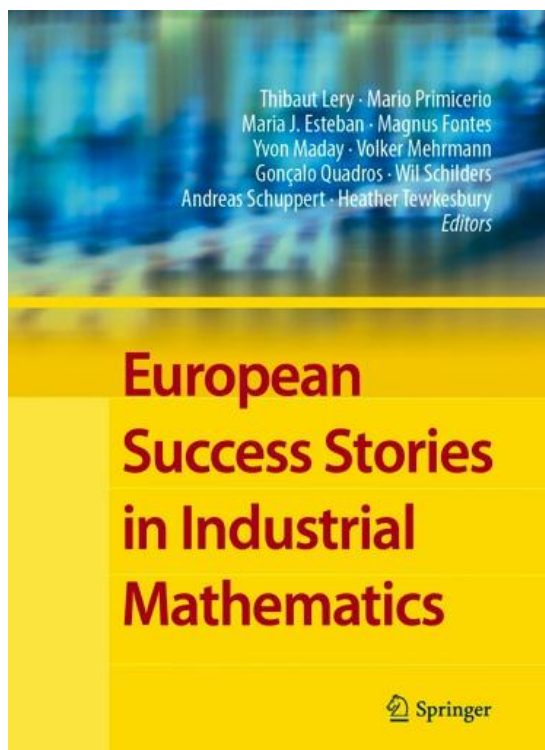


**EUROPEAN
SCIENCE
FOUNDATION**

FLM
Forward Look on
Mathematics & Industry



European Mathematical
Society



Forward Look on mathematics and industry

G.-H. Cottet
University of Grenoble and
Agence of Mathematics in Interaction with
Enterprises and Society (agence-maths-
entrprises.fr)

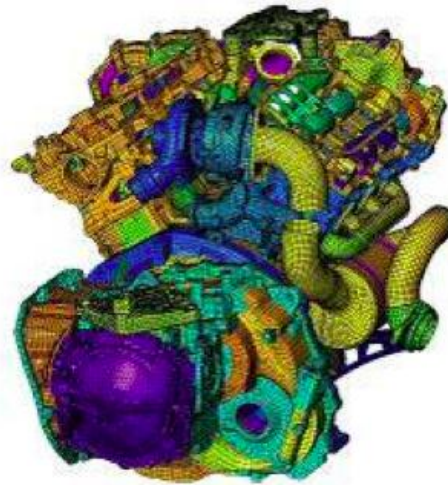
 trio.be

Mathematics in Industry

What's the problem in Europe?

