Project n° 031236

RC2

Instrument: STREP SPECIFIC TARGETED RESEARCH OR INNOVATION PROJECT

Thematic Priority: SUSTAINABLE DEVELOPMENT, GLOBAL CHANGE AND ECOSYSTEMS

<PUBLISHABLE SUMMARY M1-M12>

Period covered: From 01/11/2006 to 30/10/2007 Date of preparation: 30/11/2007

Start date of the project: November 1st, 2006 Duration: 30 months

Project Coordinator name: J.L. FILIOL

Project Coordinator organisation name: TURBOMECA

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1. PURPOSE AND OBJECTIVES

RC2 (Reduction of Cycle and Costs) project goal is the reduction of manufacturing cost and production lead-time.

RC2 will deliver not only an innovative manufacturing process based on the combination of rapid prototyping with the most suitable finishing technique but also a methodology to be applied for any kind of complex-shaped mechanic part, and through a proven manufacturing reference. RC2 results will permit a reduction of both cost and lead-time of functional prototypes by 50%. This project will last 30 months.

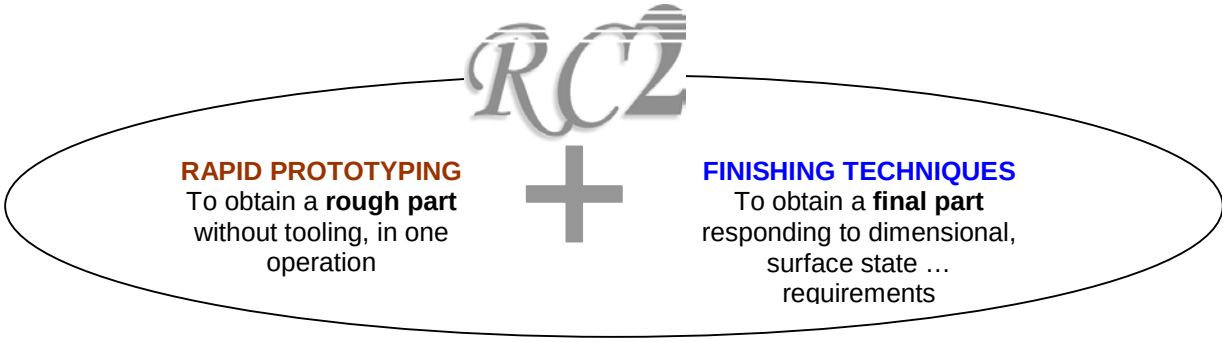
After some years, the state of the art in rapid prototyping by melting or sintering of metallic powders allows the production of geometrical prototypes thanks to different commercial procedures. Nevertheless no current rapid prototyping method can be considered as a true manufacturing process as there are many problems with surface state, resolution, material quality, accuracy and repeatability that need to be overcome. In the best case, only TURBOMECA together with PEP have managed to produce a full complex functional prototype but requiring finishing techniques.

From both an economical and technical point of view, finishing processes will have to be developed due to the differences in surface condition and in porosity of the rough parts obtained either by rapid prototyping or by conventional machining

The main research strategy of RC2 project is to focus on developing the finishing techniques applicable to parts manufactured by rapid prototyping. Contrary to many other projects RC2 do not focus on developing laser sintering and melting technologies but on implementing them as soon as they become fully operational.

RC2 process lead to a reduction of time to design and to fabricate a functional prototype by 50% involving a reduction of time to market by 10%.

RC2 strategy consists in the development of a specific manufacturing process, including a methodology to be applied for any kind of complex-shaped mechanic part, and through a proven manufacturing reference.



TECHNICAL BREAKTHROUGHS

- Development of the parameters of the rapid prototyping (RP) machine to obtain a direct part
- Development and adaptation of usual finishing techniques for parts made by RP
- Development of an innovative finishing technique (MMP process) for parts made by RP

A NEW SIMPLIFIED PROCESS

1. Design of the file definition for CAD
2. Manufacturing by Rapid Prototyping
3. Application of the most adapted and finishing technique efficient (usual or innovative)
4. Quality control

The research activities in RC2 project focus on:

