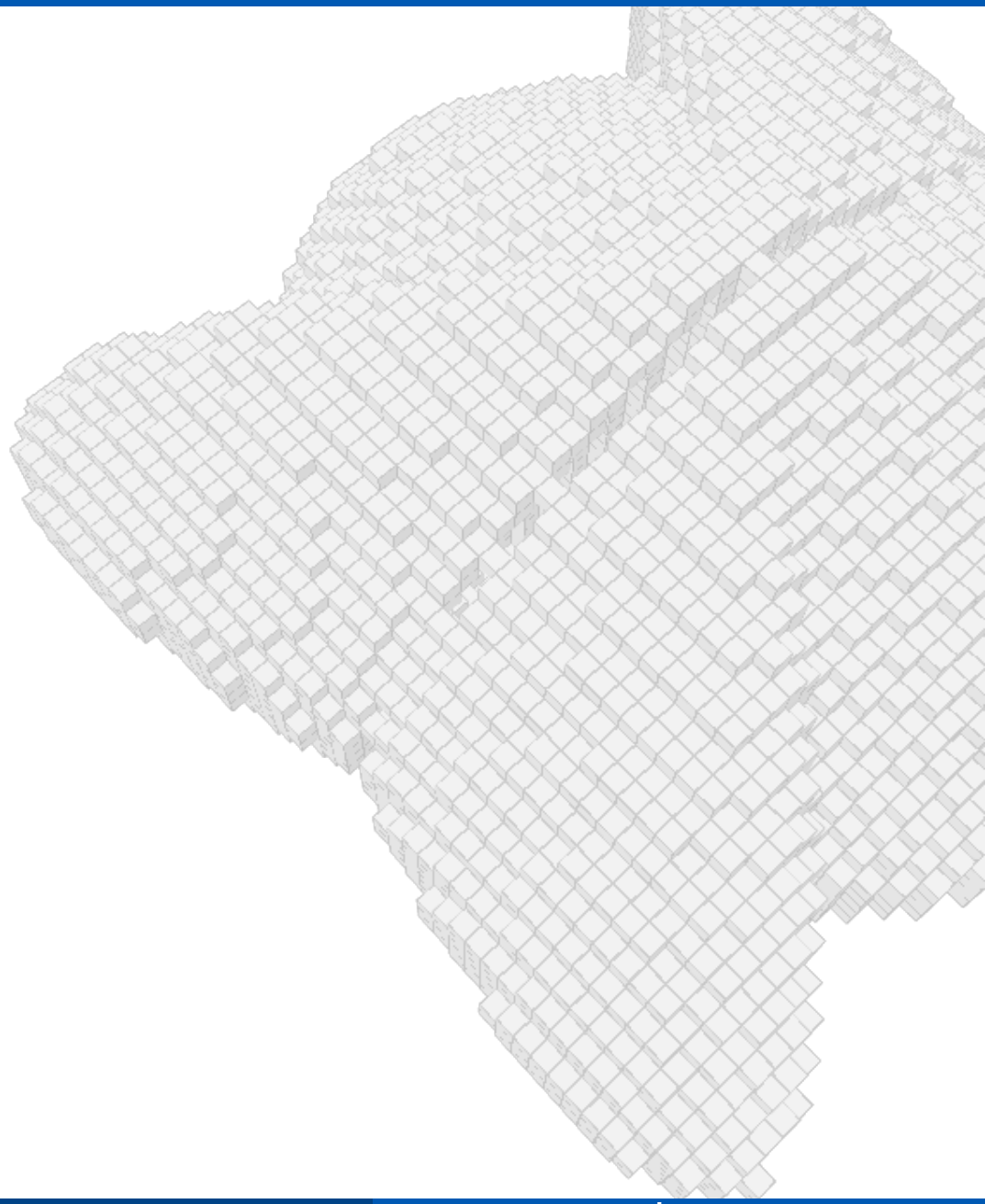
Technical aspect - 3D part

- Generation
  - Use MathJS
  - Interactivity $\rightarrow$ generation with worker(s)
  - Two versions : graph search and brute-force
- Rendering
  - Problem : detection of the outer faces
  - First version : computation during drawing
  - Following versions : computation during generation
  - WebGL : limited buffer size $\rightarrow$ multiple buffers

Technical aspect - Data export

- Save & load curves
  - XML format
  - Formula curves : stores the string of the equation
  - Freehand drawn curves : stores the list of points
- PNG export
  - Formula curves : saveSvgAsPng library
  - Drawn curves : FileSaver library and HTML5 canvas functionalities
- 3D export
  - X3D : transform each voxel into boxes
  - Excessive amount of boxes $\rightarrow$ slow to access
  - STL : binary file for 3D printer

