INEVITABLE

European Commission

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# Training materials

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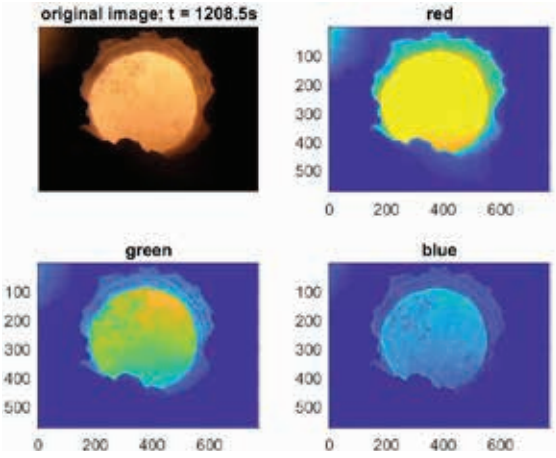
## List of training materials with short description.

To ensure that INEVITABLE project results are fully accepted and utilized by industrial process industry personnel, training materials have been created for new and existing training programs.

### Image analysis methodology

In this presentation, a range of image-analysis methods from industrial process surveillance data are presented. These involve a brief introduction of the example use case from steel industry to illustrate the approaches, the basic methodology for a robust detection of a region of interest (ROI) in image data with Matlab, particle image velocimetry (PIV) applications to industrial process videos within the tools Matlab and Labview, and machine learning algorithms and the application of convolutional neural networks to industrial image data.





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| Document pdf DOI | 10.13140/RG.2.2.26686.36162 |
| Document ppt DOI | 10.13140/RG.2.2.19320.52482 |
| Responsible partner | K1-MET |
| Target groups | • Students of technical subjects, approximately late Bachelor or Master level<br>• R&D personnel of industrial partners working on implementations of image analysis in industrial contexts |

## Mathematical modelling basics

theoretical and data-based methods for modelling of mainly technical dynamic systems. In the first part, methods based on fundamental physical and equilibrium laws are discussed, while in the second part, methods that are based on a black box approach are presented. The use of this principles is shown on modelling electrical, mechanical, hydraulic, and thermal processes.

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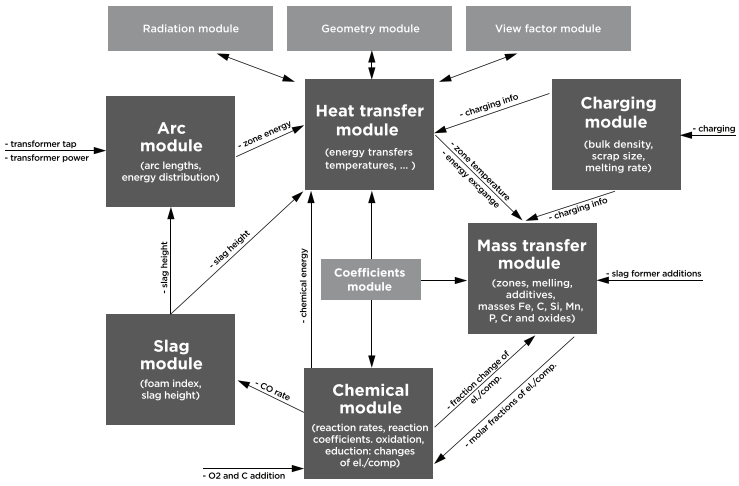
| **Document pdf DOI** | **10.13140/RG.2.2.28364.08320** |
| **Document ppt DOI** | **10.13140/RG.2.2.26031.41126** |
| **Responsible partner** | **UL** |
| **Target groups** | • **Students of electrical engineering (automation, process control, process industry)** |

## Theoretical and data-based modelling of the EAF process

In this presentation, an approach to theoretical and data-based modelling of the EAF process is presented. The first approach is used to develop a model of a complete EAF operation, covering all crucial phenomena during the steel-recycling process. The second approach is used to develop an EAF model, which relates to only a few crucial process values, such as the bath temperature and dissolved oxygen content in the bath during the refining stage of the EAF operation.

