Grace

inteGration of pRocess and quAlity Control using multi-agEnt technology

Work Package 6

Dissemination and Exploitation

Deliverable D6.2

Rolling Dissemination and Exploitation Report

Document type	:	Deliverable
Document version	:	Final
Document Preparation Date	:	10/01/2012
Classification	:	Public
Author(s)	:	AEA
File Name	:	Deliverable D6.2.pdf

Project Ref. Number	:	246203
Project Start Date	:	01/07/2010
Project Duration	:	36 months
Website	:	www.grace-project.org

Project founded by the European Commission under the "Seventh Framework Programme" (2007-2013)

Contract n° NMP2-SL-2010-246203

Rev.	Content	Resp. Partner	Date
0.1	Structure of the document and preliminary descriptions of the activities	AEA	10/12/2011
0.2	Chapters completed	AEA	30/12/2011
0.3	Comments from partners inserted	AEA	09/01/2012
0.4	Final Revision	AEA	10/01/2011

Table of Contents

1. Introduction

Deliverable 6.2 is the second output of WP6- "Dissemination and Exploitation", whose overall objectives are to disseminate the results obtained from the project to the scientific and industrial communities, to coordinate the exploitation of the technologies and the solutions coming out of the project and to pursue standardization of the GRACE technology.

The GRACE project was born with the aim of improving the future manufacturing industry; for this reason new concepts and technological results will have an impact on the manufacturing process and, then, on the final product, improving the consumers quality of life. It is therefore important to publish and disseminate the results through the most efficient channels, according to the target.

At month 18 (December 2011), the GRACE project reached the halfway mark of its work, with almost all the WPs running in parallel (with the only exception of WP5, starting in four months), so that also the Dissemination and Exploitation activities are in a very important phase. Therefore, the specific objective of D6.2 "Rolling Dissemination and Exploitation Report" is to summarize all the dissemination activities carried out by all the project partners over the first 18 months of the project and to introduce the exploitation strategy outlined during the first months of Task 6.2 (started at M13).

Furthermore, this deliverable presents tools and approaches used in order to disseminate the results and the knowledge gained thanks to the project. Some indicators are also suggested in order to assess the efficacy of the various dissemination actions.

The present document is organized as follows.

In Section 2, an overview of the approach and the objectives of the dissemination activities is presented.

In Section 3, the main outputs of the first 6 months of the dissemination activities are shortly recalled and summarized, as they have been already presented in the Deliverable 6.1.

Section 4 focuses on the website maintenance activity, which is constantly pursued with the aim of keeping the website updated with the last project outcomes, the publication of

news and events, communication of results and so on. The website indexing was also improved.

Sections 5 reports on a 2-days workshop organized in order to present the GRACE project and possible applications of the Multi-Agent technology, while section 6 describes the international conferences selected to disseminate the project results and the produced scientific contributions..

Sections 7 and 8 concern the internal dissemination, respectively reporting the list of project technical meetings and coordination meetings, and all the deliverables submitted.

In Section 9, some preliminary parameters able to monitoring the dissemination activity effectiveness are defined and the first results reached are shown.

In Section 10, the focus is on the dissemination plan for 2012, concerning fairs and events, contributions at international conferences, journal papers, update and creation of new dissemination material and the possible interaction with other related NMP Projects.

The last section is dedicated to the exploitation plan, concerning the management of the technologies and of the solutions coming out of the project.

2. Dissemination approach and objectives

This section defines the methodology adopted to implement the GRACE dissemination plan referring to what already planned in the “Description of Work” document.

The GRACE dissemination activity can be divided into two parts: internal and external dissemination.

The internal dissemination concerns instruments and activities addressed to the consortium partners, as reserved area, document templates and internal technical meetings.

The external dissemination includes instruments and activities as brochures and website, scientific publications, fairs and conferences, newsletters and other technical and communication material (video, images etc.). The external dissemination has different

targets and it will use the aforementioned tools depending on the objectives and the specific target to be reached.

In the dissemination activities, three different levels can be defined: awareness, understanding and action.

First, it is important to create **awareness** on the project, its objectives and its results. Scientific publications and participation to conferences and other events are the first steps moved by the consortium in the first part of the project.

The next step will be to select the target interested in **understanding** the project, its development and its results, improving the audience and the network of figures interested in it, gaining important feedbacks from the conversations about the project.

Then, it will be possible to reach the third level of dissemination that means **action**, change of practice. This important step involves, for example, industries that will perceive the importance of the project and its outcomes in order to improve their production processes.

According to the first level of the dissemination activities, from the beginning of the project (July 2010) different documents to allow the initial communication of the project and the tools useful for the activities of the partners (i.e. website reserved area and document templates) have been realized.