- The development of the parameters of the RP machine in order to obtain rough parts using raw materials through a single operation
- The development and the adaptation of usual finishing techniques for parts made by RP
- The development of a MMP process specific to parts made by RP
- The development of the process associating RP and the most suitable finishing process permitting to reduce cost and lead-time by 50% while obtaining final parts responding to engine manufacturers requirements

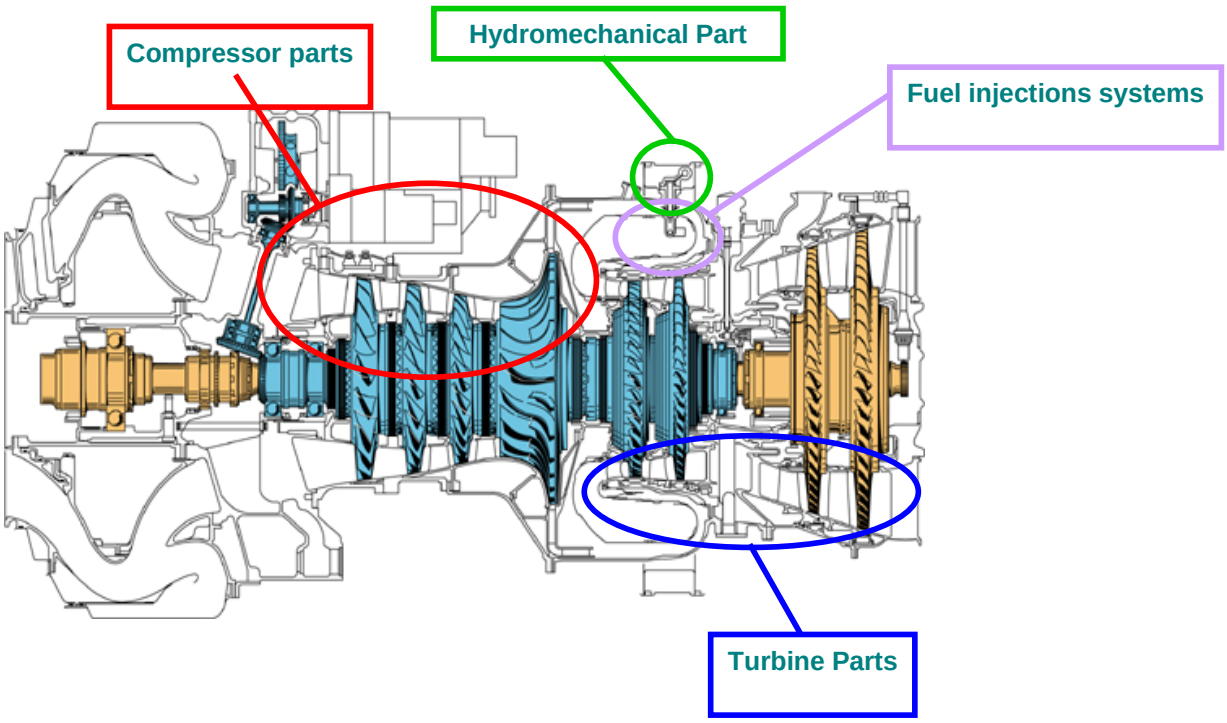
The consortium works on several gas turbine components and more specifically on static and rotating complex-shaped parts of the gas path (for compressor and cold turbine test bench) and of the fuel system.

2. RC2 CONTRACTORS

Role	n°	Name	Short name	Country	Date enter project	Date exit project
CO	1	TURBOMECA	TM	France	M1	M30
CR	2	POLE EUROPEEN DE PLASTURGIE	PEP	France	M1	M30
CR	3	BEST IN CLASS France	BINC F	France	M1	M30
CR	4	BEST IN CLASS Switzerland	BINC S	Switzerland	M1	M30
CR	5	ECOLE D'INGENIEUR DE GENEVE	EIG	Switzerland	M1	M30
CR	6	TEKNIKER	TEK	Spain	M1	M30
CR	7	SPASA	SPASA	Spain	M1	M30