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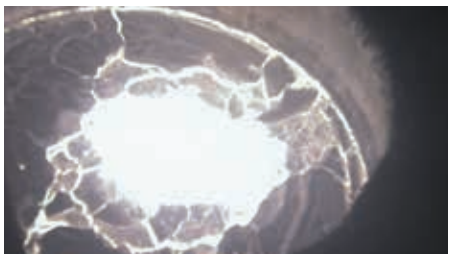
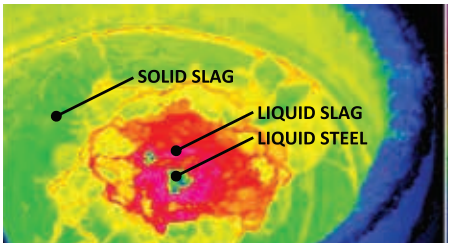
| **Document pdf DOI** | **10.13140/RG.2.2.13264.58881** |
| **Document ppt DOI** | **10.13140/RG.2.2.12609.63847** |
| **Responsible partner** | **UL** |
| **Target groups** | • **Students of electrical engineering (automation, process control, process industry)** |

## Camera-based monitoring systems and process models of BFI for process industry

In this presentation, a camera-based monitoring system is presented, which is combined with dynamic process models, for online advice for processes where liquid melts are treated, e.g. steel or aluminum manufacturing processes. The presentation gives an overview over camera systems and monitoring by means of image analysis as well as dynamic process models in general and possible applications in process monitoring and control. It focuses on the stirring monitoring for liquid steel refining. As an example, the process model for monitoring and control of steel desulphurization are described in more detail.



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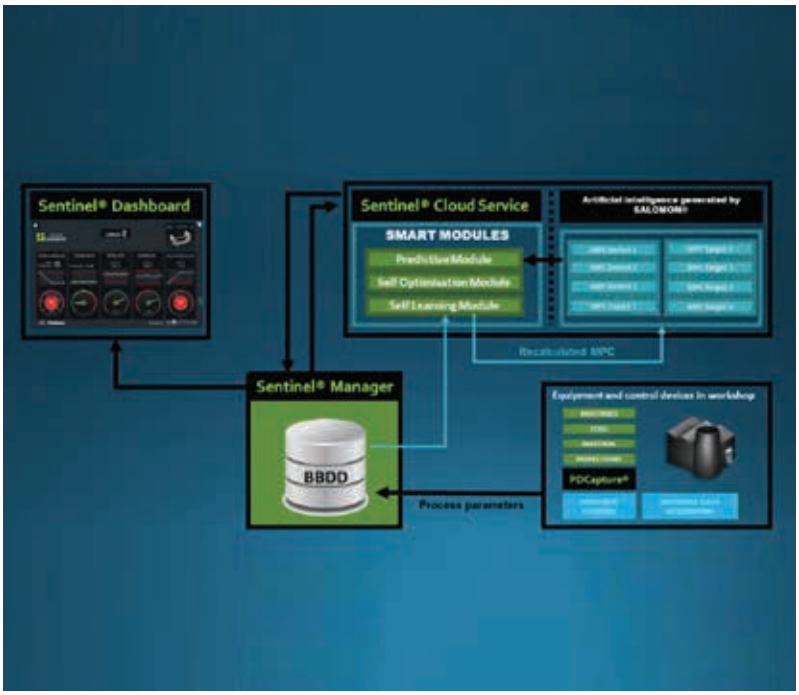
| **Document pdf DOI** | **10.13140/RG.2.2.20788.12161** |
| **Document ppt DOI** | **10.13140/RG.2.2.34420.01921** |
| **Responsible partner** | **BFI** |
| **Target groups** | • **Metal industry personnel** |

## Digitalization strategies in metallurgical industry

In this presentation, some digitalization strategies in metallurgical industry are presented. It covers the key aspects for a successful implementation of a digital and cognitive systems, the deployment of its potential through the organization, different stages of the digitalization starting from the digital audit that identifies specification and requirements for digitalization, benchmarks the situation of all process stages in terms of digitalization and establishes an action plan for implementation.

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| Document pdf DOI | 10.13140/RG.2.2.16620.03206 |
| Document ppt DOI | 10.13140/RG.2.2.20998.24642 |
| Responsible partner | AZT |
| Target groups | • IT personnel in different process industries |

## Evaluation of inclusion characteristics by connecting offline characterization with online monitoring tools

In this presentation, online monitoring tools for evaluating the non-metallic inclusion (NMI) characteristics during the steelmaking operations are given. It focuses on several rapid and online monitoring methods for evaluating NMIs based on composition analysis. A case study from the Inevitable project is demonstrated to showcase the importance of the concept.