Outline

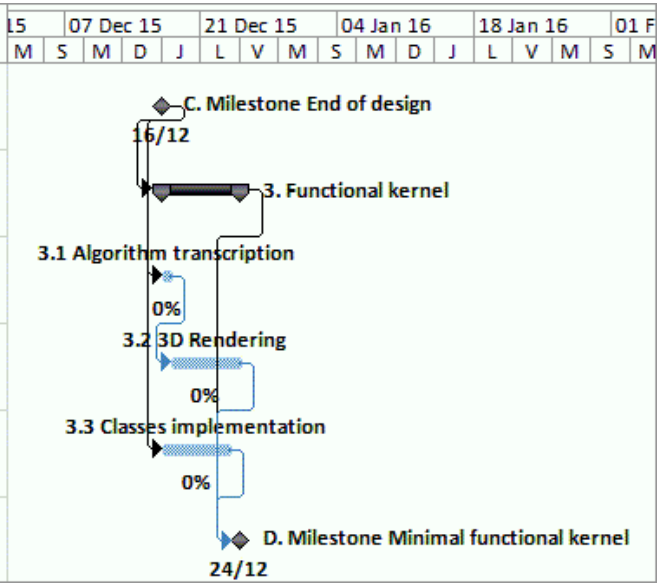


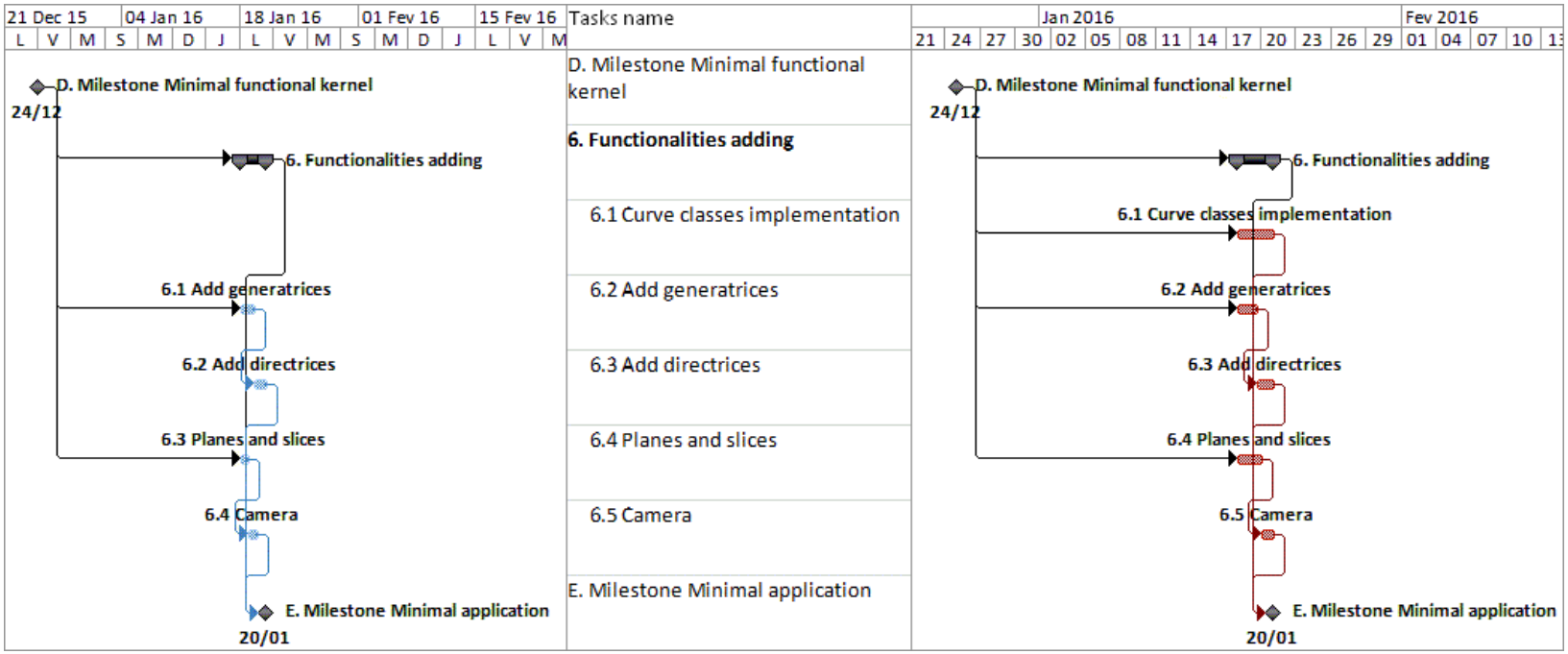
Task list

1 - Documentation, test and users help	✔		
2 - Design	✔		
3 - Functional kernel	✔	4 - Minimal interface	✔
6 - Functionalities adding	✔	5 - Interface enhancement Curve choice	✔
8 - Free hand drawn generatrix	✔	7 - Interface enhancement Parameters	✔
9 - Data management	✔	10 - Interface enhancement Formula input	✔
11 - User's curve (optional)	✘		
12 - Technical report	✔		

