



147 European Study Group with Industry (147 ESGI)

The 147 European Study Group with Industry (ESGI) was held from 8th to 12th of April 2019 at the Faculty of Mathematics of the University of Santiago de Compostela ([USC](#)), thanks to the collaboration between the Spanish Network for Mathematics & Industry ([math-in](#)) and the Technological Institute for Industrial Mathematics ([ITMATI](#)).

Initiated in Oxford in 1968, Study Groups with Industry provide a forum for industrial scientists to work alongside academic mathematicians on problems of direct industrial relevance. They are an internationally recognized method of technology and knowledge transfer between academic mathematicians and industry.

The success of the ESGI is the unique format which has been copied around the world, in which mathematics community works on reduced groups to study problems, proposed by industry. These problems are presented from any economic sector thanks to the Mathematics' transversally. The objective is to present the capabilities of Mathematicians and the applicability of Mathematics in a large part of the challenges and needs of the industrial, bringing small, medium and large companies a technology with great potential, with highly qualified researchers and that does not require large investments to use.

This simple format has proved its value again and again: companies from diverse industries have benefited from the insights gained through mathematical analysis of their problems, while mathematicians with diverse interests have benefited from the exciting research opportunities presented by unsolved problems with practical significance.

Therefore, collaboration between industry experts and researchers is a key to addressing technological innovation problems into a mathematical successful. The realization of ESGI contributes to the promotion of mathematics and awareness of companies to use Mathematics to improve their processes.

GOALS:

- to find solutions and insights into existing industrial problems;
- to establish lasting and productive working links between applied mathematicians and industry;
- to propose new lines of research based on business challenges;
- to reinforce the importance of mathematics in industry and to open new jobs of mathematical profile in companies; and

**Instituto Tecnológico
de Matemática Industrial**

www.itmati.com

Edif. Instituto Investigaciones Tecnológicas, planta -1
Rúa de Constantino Candeira s/n.
15782 Campus Vida / Santiago de Compostela.
itmati@itmati.com | Telf.: +34 881 813 357



- to stimulate greater awareness in the wider community of the power of mathematics in providing solution paths to real-world problems.

INDUSTRIAL PROBLEMS

In the 147 ESGI three problems were presented:

■ **PROBLEM 1: Optimum sample sizes for reflectivity sampling in solar field**

- **Academic Coordinator:**
 - [Javier Martínez Torres. Associate Professor at International University of La Rioja \(UNIR\)](#)
 - [Javier Roca Pardiñas. Associate Professor at UVigo and affiliated researcher of ITMATI](#)
- **Business Coordinator:** [Alejandro Parra Martín. R & D Project Manager](#)
- **Description:** The goal is to find out the average reflectivity of the mirrors of a solar field with a P precision (normally of 95%) and a e/μ relative error (normally of around 0.1%).

The field is composed of several sections, in each of which there is a N_j number of mirrors, for which the μ_j average reflectivity and the σ_j dispersion are known.

The main objective is to figure out the minimum number of mirrors (m_j) to be sampled from each of the mentioned sections so that the number of total samples (m) is the minimum possible.

- **Further information:** [147 ESGI \(problem 1\)](#).

■ **PROBLEM 2: Identification of control parameters of wind turbine**

- **Academic Coordinators:** [Fernando Varas Mérida. Professor at the Department of Applied Mathematics in Aerospace Engineering, Polytechnic University of Madrid \(UPM\)](#)
- **Specialist:**
 - [Eva Balsa Canto. Permanent researcher at the \(Bio\)Process Engineering Group at the IIM-CSIC.](#)
 - [Carlos Vilas Fernández. IIM-CSIC.](#)
 - [Miriam Rodríguez García. IIM-CSIC.](#)

Instituto Tecnológico
de Matemática Industrial

www.itmati.com

Edif. Instituto Investigaciones Tecnológicas, planta -1
Rúa de Constantino Candeira s/n.
15782 Campus Vida / Santiago de Compostela.
itmati@itmati.com | Telf.: +34 881 813 357



- **Business Coordinator:**
 - [Héctor Burgueño Rueda. CFD Engineer at Solute](#)
 - [Eduardo Jané Soler. Project Engineer at Solute](#)
- **Description:** The problem consists in the identification of control parameters of a wind turbine given its aeroelastic model, assuming certain control logic and using measures of the response of the state variables and control of such turbine in operation.

The aim is to obtain a solid, robust and efficient procedure to identify the control parameters for a given linearized wind turbine dynamic model.