3. ACHIEVEMENTS

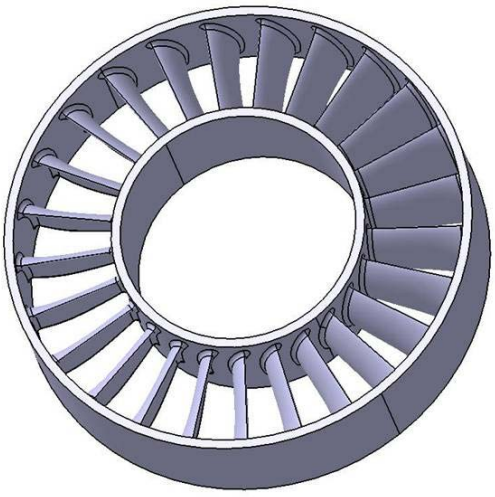
RC2 project started with the identification of the parts that are the critical path in term of time to market and production cost within the design step of an engine prototype.
We have identified 4 family of part with 9 references. In this section we will provide a summary of the 9 parts performed and the first results obtained.



3.1. Compressor parts family

3.1.1. Straightener

	Status	Comments
Material		- EOS MS1 (X 3 Ni Co Mo Ti 18 9 5)
Production part		- 40 hours (EOS M270)
Finishing process		- 7 machining step
Quality		- Geometric capacity is too limited in relation to the requirements - Porosity on surface
Cost / Time (estimate)		- Cost factor 0,4 - Time factor 0,3



Roughness before polishing

- Extrados : Ra = 6.64 - Intrados : Ra = 6.78 - External air path Ra = 7.11 - Internal air path Ra = 7.57

Roughness after polishing

- Extrados : Ra = 0.77 - Intrados : Ra = 0.29 - External air path Ra = 0.39 - Internal air path Ra = 2.77

3.1.2. Axial wheel

	Status	Comments
Material	☹	- EOS MS1 (X 3 NiCoMoTi 18 9 5) - EOS MP1 (CoCrMo) → Specific density is too important
Production part	☹	- 32 hours (EOS M270) - Deformations - Problems with the down skin
Finishing process	😐	- balancing the RP part
Quality	☹	- Geometry is not conformed - Surface condition is not conformed
Cost / Time (estimate)	😐	- Results must be demonstrated with a conform part

Roughness before polishing

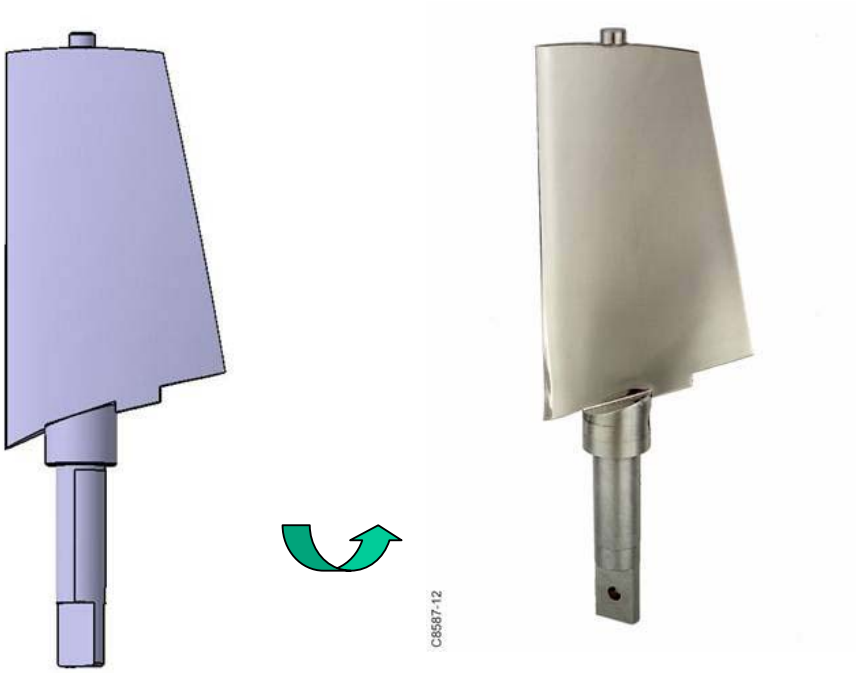
- Extrados : Ra = 11.24 - Intrados : Ra = 24.14 - Internal air path Ra = 7.22