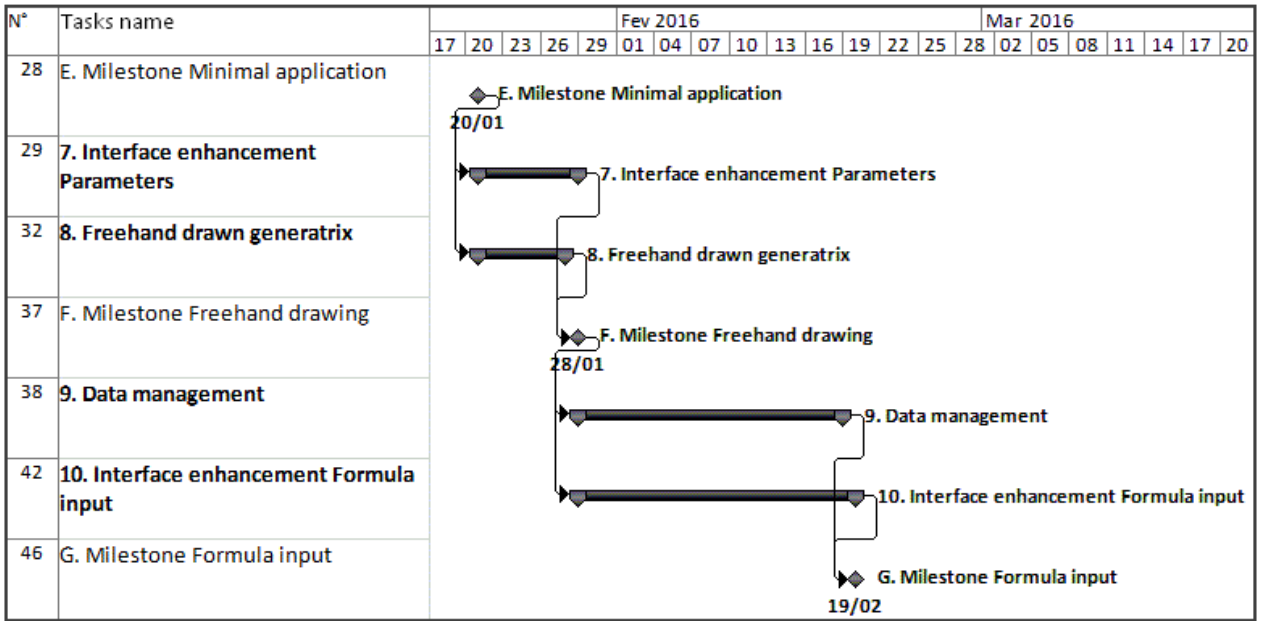
Gantt diagram

N°	Task name
9	C. Milestone End of design
10	**3. Functional kernel**
11	3.1 Algorithm transcription
12	3.2 3D Rendering
13	3.3 Classes implementation
18	D. Milestone Minimal functional kernel

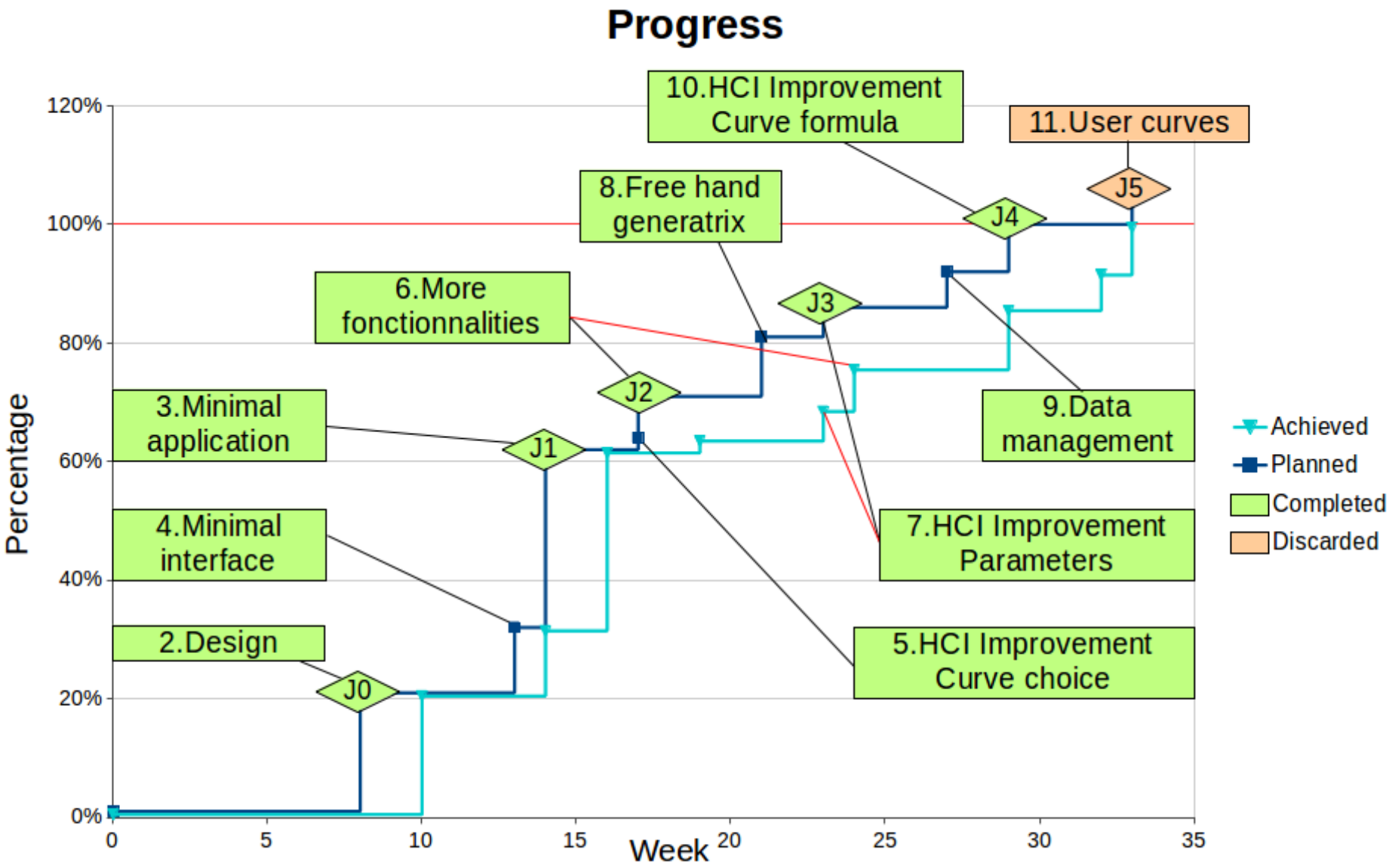




Gantt diagram



Progress


Progress
10.HCI Improvement Curve formula
11.User curves
8.Free hand generatrix
6.More fonctionnalities
3.Minimal application
4.Minimal interface
2.Design
9.Data management
7.HCI Improvement Parameters
5.HCI Improvement Curve choice
J0
J1
J2
J3
J4
J5
120%
100%
80%
60%
40%
20%
0%
Percentage
0
5
10
15
20
25
30
35
Week
Achieved
Planned
Completed
Discarded