Successes exist but in a fragmented landscape

No calls ever for mathematics in any Framework Programs



No infrastructure at European level

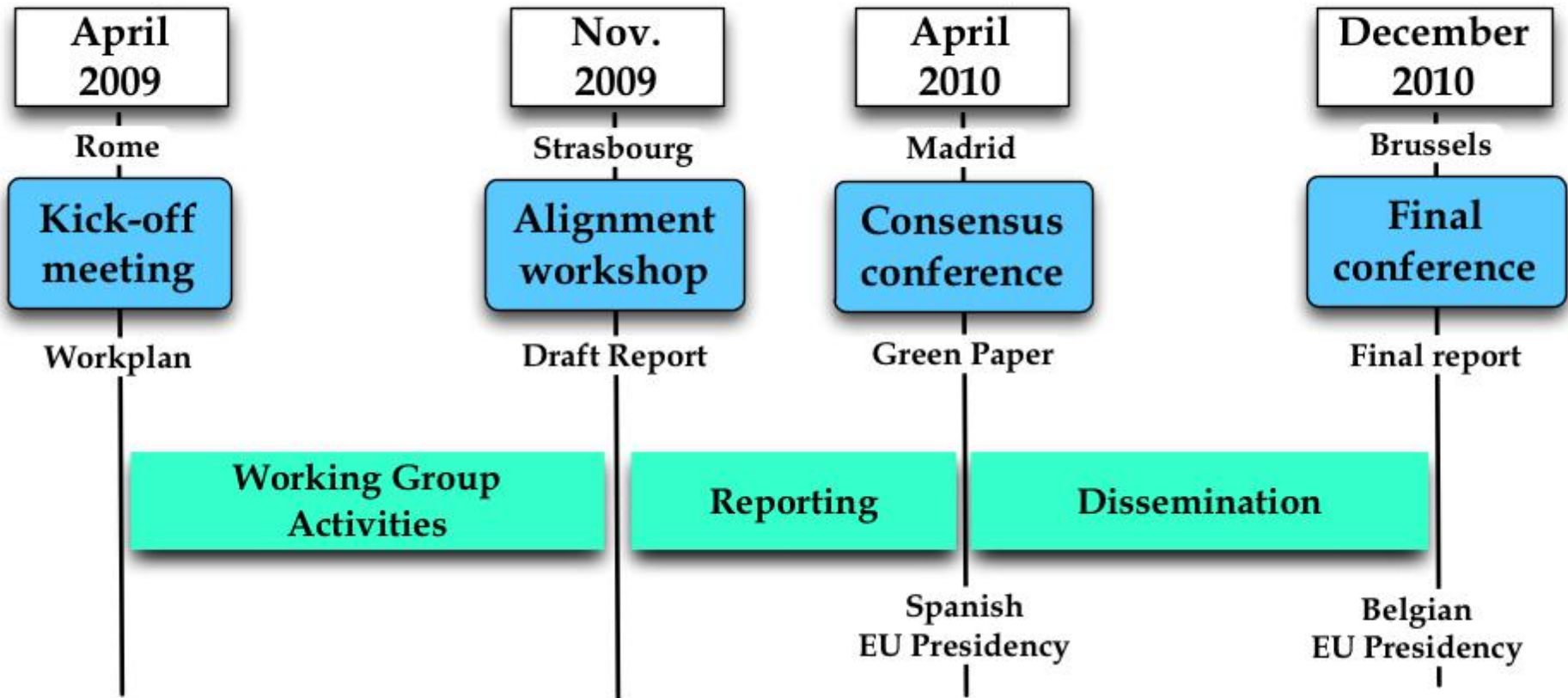
Dispersed information

No European strategy for research and education in mathematics

Forward Look on “Mathematics and Industry”



Forward Look Timeline



Outcomes of the Forward Look

- One report with recommendations (Dec. 2010)
- One book on success stories (Oct. 2011)
- Dissemination plan (2011-2012)
- Implementation plan (activities at National and European levels)

Outcome 1: The Forward Look Report

- **State-of-the-Art review**
 - Current state of research in the area and highlights of the major advances in the last years
- **Scientific challenges**
 - Impact of those advances on the research agenda
 - Indication of major knowledge gaps and potential ‘hot topics’
 - Identification of European strength and weakness
- **Vision**
 - Presentation of a vision with major goals that could provide directions for research in the medium and long term time frame
 - Implementation plan (in terms of infrastructure, institutional innovation, human resources, governance)
- **Impact and Follow-up**
 - Key stakeholders likely to play a key role in the implementation
 - **Targeted recommendations**
 - **Follow-up mechanism to ensure delivery and avoid risks**