- **Further information:** [147 ESGI \(problem 2\).](#)

■ **PROBLEM 3: Modelling of a continuous casting machine**

- **Academic Coordinator:** [Elena Martín Ortega. Associate professor at Universidad de Vigo and affiliated researcher of ITMATI.](#)
- **Business Coordinator:** [José Miguel Caamaño Castro. Engineering and R & D Department at Estaños y Soldaduras Senra S.L.U.](#)
- **Description:** Modelling of a continuous casting machine for the cooling and conforming in cylinders of tin-based alloys. It is a multi-physical problem, with two states of the material, solid and liquid, coexisting in the same space. Two situations should be studied in the transitory regime, the initial filling of the machine with molten metal and then the drag produced in the molten material as a consequence of the extraction of a part of the solidified metal.

The main purpose is to determinate the optimal operating parameters in which the solidification occurs without trapping air bubbles inside the cylinders.

- **Further information:** [147 ESGI \(problem 3\).](#)



PARTICIPATING ENTITIES AND ENTERPRISES

- [TSK](#)
- [SOLUTE](#)
- [Estaños y Soldaduras Senra](#)

SCIENTIFIC COMMITTEE

- Alonso Ayuso, Antonio. Professor of the Department of Computer Science, Computer Architecture, Languages and Computer Systems, Statistics and Operational Research, University of Rey Juan Carlos (URJC) and member of math-in.
- Armesto González, Julia. Associate Professor in the Department of Natural Resources Engineering and Environment, University of Vigo, Affiliated researcher of ITMATI.
- Barral Rodiño Patricia. Associate Professor in the Department of Applied Mathematics, University of Santiago de Compostela. Affiliated researcher of ITMATI.
- Francisco Fernández, Mario. Associate Professor in the Department of Mathematics University of A Coruña. Affiliated researcher to ITMATI
- Rapún Banzo, María Luísa. Professor of the Department of Mathematics Applied to Aerospace Engineering, Polytechnic University of Madrid (UPM) and secretary of math-in.

**Instituto Tecnológico
de Matemática Industrial**

[**www.itmati.com**](http://www.itmati.com)

Edif. Instituto Investigaciones Tecnológicas, planta -1
Rúa de Constantino Candeira s/n.
15782 Campus Vida / Santiago de Compostela.
[**itmati@itmati.com**](mailto:itmati@itmati.com) | Telf.: +34 881 813 357



ORGANIZING COMMITTEE

- Casal Nogueira, Yago. Technology transfer Manager of the Spanish Network for Mathematics-Industry (math-in).
- Castro Novo, Adriana. Coordinator of the Transfer Management Unit of ITMATI.
- Francisco Fernández, Mario. Associate Professor in the Department of Mathematics of the University of A Coruña. Affiliated researcher to ITMATI.
- Tomoni, Raluca Silvana. Technology transfer and innovation manager of ITMATI.

CALL FOR COMPANIES

An open call for companies who want to present an industrial problem in 147 ESGI was carried out.

Companies from different industrial sectors had the opportunity to benefit from the insights gained through mathematical analysis of their problems. If a company needs to reduce production costs, innovate its processes or improve its services, then could present a problem to the lead mathematicians to brainstorm new ideas and work towards practical solutions.

Each company benefited from the work carried out by the participants, the direct interaction with academics, the participation of international researchers from entities of recognised prestige, and the written report on the problem.

The submission of the industrial problem was free, but there had been a charge for each problem selected by the Scientific Committee for the Study Group. The level set this year for the 147 ESGI was 800 € + VAT (except for math-in associated companies, who have enjoyed a reduced price of 400€ + VAT). This was to cover all organization running costs and to ensure a proper development of 147 ESGI.

Further information: <http://www.math-in.net/147esgi/en/companies>

**Instituto Tecnológico
de Matemática Industrial**

www.itmati.com

Edif. Instituto Investigaciones Tecnológicas, planta -1
Rúa de Constantino Candeira s/n.
15782 Campus Vida / Santiago de Compostela.
itmati@itmati.com | Telf.: +34 881 813 357



FURTHER INFORMATION AND SCHEDULE: <http://www.math-in.net/147esgi/en/program>

Opening ceremony:

- Mrs. Elena Vázquez Cendón. Dean of the Faculty of Mathematics (USC)
- Mrs. Peregrina Quintela Estévez. Director of ITMATI and President of math-in
- Mr. Juan Manuel Cividanes Roger. General Director of the Galician Institute for Economic Promotion (IGAPE).