Deliverables

N°	Deliverable	Tasks	Planned date	Actual date
1	Interface and algorithm result	2, 3, 4	Dec. 23rd	Jan. 18th
2	Minimal application	5, 6	Jan. 21st	Jan. 25th
2bis	Multi-slice and parameters	7	—	Jan. 29th
3	Free hand drawing and curves with editable parameters	7, 8	Jan. 29th	Feb. 24th
4	Equations and export	9, 10	Feb. 19th	Feb. 24th
5	Final application ~~and documentation~~	1 to 11	Mar. 2nd	Mar. 2nd
5bis	Final documentation	1	Mar. 11th	Mar. 14th

List of risks

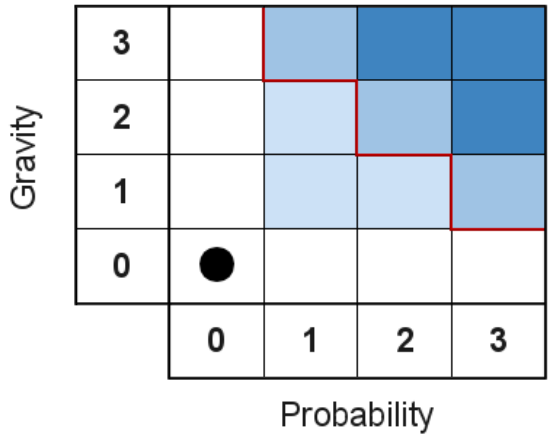
Risk	Gravity	Probability	Criticity	
Server linked problems	1	0	0	✻
New clients	1	2	1	✻ ✔
3D rendering needs too much ressources	2	1	1	✻ ✔
Evolution of the generation algorithm	1	3	2	✻
Equipment/device dysfunction	1	1	1	✚ ✔
Validation reveals serious technical problem	2	1	1	✻

✻ Initial ✚ Added ✔ Encountered

Risks

- Server linked problems

Gravity	0	1	2	3
Delay	●			
Costs	●			
Receipts	●			
Performance	●			
Other				
Global	●			

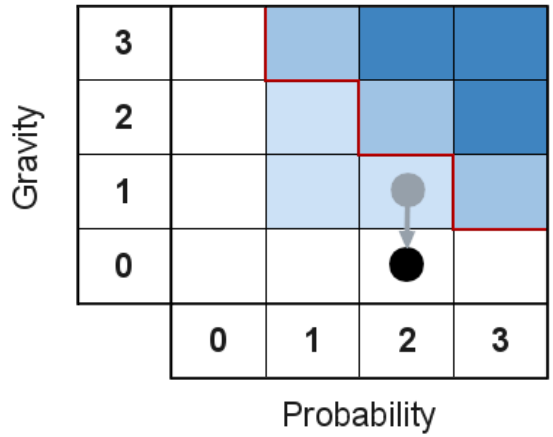


Level	Gravity	Probability	Criticity
0	None	$< 1\%$	No critical
1	Low	de 1% à 5%	
2	Important	de 5% à 20 %	Critical
3	Dangerous	$> 20\%$	

Risks

- New clients

Gravity	0	1	2	3
Delay	● ←	●		
Costs	●			
Receipts	●			
Performance	● ←	●		
Other				
Global	● ←	●		

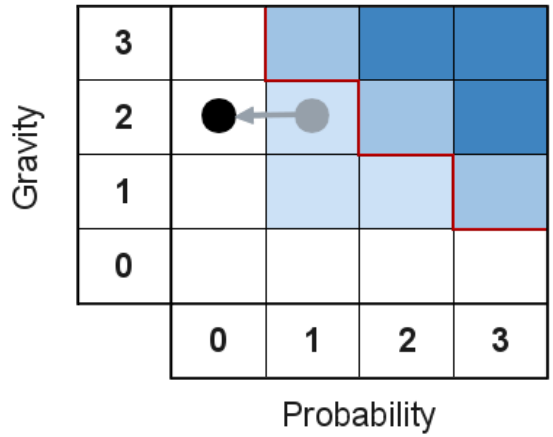


Level	Gravity	Probability	Criticity
0	None	$< 1\%$	No critical
1	Low	de 1% à 5%	
2	Important	de 5% à 20 %	Critical
3	Dangerous	$> 20\%$	

Risks

- Slow rendering

Gravity	0	1	2	3
Delay			●	
Costs	●			
Receipts	●			
Performance			●	
Other				
Global			●	

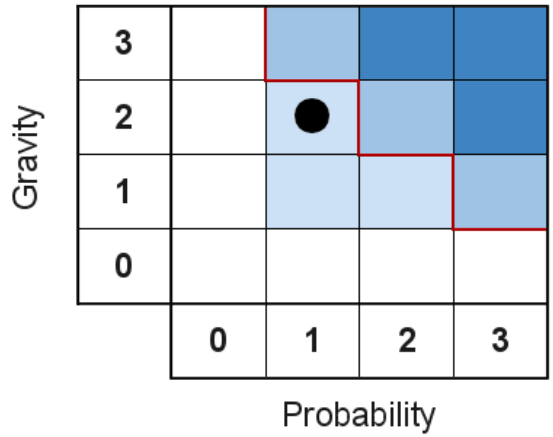


Level	Gravity	Probability	Criticity
0	None	$< 1\%$	No critical
1	Low	de 1% à 5%	
2	Important	de 5% à 20 %	Critical
3	Dangerous	$> 20\%$	