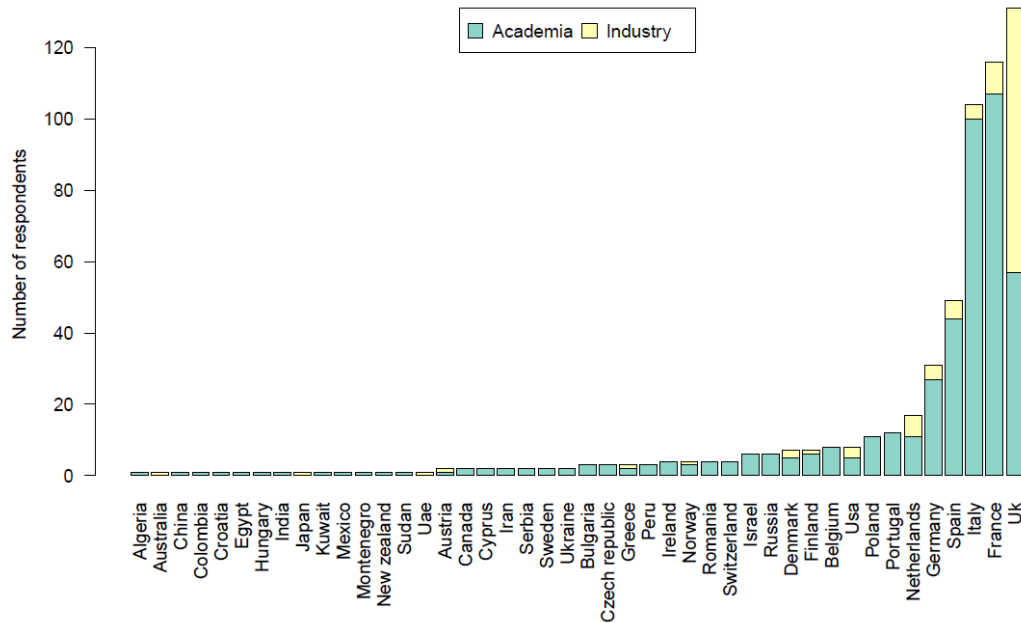


Input for the Report - 1: Studies and reviews from Europe and beyond (OECD, NSF ..):

Innovation and gain in competitiveness require
more and more Mathematics
(complexity, constraints, time-scales ..)
Mathematics: engine of growth

Must develop awareness in academia and enterprises
and among students that mathematics can provide
solutions for real world problems

Input for the Report - 2: A survey towards researchers in academia and industry



459 from academia and
116 from Industry

Figure 1: Country of origin of respondents.

QuickTime™ et un
décompresseur
sont requis pour visionner cette image.

Fields considered as important
by researchers and enterprises

Emerging challenges at the interface maths-enterprises

- Multi-mathematics (e.g. physical modeling, simulation and uncertainty quantification)
- Multi-objective optimization
- Analysis/modeling/visualization of large data sets



Recommendations to Policy makers and funders

Recommendation 1: Policy makers and funding organisations should join their efforts to fund mathematics activities through a European Institute of Mathematics for Innovation.

Roadmap implementation:

- EU and National funding agencies should coordinate *clusters of excellence* in industrial mathematics and create a **European Institute of Mathematics for Innovation (EIMI)**.
- EU must identify industrial and applied mathematics as an **independent cross-cutting priority for Horizon2020**.

Recommendations to Academia and Industry

Recommendation 2: In order to overcome geographical and scientific fragmentation, academic institutions and industry must share and disseminate best practises across Europe and disciplines via networks and digital means.

Roadmap implementation:

- Researchers in academia and industry must disseminate best practises.
- Academic institutions and industry must facilitate the employment **mobility between academy and companies.**



Recommendations to Academia

Recommendation 3: Mathematical Societies and academic institutions must harmonise the curriculum and educational programmes in industrial mathematics at European level.

Roadmap implementation:

- Academia must create a **European Curriculum** for industrial mathematics.
- **Academia must help strengthening mathematics education at all levels from school to university in order to increase its visibility in society.**

A second outcome: A Book on Success Stories in Mathematics and Industry (Oct. 2011)

- To show the key contribution of mathematics to the industrial creation of value when addressing complex systems
- To show the process that has driven successful partnerships
- To show that it can and has been done
- To promote mathematics in society for educational purpose

Example: Same mathematical solution applied in several companies



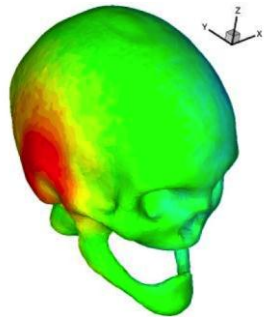
Imbalance Estimation in Rotating Machinery

- In most cases the balancing of rotating machinery is a time consuming and expensive process.
- Modern mathematical methods allow researchers to reduce the vibration of rotators.
- The developed methods have been used in industry, e.g., with
 - **RollsRoyce** (for reconstruction of imbalances in aircraft engines)
 - **Siemens** Automation and Drives (for generators)
 - **Oerlikon Leybold** (for vacuum pumps)
 - **BerlinWind** (for wind power plants).