From 2012, when the first results achieved with the project will be available, more focused and interesting dissemination activities will begin, according to the 2nd level of dissemination.

Target groups of the project as industry, research centres, academia and decision makers at international level will be precisely defined, in order to address the third level of dissemination.

3. Dissemination Activities M1-M6

The dissemination activities carried out during the first 6 months of the project are shortly summarized hereafter as they have been already presented in the Deliverable 6.1.

Project brand image is fundamental for the project promotional activities and to build a clear reputation and identification of the project. To this aim a strong logo, brochure, poster and various document templates have been developed. First of all, the logo has been chosen, among different proposals, and it has been the base for the design of the corporate image, with styles and colours for templates including letters, presentations, web site, etc. After that, brochure and poster have been realized, to allow the project partners promoting the communication of the concepts developed in GRACE.

As described in the deliverable 6.1, important activities have been successfully carried on with the following outputs:

a. Logo

Figure 1 - The GRACE logo

GRACE logo focuses on the concepts of production line and multi-agent architecture, which are the core of the GRACE project. In the logo, the name is written in lowercase, apart from the first letter, in order to highlight it from the simple acronym, giving physical substance to the GRACE project. The blue colour is associated to calm and confidence and it embodies the innovative concepts of the project which focuses on self-learning, self-adaptation and self-optimization characteristics. The two lines above the name ‘Grace’

represent the integration between the concept of the old production line and the new one, where a Multi-Agent architecture has been integrated. Agents, in charge of process and quality control, are represented as differently coloured round elements. The logo as a whole gives the idea of movement according to the evolution of the process, the sharing of the information and the adaptability of the control characterizing the GRACE project.

b. Brochure and poster

To promote the dissemination of GRACE project brochure and poster have been designed, as two communication tools available to partners, containing information about the project, the partners, the contract and the European Commission.

Figure 2 - GRACE brochure and poster

The **brochure** consists in an A4 format folded into three parts.

The cover has the GRACE name, with the graphical elements, the expansion of the acronym and further information about the contract and the European Commission, which finances part of the project.

Figure 3 - GRACE brochure

Opening the leaflet, the description and the vision of the GRACE project, with a representative image, can be found on the left. Information about the partners can be found on the right. Opening this last page, other two pages contain information about the objectives and the benefits of the GRACE project. On the back, the last page shows the contacts of the Project Coordinator, the Scientific/Technical Project Manager and the Dissemination Project Manager.

This leaflet has been printed and delivered to all the partners, in order to distribute it during events, fairs and seminars. The pdf format is also available for the download on the website.

Figure 4 - GRACE poster

Furthermore, to contribute to the dissemination of the GRACE project a **poster** has been designed, with dimensions (width x height) 70x100 cm. It is composed of three parts: the GRACE logo and website link at the top, a description of the project, the explanation of the architecture and the list of benefits in the central part and, at the bottom, the logo of the partners involved in the project, the contacts of the project coordinator and the information about the contract and the European Commission, which finances part of the project. The poster has been printed and distributed to all the partners, to be displayed within their laboratories or used in fairs or events.

c. Documents templates

For the daily activities of the project important tools such as letterhead, presentations and documents template are needed.

Figure 5 - GRACE letterhead and deliverable template

The letterhead is fundamental for the official communication concerning the project. At the top, the GRACE project letterhead is composed of the GRACE logo, the EU Commission and 7th Programme logos, the contract number and the GRACE website address. At the

bottom, there are the partners logos under a light blue line, which is a section of the GRACE logo.

A deliverable template, with GRACE logo and information about the contract, has been created also. To ensure the right use of the template, clear instructions are created, with information about fonts and styles of every element (cover, titles, text, images etc.)

A similar approach has been used to create a template for presentations.

Figure 6 - GRACE template for presentations

d. Website

One of the most efficient ways for dissemination is considered to be the public website. It is the best tool to spread information about the GRACE project activities and it is designed to improve both ease of use and information completeness.

The URL is http://grace-project.org and it is reported in all dissemination materials produced for GRACE, so that people can be redirected to the website to find further details about the project.

In the website it is possible to recognize the same graphical elements designed for the GRACE dissemination activities: from the logo to the colors used for titles and the website design.

Figure 7 shows a screenshot of GRACE website homepage, where it is possible to gain information on the GRACE project at a glance. At the top, in the header, the visitor can see the project name, its meaning and the contextualization of the research program.

Figure 7 - GRACE website homepage

Below the header there is the upper menu, to visit all the website sections, and a slideshow with images offering an emotional idea about the scope of the project, its vision and objectives.

Under the slideshow it is possible to see the last updates published about the project and, at the bottom, the logos of the partners involved in the project.