Risks

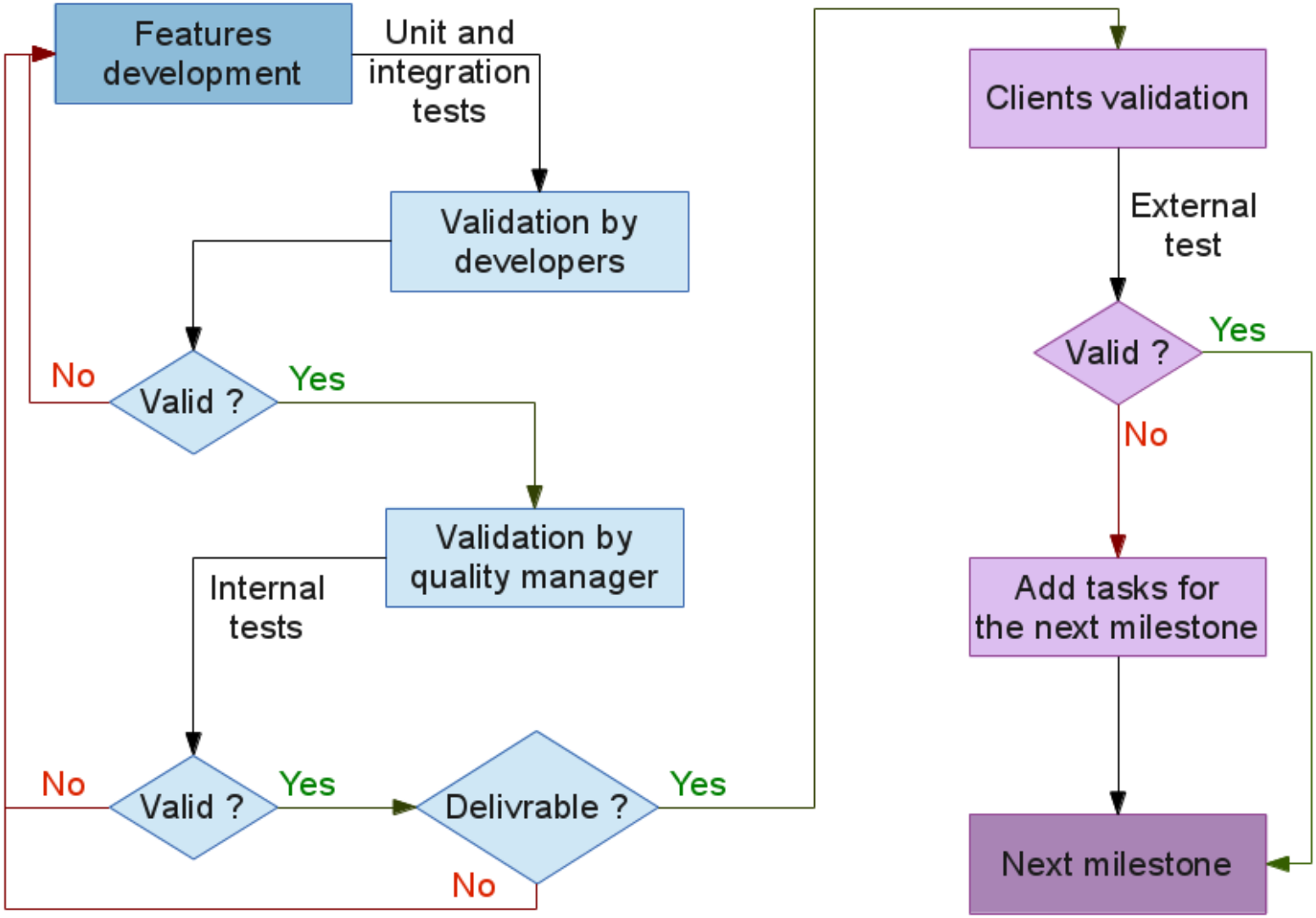
- Evolution of the generation algorithm

Gravity	0	1	2	3
Delay	●			
Costs	●			
Receipts	●			
Performance			●	
Other				
Global			●	