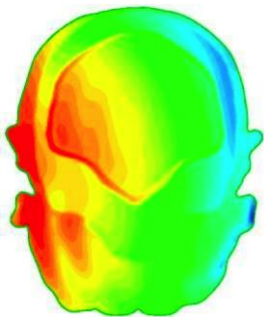


Mathematical solutions applied in health hazards

Modeling of human head exposure to electromagnetic waves



- This research project was concerned with the numerical modeling of the propagation of an electromagnetic wave emitted by a mobile phone throughout the head tissues.
- The research partnership has led to the development of a new modeling approach that could save lives.



Mathematical solutions applied in everyday's life

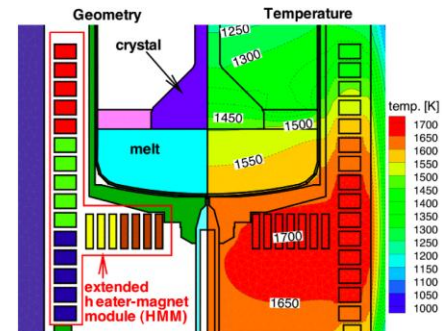
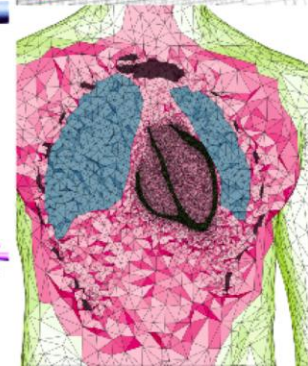
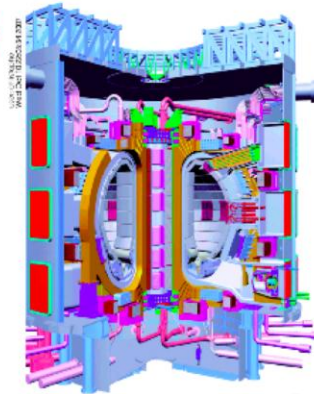
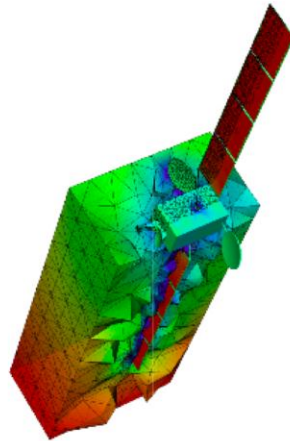
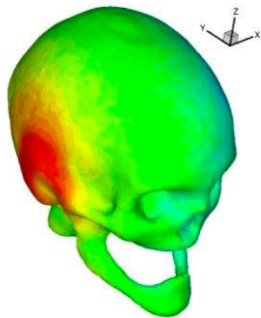
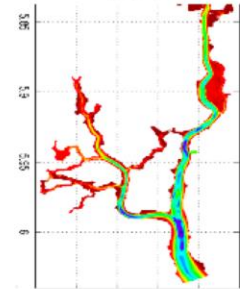
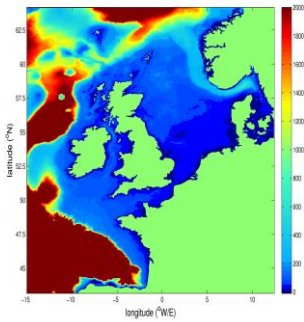
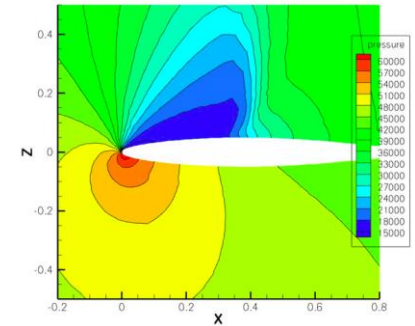
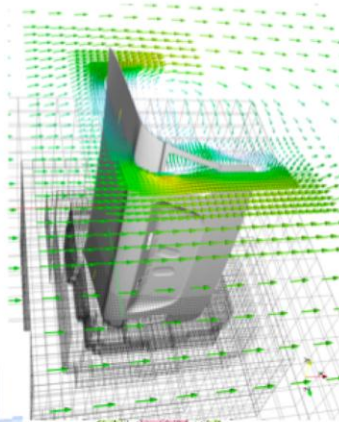
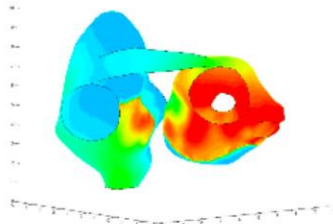
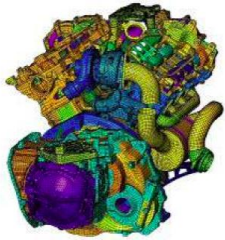
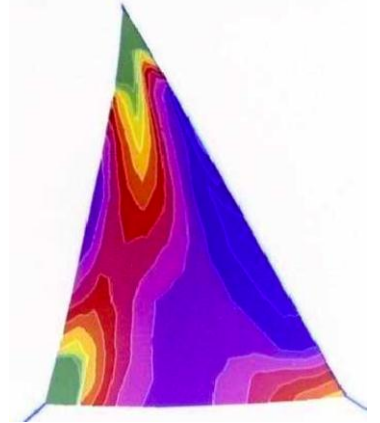
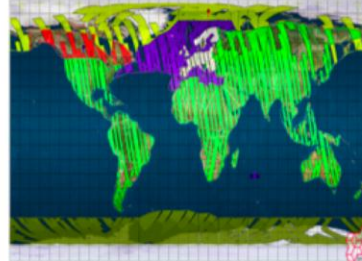
Optimisation of Public Transport Systems