Schedule:

	Monday		Tuesday-Thursday		Friday
09:00 09:30	Reception of participants	09:00 11:00	Group Work	09:00 11:00	Group Work
09:30 10:00	Opening Ceremony				
10:00 10:35	P1 presentation				
10:35 11:10	P2 presentation				
11:10 11:40	Coffee break				
11:40 12:15	P3 presentation	11:00 11:30	Coffee break	11:00 11:30	Coffee break
12:15 12:40	Distribution of the Groups				
12:40 13:30	Group Work				
13:30 15:30	Lunch				
15:30 18:30	Group Work				

**Instituto Tecnológico
de Matemática Industrial**

www.itmati.com

Edif. Instituto Investigaciones Tecnológicas, planta -1
Rúa de Constantino Candeira s/n.
15782 Campus Vida / Santiago de Compostela.
itmati@itmati.com | Telf.: +34 881 813 357



SUMMARY OF THE ACTIONS

147 ESGI concluded with a successful participation and results: the participating researchers managed to find solutions to the three industrial problems. The three companies that posed challenges related to thermosolar sector, wind turbine industry and the improvement of industrial processes in the manufacturing industry were: TSK, Solute and Estaños y Soldaduras Senra. Technologies such as big data, machine learning and MSO (Modeling, Simulation and Optimization) are behind the solutions, since to reach the automation of the processes first mathematical methodology is needed. Converting a sum of complex calculations in a simplified model without losing accuracy, finding the expression of a physical phenomenon in which numerous variables participate or looking for the relationship between the data collected by sensors are some of the tasks that a mathematician has to address before the machines can get to do their job.

147ESGI had 52 participants coming from institutions from four different countries (Spain, Germany, Bulgaria, and France) and seven nationalities, who managed to find solutions to the three industrial problems: 8 participants from companies, 9 PhD students, 7 master students and 22 researchers and/or teaching staff. Number of female attendees: 21.

Number of participants per country (taking into account the institution they come from):

Nº.	Country	Number of attendees
1	Spain	45
2	Germany	5
3	Bulgaria	1
4	France	1

Number of participants per country (nationality):

Nº.	Country	Number of attendees
1	Spain	45
2	India	2
3	Cuba	1
4	Bulgaria	1
5	Netherlands	1
6	Georgia	1
7	Poland	1


**Instituto Tecnológico
de Matemática Industrial**

www.itmati.com

Edif. Instituto Investigaciones Tecnológicas, planta -1
Rúa de Constantino Candeira s/n.
15782 Campus Vida / Santiago de Compostela.
itmati@itmati.com | Telf.: +34 881 813 357



PROMOTIONAL POSTER OF THE ACTION






European Study Group with Industry
147 ESGI
8-12 April, 2019 - Santiago de Compostela



Optimum sample sizes for reflectivity sampling in solar field




Identification of control parameters of wind turbine



Modelling of a continuous casting machine

REGISTER NOW!!
<http://www.math-in.net/147esgi/en/registration>

Faculty of Mathematics | Santiago de Compostela
More info | <http://www.math-in.net/147esgi/>



Funded by the Horizon 2020 Framework Programme of the European Union






FACULTAD DE MATEMÁTICAS



XUNTA DE GALICIA



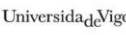
Igapec



UNIVERSIDADE DA CORUÑA



USC



Universidade de Vigo

Instituto Tecnológico
de Matemática Industrial

www.itmati.com

Edif. Instituto Investigaciones Tecnológicas, planta -1
Rúa de Constantino Candeira s/n.
15782 Campus Vida / Santiago de Compostela.
itmati@itmati.com | Telf.: +34 881 813 357

REPORT AND PHOTOGRAPHS: <http://www.itmati.com/en/147-esgi-concluded-successful-participation-and-results>



Opening Ceremony for the 147 ESGI



1st Problem presentation: Optimum sample sizes for reflectivity sampling in solar field.

**Instituto Tecnológico
de Matemática Industrial**

www.itmati.com

Edif. Instituto Investigaciones Tecnológicas, planta -1

Rúa de Constantino Candeira s/n.

15782 Campus Vida / Santiago de Compostela.

itmati@itmati.com | Telf.: +34 881 813 357



2nd Problem presentation: Identification of control parameters of wind turbine.



3rd Problem presentation: Modelling of a continuous casting machine

**Instituto Tecnológico
de Matemática Industrial**

www.itmati.com

Edif. Instituto Investigaciones Tecnológicas, planta -1

Rúa de Constantino Candeira s/n.

15782 Campus Vida / Santiago de Compostela.

itmati@itmati.com | Telf.: +34 881 813 357



Problem 1 Working Group: Optimum sample sizes for reflectivity sampling in solar field.



Problem 2 Working Group: Identification of control parameters of wind turbine.

**Instituto Tecnológico
de Matemática Industrial**

www.itmati.com

Edif. Instituto Investigaciones Tecnológicas, planta -1

Rúa de Constantino Candeira s/n.