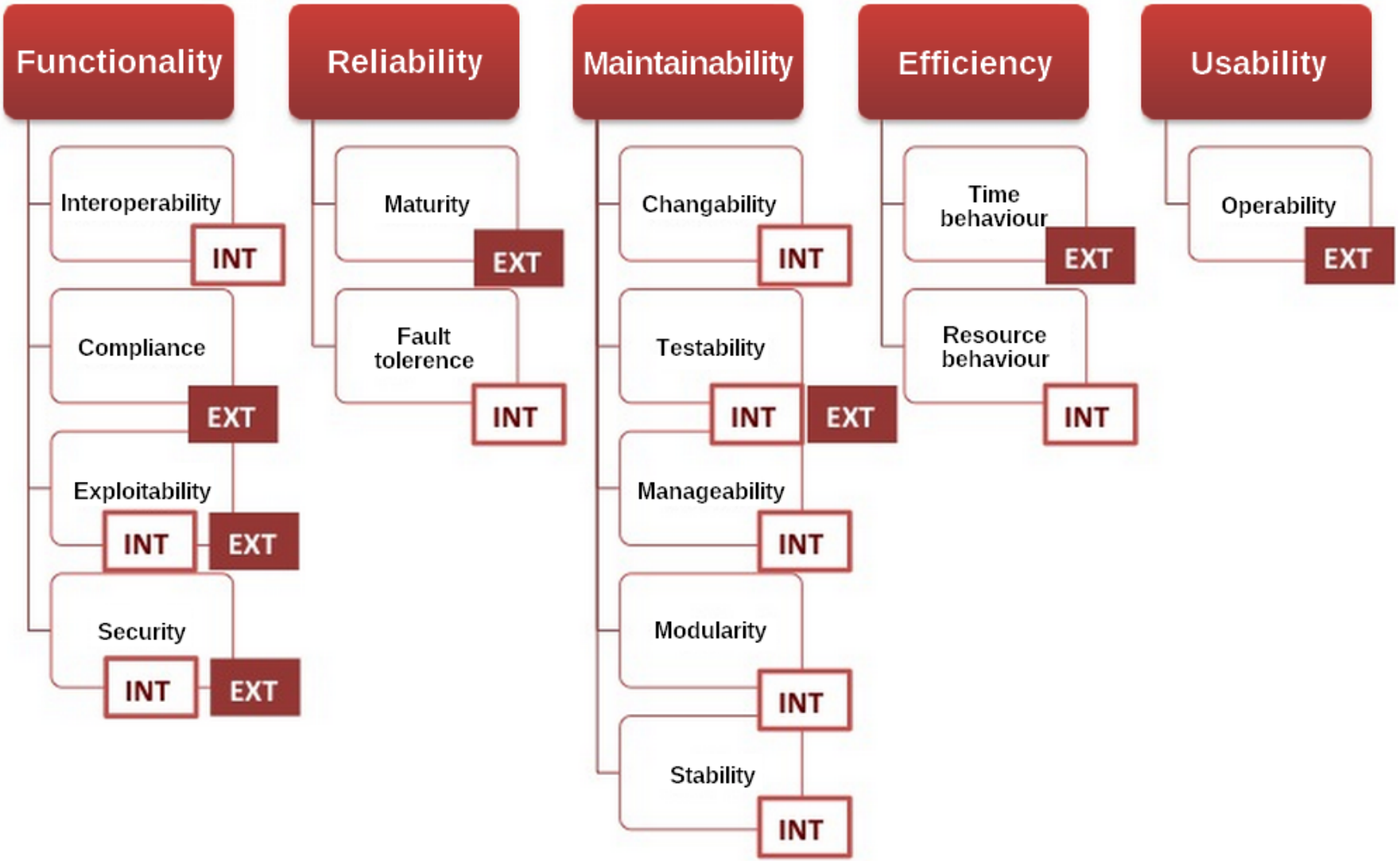


Level	Gravity	Probability	Criticity
0	None	$< 1\%$	No critical
1	Low	de 1% à 5%	
2	Important	de 5% à 20 %	Critical
3	Dangerous	$> 20\%$	

Quality insurance plan



ISO 9126

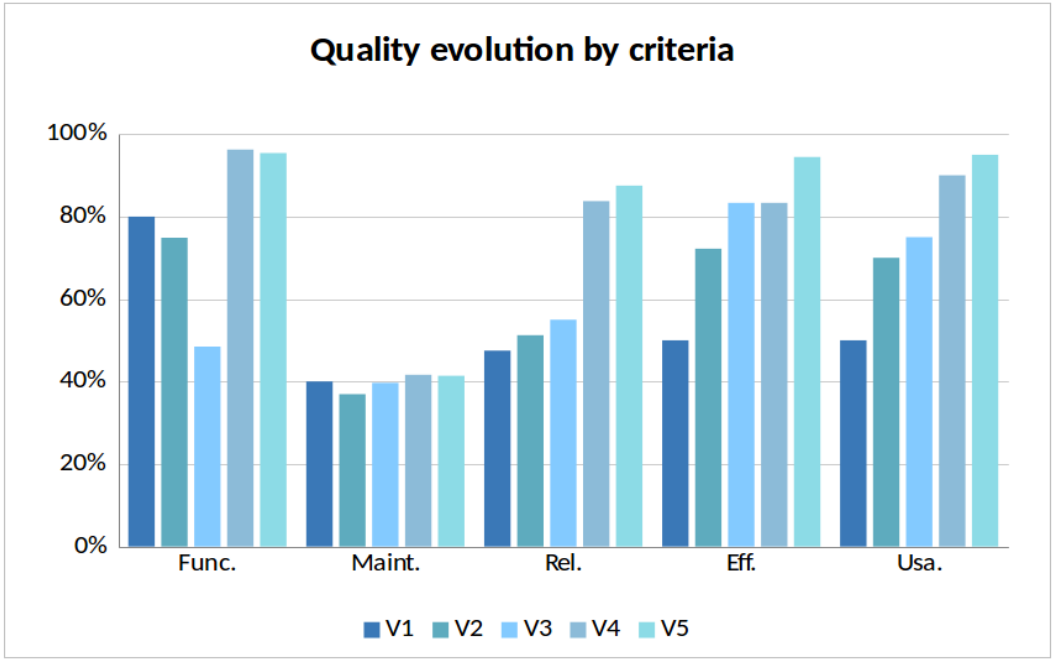

Functionality
Interoperability
INT
Compliance
EXT
Exploitability
INT
EXT
Security
INT
EXT
Reliability
Maturity
EXT
Fault tolerence
INT
Maintainability
Changability
INT
Testability
INT
EXT
Manageability
INT
Modularity
INT
Stability
INT
Efficiency
Time behaviour
EXT
Resource behaviour
INT
Usability
Operability
EXT