- The decision, planning, and optimization problems arising in public transport are highly complex and often of gigantic size.
- It has resulted in **spin-off companies** providing today mathematical tools that are employed worldwide.
- **Hundreds of million Euros are saved in this way annually. These tools have become best practice industry standards**



Many other examples (>130) in our book





Implementation plan: An EC Proposal to design a European Infrastructure of Mathematics for Innovation (1/2)

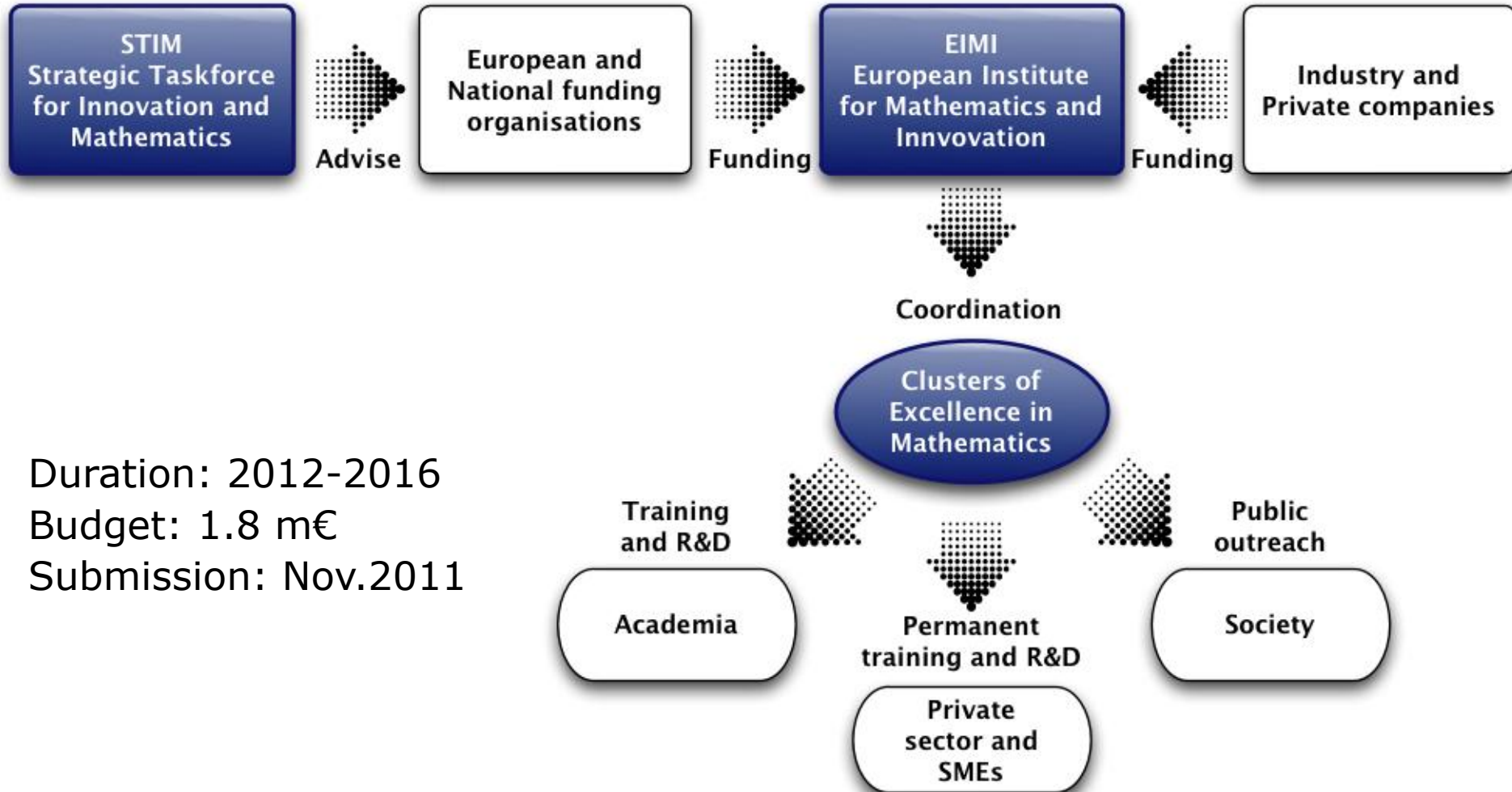
E-infrastructure

- **to provide services** to users of mathematical technology in companies and academic institutions
- **through comprehensive data infrastructures** (libraries, databases, algorithms and software).

will also support knowledge transfer, simulation and prototyping services to industry



Implementation plan: An EC Proposal to design a European Infrastructure of Mathematics for Innovation (2/2)

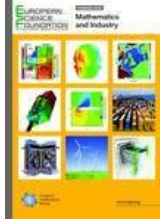


Duration: 2012-2016
Budget: 1.8 m€
Submission: Nov.2011

A New Roadmap

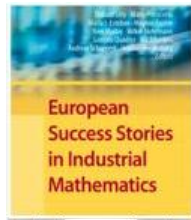
ESF Forward Look on "Mathematics and Industry"

2009 – 2011



FLMI Report & Book

2010 – 2012



Irish EIMI + EC VEIMI Projects

2012 – 2017



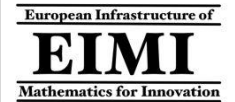
Horizon 2020

2014 – 2017



EIMI + Horizon 2020

2016 – 2017



Scoping Phase (ESF-EMS)

2008 – 2009



2009

2010

2011

2012

2013

2014

2015

2016

EIMI Timeline



An example of a French implementation of
FL recommendations :

AMIES (Agence pour les mathématiques en Interaction
avec l'Entreprise et la Société)

Particular context of the « Investissements d'Avenir »
(Grand Emprunt):

Build or reinforce excellence academic centers
(networks allowed in some rare cases)



French bodies at the origin of the project : CNRS, SMAI

Project awarded « Laboratoire d'Excellence »,
Spring 2011 (only math project in the top list)

Network involving all math labs nationwide,
all mathematical fields



Programs of AMIES are very much inspired by existing or projected tools in Europe:

- Study groups (for PHD Students)
- Network of technological translators to connect academia and enterprises
- Support to exploratory projects
- Databases and showcase of training programs and local expertises
- Lobbying towards funding agencies (ANR) to support Math-industry programs



Conclusion:

- Europe is the right scale to promote/support Math/industry programs (market vs science)
- Need infrastructure, to build a community, disseminate information, implement common tools