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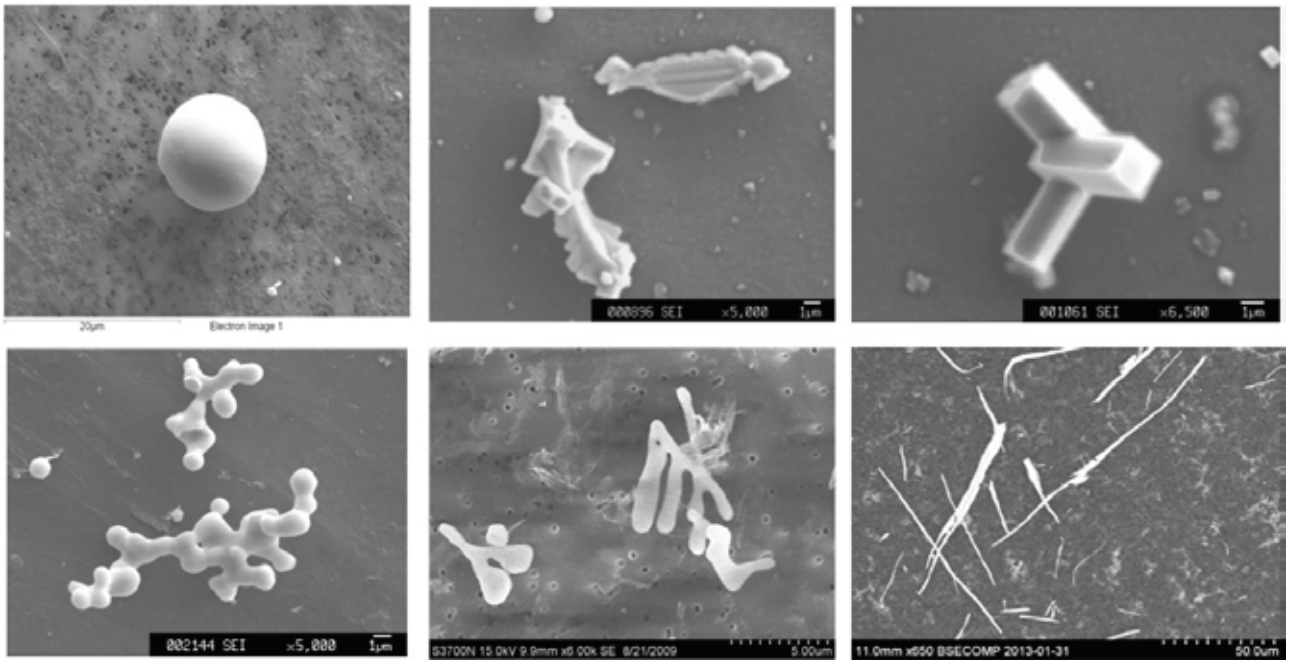
| Document pdf DOI | 10.13140/RG.2.2.12399.51367 |
| Document ppt DOI | 10.13140/RG.2.2.21837.10725 |
| Responsible partner | KTH |
| Target groups | • University students and steel-plant operators |

## Modification of non-metallic inclusions using calcium treatment during the secondary steelmaking process

In this presentation, calcium treatment during the secondary steelmaking process is presented. It focuses on the modification of the non-metallic inclusions, which can be used to improve the calcium treatment process, i.e. using modified calcium injection, solid alumina and spinel inclusions in liquid globular calcium aluminate inclusions. With the optimum modification of non-metallic inclusions, problems of nozzle clogging in casting operations do not occur. A case study associated with the Voestalpine steel plant is demonstrated to justify the above concept.



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| Document pdf DOI | 10.13140/RG.2.2.34209.89443 |
| Document ppt DOI | 10.13140/RG.2.2.10931.91688 |
| Responsible partner | KTH |
| Target groups | • University students and steel-plant operators |

## Process digitalization, data infrastructure and cases of use

In this presentation, steps towards process digitalization and data infrastructure are presented, split into three connected topics, i.e. digitalization basics, communication, and industrial IoT. The first topic introduces the digitalization topics, and the challenges that companies face on the path to digitalization. The second topic covers the data infrastructure part and the Industrial IoT, as well as the basics of the Siemens MindSphere environment. The third topic focuses on the methodology developed in the scope of the WP5 of the INEVITABLE project.


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| Document pdf DOI | 10.13140/RG.2.2.23488.20487 |
| Document ppt DOI | 10.13140/RG.2.2.31064.57604 |
| Responsible partner | SIEMENS |
| Target groups | • OT managers, OT operators<br>• Security specialists, analysts,<br>• Production data owners |