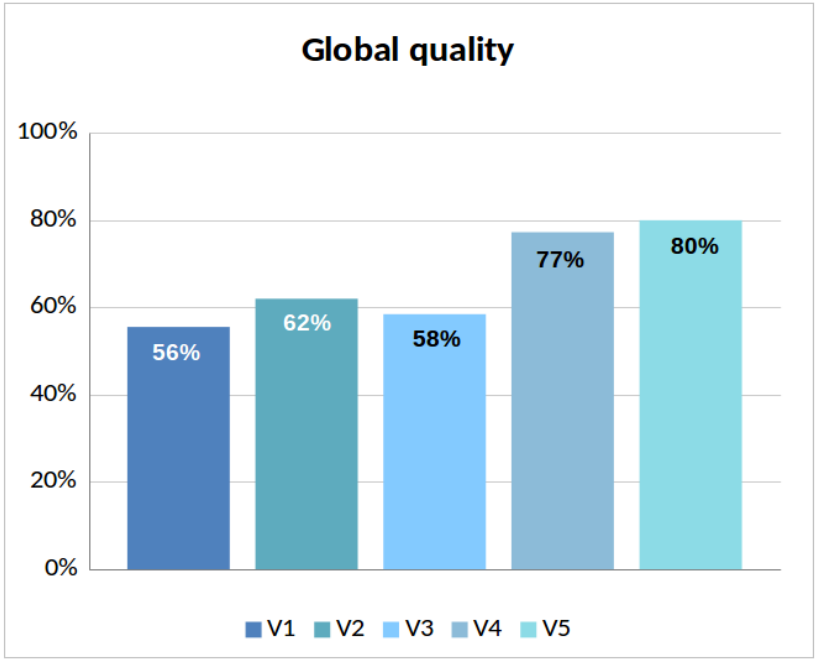
Software quality measurment

1	Question	Version 5
1	Overall vision	1
2	The ease to find the information	1
3	Response speed	1
4	Utility of the information	1
5	The choice of title and heading and their meanings	1
6	The completeness of the information found against the need	1
7	Execution speed	1
8	Errors rate	1
9	Handling the use	0.5
10	The reliability of the application	1
	Total	95%

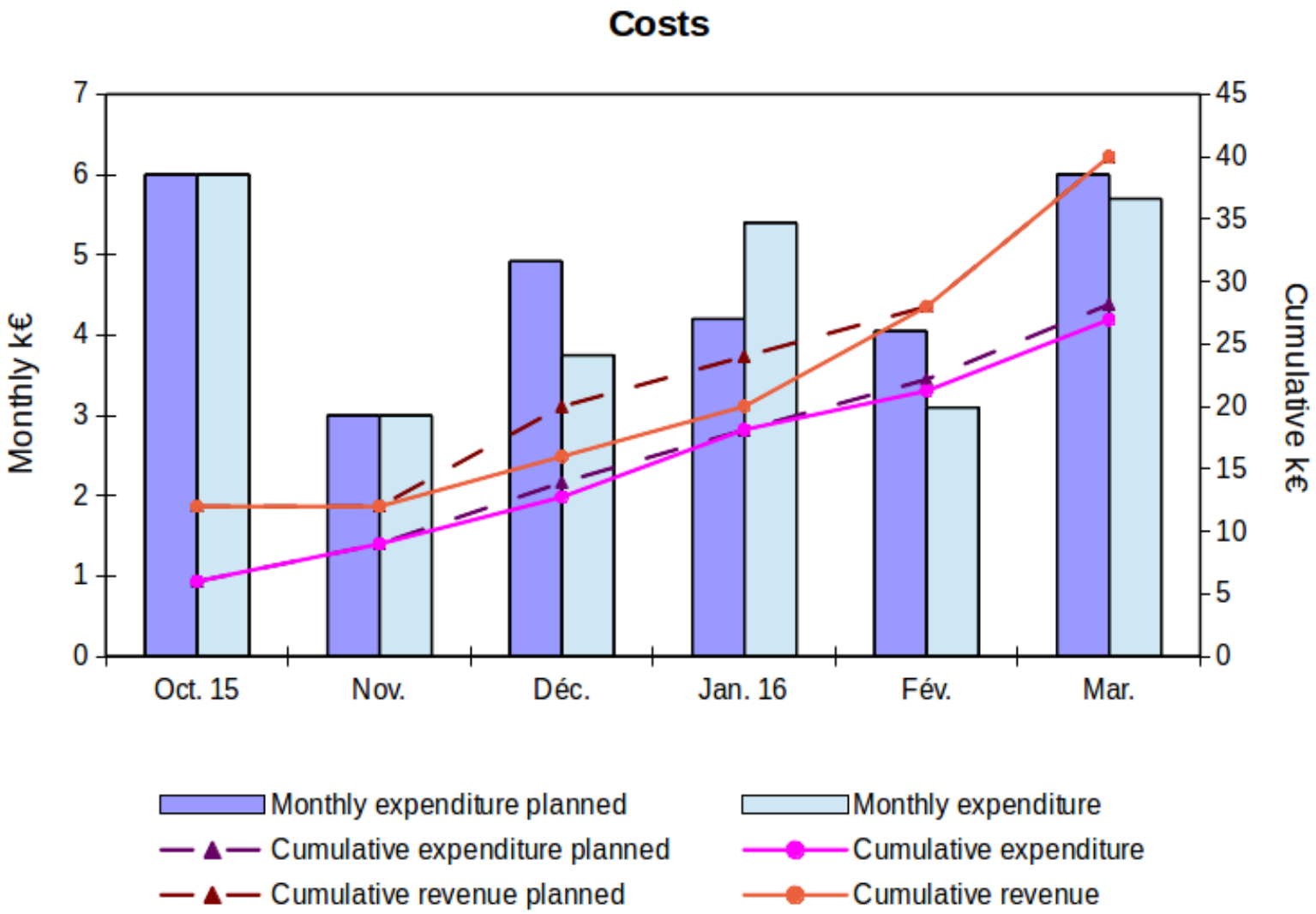
1	Functionality	Version 5	
		Int	Ext
1	Interoperability		
Goal	Ability to interact with one or more systems		
Question	Is the application uses norms and technical standards?		
Evaluation		95.83%	
1	Adequacy		
Goal	Checking the adequacy of spots against the needs		
Question	Does each function is adequate to the customer need?		
Evaluation			90%
0.5	Operability		
Goal	The ability to properly use the software system		
Question	At what level the software is usable?		
Evaluation			100%
	Note I/E	95.83%	95%
	Functionality	95.41%	