Finally, on the right side, there is the section with the latest news and events and the link to the reserved area.

e. Reserved area

In the website home page there is also the link to access the **reserved area**. This area is restricted to the steering and technical committees of the project and it is the platform for managing and sharing documents about the GRACE project.

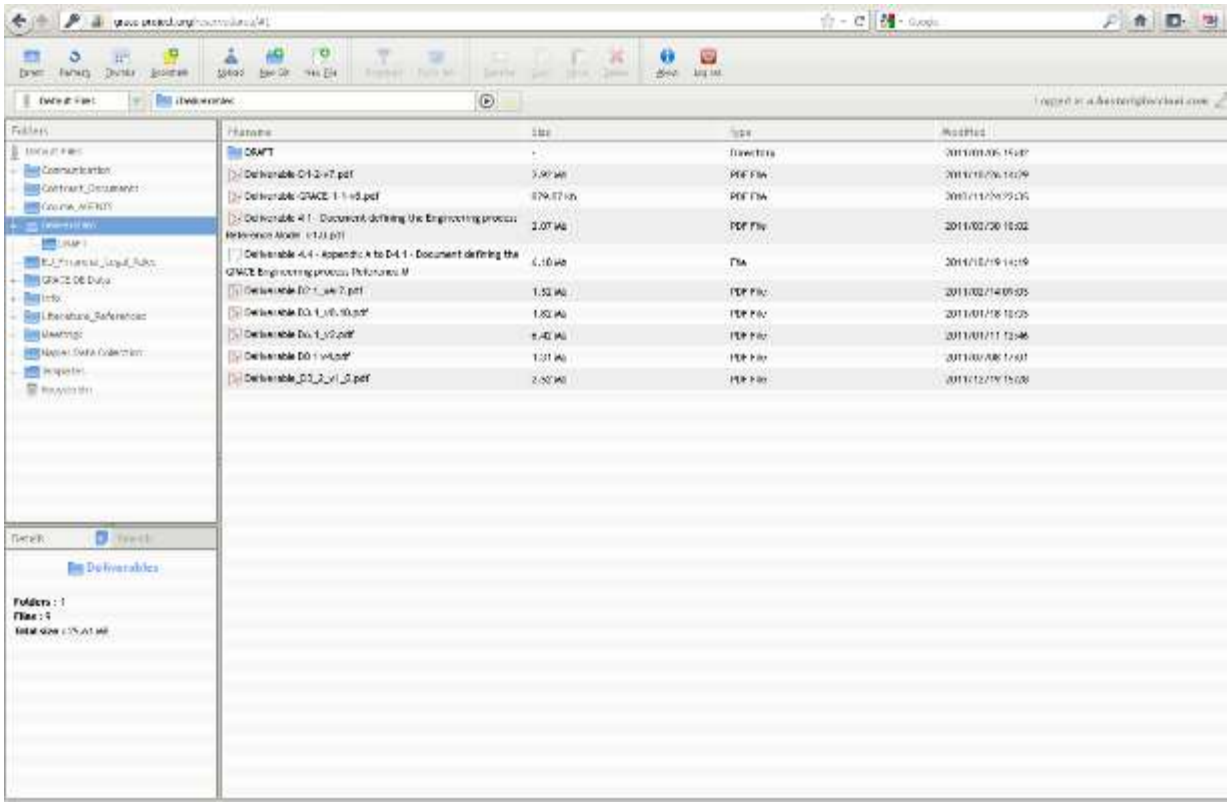


Figure 8 - Reserved area

This area contains reserved documentation about communication, contract documents, deliverables, EU financial legal rules, literature references, minutes and presentations of the meetings, template and some other information. The reserved area is a useful tool and consortium partners update it with documents and other material required for the project.

4. Website Maintenance

Since its birth the website has been updated, in particular the sections regarding news, events, download and publications.

Each section has been enriched with the latest information and documents.

In the news and events section 13 posts about deliverables and conferences concerning the dissemination of GRACE project have been published over the last year, listed hereafter.

NEWS

Deliverable 3.2, December 19th, 2011

Deliverable 1.2, November 8th, 2011

Deliverable 8.1, July 13th, 2011

Deliverable 4.1, March 31st, 2011

Three new deliverables!, February 18th, 2011

EVENTS

GRACE review meeting, December 6th -7th, 2011

GRACE exploitation seminar, December 5th, 2011

GRACE lands in Australia!, October 14th, 2011

GRACE at HoloMAS 2011, September 19th, 2011

INDIN'11: first GRACE simulation, July 26th, 2011

Seminar on Agent Technologies, July 19th, 2011

Second Technical Coordination Meeting in Trondheim, June 23rd, 2011

First Milestone accomplished!, February 15th, 2011

In the two following images, examples of a typical post layout is presented; figure 9 represents a part of the home page where the latest news published are highlighted. Each box contains the title, the date, an image and an introduction to the news.