Roughness after polishing

- Extrados : Ra = 0.18 - Intrados : Ra = 16.06 - Internal air path Ra = 0.14

3.1.3. INLET GUIDE VANE

	Status	Comments
Material		- EOS MS1 (X 3 Ni Co Mo Ti 18 9 5)
Production part		- 47 hours (EOS M270)
Finishing process		- 7 machining step
Quality		- Geometric capacity is too limited in relation to the requirements
Cost / Time (estimate)		- Cost factor 0,5 - Delay factor 0,4



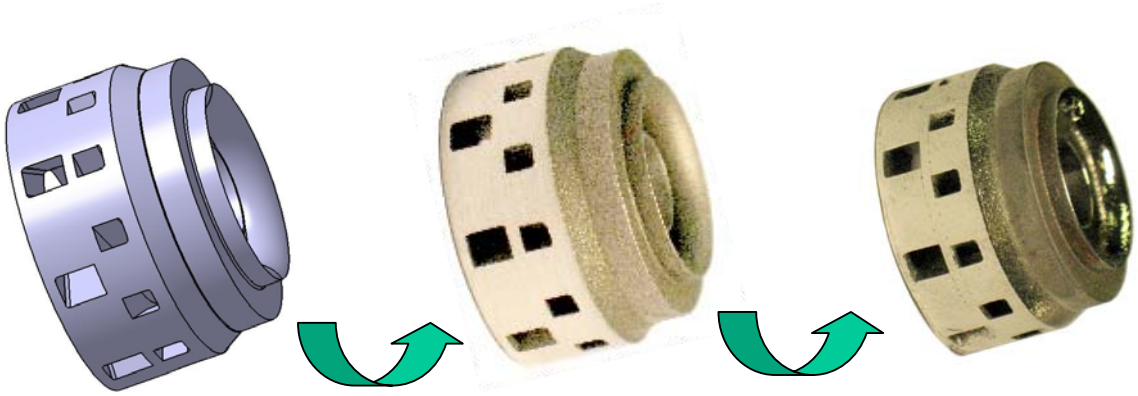
Roughness before polishing
- Extrados Ra = 3.21 - Intrados Ra = 3.45

Roughness after polishing
- Extrados Ra = 0.09 - Intrados Ra = 0.02

3.2. Combustion family parts

3.2.1. SWIRLER

	Status	Comments
Material		- EOS MP1 (Co Cr Mo)
Production part		- 47 hours (EOS M270)
Finishing process		- 4 machining step
Quality		- Surface condition is not conformed - Too dispersion on surface condition between the outside and inside part
Cost / Time (estimate)		- Cost factor 1,1 - Delay factor 0,3



Roughness before polishing

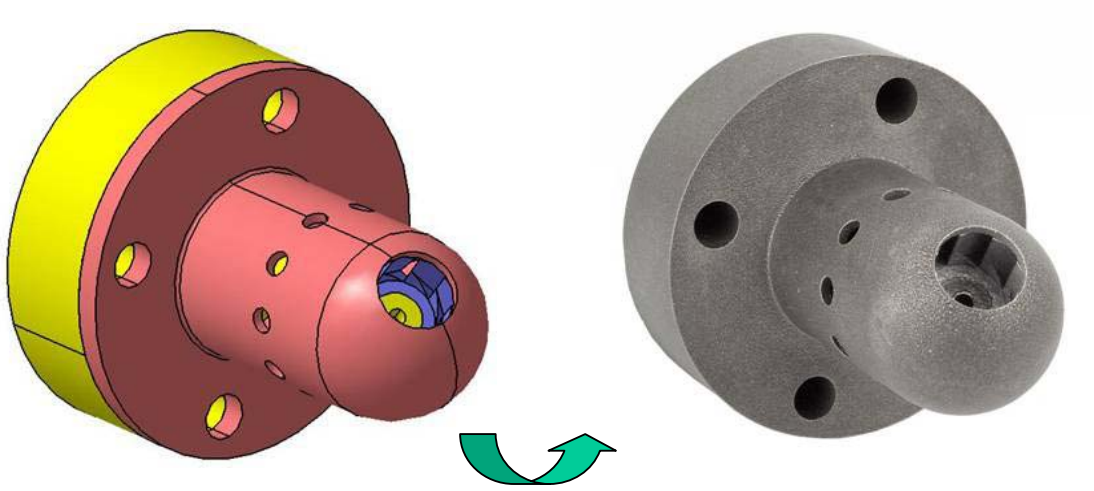
- External diameter Ra = 5.75 - Internal air path Ra = 19.88