Software quality evaluation

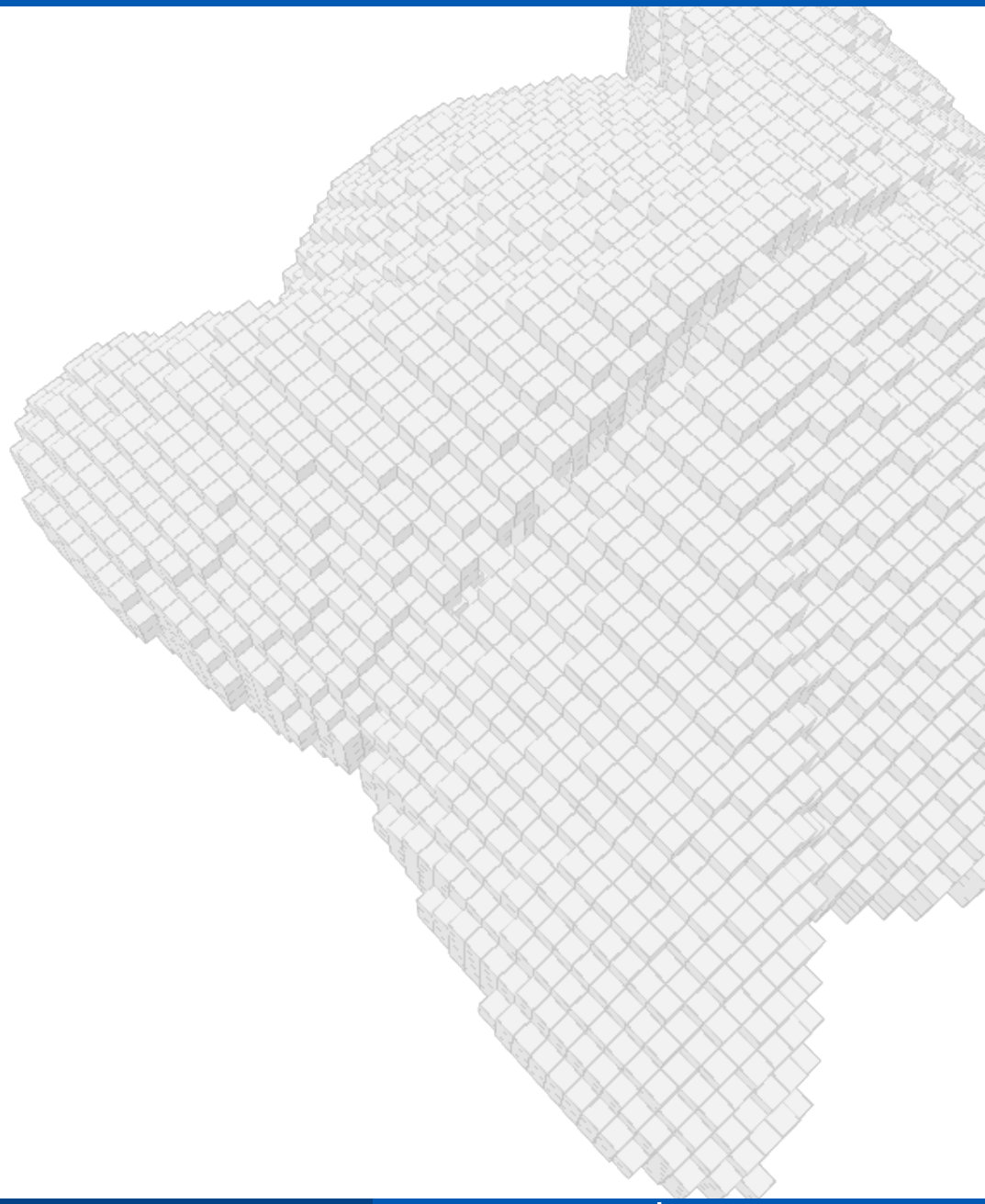




Costs


Costs
Monthly k€
Cumulative k€
0
1
2
3
4
5
6
7
0
5
10
15
20
25
30
35
40
45
Oct. 15
Nov.
Déc.
Jan. 16
Fév.
Mar.
Monthly expenditure planned
Monthly expenditure
Cumulative expenditure planned
Cumulative expenditure
Cumulative revenue planned
Cumulative revenue

Outline



Technical aspect

- Clients satisfied by the application
- Application available on XLIM website
- All main functionalities developed
- Final delivrable in two stage
- Possible improvements
  - X3D export
  - More information for users
  - More types of curve
- Perspectives
  - New algorithms
  - Lydie's internship subject

Project management aspect

- Weekly meetings with the pedagogic supervisor
- Interactions with clients
- Example of quality insurance plan
- Planning management
- Risks encountered

Personnal review

- Improvement in Javascript
  - classes, inheritence, worker, etc.
  - jQuery, MathJS, FileSaver
  - WebGL
- Spiral development : new experience
- Solving mathematical problem
  - base matrices
  - drawing implicit curves
  - etc.

Discrete 3D surfaces of revolution

Final presentation

Thanks for your attention.

Are there any questions ?