15782 Campus Vida / Santiago de Compostela.

itmati@itmati.com | Telf.: +34 881 813 357



Problem 3 Working Group: Modelling of a continuous casting machine

MENTIONS IN MEDIA

- [El Pais](#) (10/04/2019)
- [USC](#) (8/04/2019)
- [Xunta de Galicia](#) (8/04/2019)
- [Europa Press](#) (8/04/2019)
- [Galicia Press](#) (8/04/2019)
- [Capital](#) (8/04/2019)
- [IGAPE](#) (8/04/2019)
- [RSME](#) (8/04/2019)
- [SCCB](#)
- [USC](#)
- [USC](#)
- [ECMI](#)
- [ICIAM 2019](#)
- [ICIAM 2019- Twitter](#) (4/02/2019)
- [SGAPEIO](#)
- [MI-NET](#)

**Instituto Tecnológico
de Matemática Industrial**

www.itmati.com

Edif. Instituto Investigaciones Tecnológicas, planta -1
Rúa de Constantino Candeira s/n.
15782 Campus Vida / Santiago de Compostela.
itmati@itmati.com | Telf.: +34 881 813 357



- [La Voz de Galicia](#) (20/08/2018)

PRESS RELEASES

- PRESS RELEASE: “During a week mathematical experts will try to solve real business problems” ([click here](#))
- PRESS RELEASE: “Mathematics prove to be effective in metallurgy, energy sector and industrial processes” ([click here](#))

ORGANIZERS

Spanish Network for Mathematics & Industry ([math-in](#)) and the Technological Institute for Industrial Mathematics ([ITMATI](#)). Co-organizer: [COST Action Mathematics for Industry Network \(MI-NET\)](#).

[COST Action TD1409, Mathematics for Industry Network \(http://mi-network.org/\)](#), granted by the European Cooperation in Science and Technology ([http://www.cost.eu/](#)), co-financed this event.



Cost is supported by the EU Framework Programme Horizon 2020

The 147 ESGI was also co-funded by:

- the Ministry of Economy, Industry and Competitiveness – State Research Agency with the n° of reference MTM2016-81745-REDT through the Thematic Network RTMath-in, granted within the call “Networks of Excellence” 2016,
- Galician Institute for Economic Promotion (IGAPE) from the Reginal Government of Galicia
- the Strategic Network in Mathematics with the n° of reference MTM2016-81711-REDE and by
- ROMSOC project, financed by the EU within the Horizon 2020 Research and Innovation Programme under the Marie-Skłodowska-Curie grant agreement No 765374.

**Instituto Tecnológico
de Matemática Industrial**

www.itmati.com

Edif. Instituto Investigaciones Tecnológicas, planta -1
Rúa de Constantino Candeira s/n.
15782 Campus Vida / Santiago de Compostela.
itmati@itmati.com | Telf.: +34 881 813 357



SPONSORS



Funded by the Horizon 2020 Framework Programme of the European Union



**Instituto Tecnológico
de Matemática Industrial**

www.itmati.com

Edif. Instituto Investigaciones Tecnológicas, planta -1

Rúa de Constantino Candeira s/n.

15782 Campus Vida / Santiago de Compostela.

itmati@itmati.com | Telf.: +34 881 813 357



FURTHER INFORMATION

The International Center for Doctoral and Advanced Studies of the USC (CIEDUS) **recognized this activity as a training course from the Doctorate Programs:** "Mathematical Methods and Numerical Simulation in Engineering and Applied Sciences (USC-UVigo-UDC)" and "Statistics and Operational Research (USC-UVigo - UDC)". According to the involvement of the PhD students in the preparation of the conclusions and the proceedings of the event, there have been two modalities: Basic 147 ESGI (1.5 ECTS) and Advanced 147 ESGI (4 ECTS).

For students enrolled in the **Master of Industrial Mathematics (M2i)**, jointly delivered by the University of Santiago de Compostela (USC), University of A Coruña (UDC), University of Vigo (UVigo), Carlos III University of Madrid (UC3M) and Technical University of Madrid (UPM), the appropriate procedures were also carried out, so that this event could be considered as a training course within the official program of the mentioned master.

Furthermore, the UDC, USC and UVigo recognized the 147ESGI a **training activity for the teaching and research staff.**

PREVIOUS ESGIs

Since 2013 the Spanish Network for Mathematics & Industry (math-in) and the Technological Institute for Industrial Mathematics (ITMATI) have been developing European Study Groups with Industry in close collaboration. These are the previous events co-organized between the two entities:

- [97 ESGI](#)
- [110A ESGI](#)
- [122 ESGI](#)
- [139 ESGI](#)

All the information related to this event is available on the 147 ESGI website: <http://www.math-in.net/147esgi/en>

**Instituto Tecnológico
de Matemática Industrial**

www.itmati.com

Edif. Instituto Investigaciones Tecnológicas, planta -1
Rúa de Constantino Candeira s/n.
15782 Campus Vida / Santiago de Compostela.
itmati@itmati.com | Telf.: +34 881 813 357