Roughness after polishing

- External diameter Ra = 0.63 - Internal air path Ra = 4.97

3.2.2. CTA2 FUEL SYSTEM INJECTION

	Status	Comments
Material		- EOS MP1 (Co Cr Mo)
Production part		- 130 hours (EOS M270)
Finishing process		- In development
Quality		- Surface condition is not conformed - Too dispersion on surface condition between the outside and inside part
Cost / Time (estimate)		- Cost factor 1,3 - Delay factor 0,3



Roughness before polishing

- External diameter Ra = 5.23

Roughness after polishing

- External diameter Ra = 0.07

3.2.3. LOPOCOTEP FUEL SYSTEM INJECTION

	Status	Comments
Material	☺	- EOS MP1 (Co Cr Mo)
Production part	😐	- 60 hours (EOS M270)
Finishing process	😐	- In development
Quality	😐	- Surface condition is not conformed - Too dispersion on surface condition between the outside and inside part
Cost / Time (estimate)	😐	- Cost factor 1,2 - Delay factor 0,3

Roughness before polishing

- Flange Ra = 2.55 - Internal air path Ra = 3.63

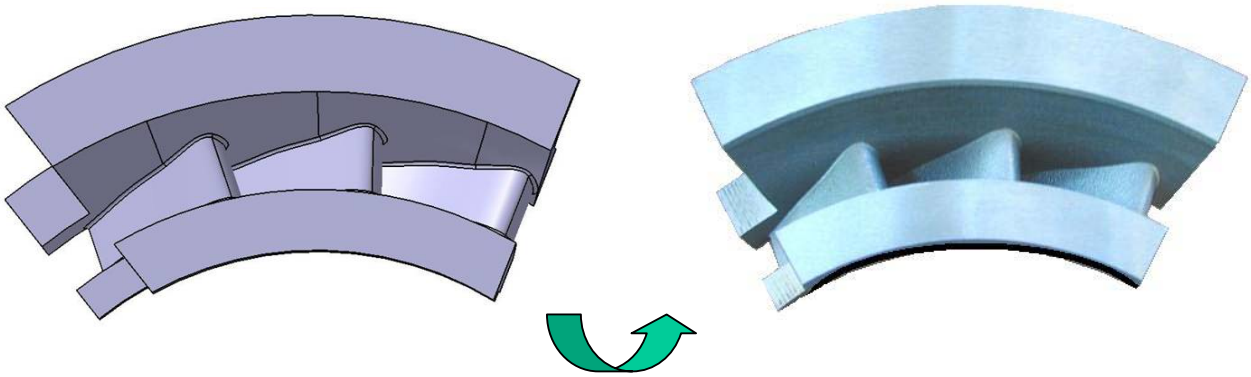
Roughness after polishing

- Flange Ra = 0.58 - Internal air path Ra = 0.67

3.3. Turbine family parts

3.3.1. NOZZLE GUIDE VANE

	Status	Comments
Material		- EOS MS1 (X 3 Ni Co Mo Ti 18 9 5)
Production part		- 2*75 hours (EOS M270) - Problems with the down skin
Finishing process		- In development
Quality		- Nothing to report for the moment
Cost / Time (estimate)		- Cost factor 1,5 - Delay factor 0,6



Roughness before polishing

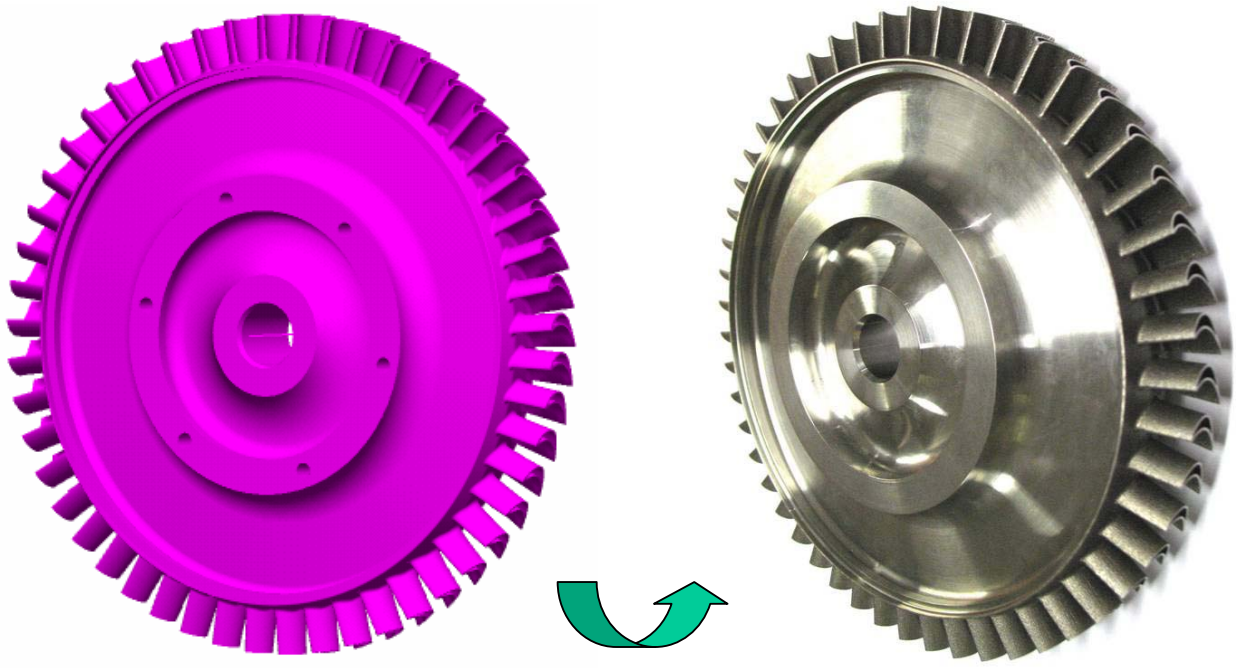
- Extrados : Ra = 4.85 - Intrados : Ra = 13.8 - external air path Ra = 5.48 - internal air path Ra = 6.49

Roughness after polishing

- Extrados : Ra = 0.05 - Intrados : Ra = 4.56 - external air path Ra = 0.12 - internal air path Ra = 0.03

3.3.2. TURBINE WHEEL

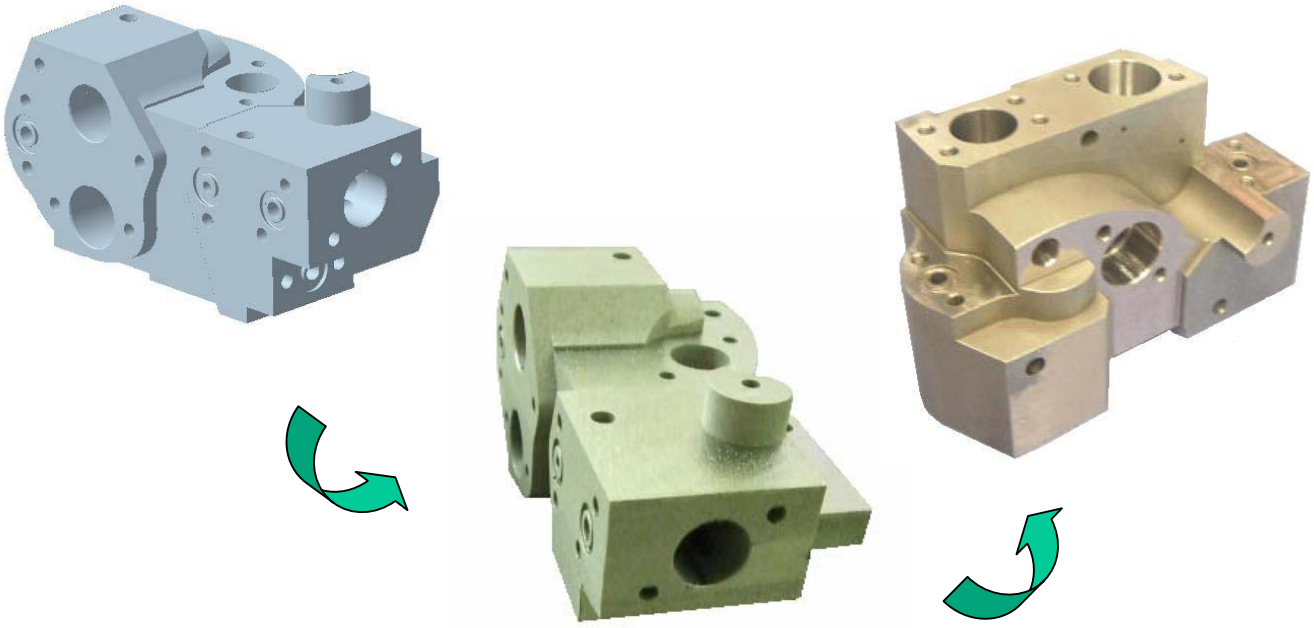
	Status	Comments
Material	😐	EOS MS1 (X 3 Ni Co Mo Ti 18 9 5) → Specific density is too important
Production part	😐	- 114 hours (EOS M270) - Deformations - Problems with the down skin
Finishing process	😐	- In development
Quality	☹	- Geometry is not conformed - Surface condition is not conformed
Cost / Time (estimate)	😐	- Cost factor 1,2 - Delay factor 0,4



3.4. Hydromecanical family part

3.4.1. VALVE UNIT HOUSING

	Status	Comments
Material		- EOS MS1 (X 3 Ni Co Mo Ti 18 9 5) - Oxidation problem
Production part		- 35 hours (EOS M270)
Finishing process		- 4 machining step - 90 hours for machining
Quality		- Geometry is conformed - Surface condition is conformed
Cost / Time (estimate)		- Cost factor 2 - Delay factor 0,4



4. DISSEMINATION AND EXPLOITATION

Dissemination activities within RC2 period 1 can be sum-up as follow :

- Establishment of a communication charter
- Establishment of an dissemination strategy
- Elaboration of RC2 Web site : www.rc2project-rapidmanufacturing.eu

The dissemination strategy for the next periods is actualized regularly. At M12 we can sum-up the publications and events where RC2 partners will present their work on the following table :

Target Group	Message	Information to disseminate	Main media
SAFRAN Group companies	The Rapid manufacturing allows to reduce by 50% of manufacturing costs and cycles on TURBOMECA prototype parts	TBD	Web & newsmagazines of the group : Bleu SAFRAN Intranet site : Nectar
TURBOMECA	The Rapid manufacturing allows to reduce by 50% of manufacturing costs and cycles on TURBOMECA prototype parts	Money and time savings for same or better quality	Turbomeca corporate magazine : TIM Intranet site : Intranet TURBOMECA
Sintering machine manufacturers	Way for developments to answer engine manufacturer's needs	Technical issues within RC2 productions	Presentation at Euromold annual fair
Sintering machine manufacturers and users	Way for developments to answer engine manufacturer's needs	Technical issues within RC2 productions	Presentation at PEP technical day
Sintering machine manufacturers	TBD	TBD	SME (Society of manufacturing Engineers annual fair (North America's Largest Annual Rapid Manufacturing Event)
Aeronautic engine manufacturers	Ability to realize finished and useful parts and more widely, added value of the complete process	TBD	No yet identified, maybe through fairs
Mold-maker companies			
Health Industries			
Luxury Industry			
Tekniker group	TBD	TBD	Newtek
Scientific community	The effective results of the project	Poster with general information of the project	BIEMH
		Results articles	Scientific Journal (indexed)
			IMHE
		Results presentation	Conferences : Oral presentation on XVII Congreso de Máquinas –herramienta y Tecnologías de Fabricación
ACITURRI Group	TBD	TBD	Newsmagazine of the group
Wide audience	TBD	Project and process presentation	MATER exhibition
Aeronautical engine manufacturer: SNECMA, ITP, Rolls Royce, MTU, FIAT Avio, Volvo	R&C cost reduction	Process baseline	Flight International, Speed News (Newsletter)
	TBD	Cost reduction indications	TBD
	Part number and assembly operations reduction	Material availability and quality (which materials can be obtained with this process and their quality)	TBD
Prototypists	Cost reduction	TBD	TBD
Aeronautic in TM	New capacities of SLM process	Profit	TBD
Other field	TBD	Dimensional and mechanical properties	Trade shows
Technical centre	TBD	TBD	TBD
Laboratory	Possibilities in PEP	TBD	Publications conferences