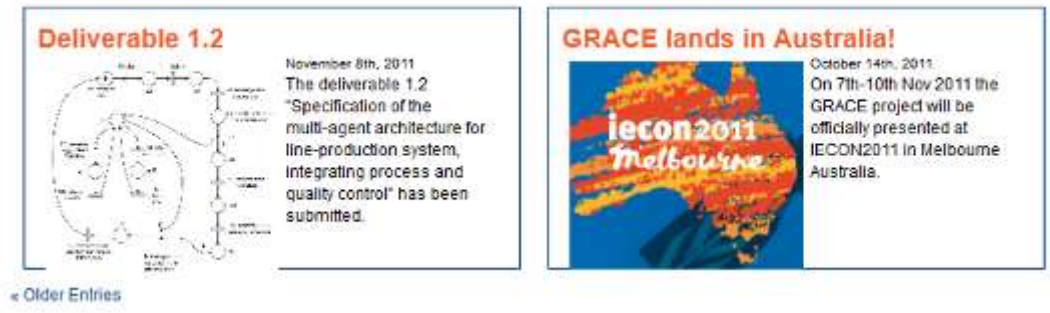


Figure 9 –Example of latest posts.

Furthermore, by clicking on the box it is possible to read the whole article and get the complete information.

Figure 10 - GRACE website example of article

Inside each article there is the link to the previous or next article and below the two boxes, in the homepage, there is a link to the older entries, so that the visitor can get all the published information.

Publications and download sections have also been updated with new documents.

An important action that will be put in place between January and February 2012 is the improvement of the indexing of the site, to simply find the website by search engines.

5. Workshops

A two days intensive course on Multi-Agent System was organized and held by Prof. Paulo Leitao (IPB) at the premises of Faculty of Engineering of Università Politecnica delle Marche, Ancona (Italy), on 21st- 23rd September 2011.

The main topics addressed during the course were:

- ✓ Introduction to Multi-Agent Systems (MAS)
- ✓ Agent architectures

- ✓ Interaction among agents and communication
- ✓ Ontologies to support communication
- ✓ Integration with physical and legacy systems
- ✓ JADE framework for the development of MAS solutions
- ✓ Practical development following a project-based learning

As shown in Figure 11, the course was organized in three theoretical modules and a complete practical class project structured in five progressive modules. During the classes, the attendees were also provided with teaching material, the needed software and examples of Java exercises for the practical part.

The course was opened to all the interested project partners, students, PhD students and teaching staff of Università Politecnica delle Marche, for a total of 15 attendees.

Module 1 Introduction to MAS: definition and properties of an agent, typologies, MAS, interactions, advantages and disadvantages.	**Module 5:** Formal representation of behaviours. Ontologies to support the knowledge sharing.
Module 2: Applications, road blockers and future trends. Development languages: functionalities and available frameworks. JADE: description and provided tools.	**Module 6:** Practical exercises using JADE. Exercises n. 6 and 7.
Module 3: Practical exercises using JADE. Exercises n. 0, 1, 2 and 3.	**Module 7:** Practical exercises using JADE. Exercises n. 8.
Module 4: Practical exercises using JADE. Exercises n. 4 and 5.	**Module 8:** Practical exercises using JADE. Exercises n. 9 and 10.

Figure 11 Intensive Course on Multi Agent System Overview (Blue – theory; pink – practical in class project)

6. Scientific Publications

The principal technological and scientific outcomes of the GRACE project, mainly obtained over the first year and half of activities, have been already submitted and presented in four different International conferences in the area of Control, Industrial Informatics and Intelligent Manufacturing Systems and one National Conference. Other works are currently being planned or in preparation, to be submitted and presented at International Conferences during the next year (2012). Details about future planned publications can be found in section 10 “Dissemination plan for 2012”.

Due to limited funds and resources, International conferences and journals are selected in order to make as more effective as possible the dissemination activities which aim at

- using these events as platforms to promote the project and project partners
- gathering relevant contacts from which the project could benefit

In the following, the five selected conferences where the accepted works have been presented are listed and shortly described.

- HoloMAS 2011 is the 5th international conference on Industrial Applications of Holonic and Multi-Agent Systems, whose focus is on bringing together researchers active in the area of holonic and multi-agent systems together with key engineers and industrial decision makers to share their views and experience in **design, development** and **applying** holonic and multi-agent systems for industrial problems

Conference Venue and Date: Toulouse (France) - August 29th – 31st , 2011

GRACE Contribution:

Title: Multi Agent System for on-demand Production integrating production and quality control

Authors: Paulo Leitao (IPB), Nelson Rodriguez (IPB)

Abstract: Multi-agent systems are being pointed as particularly suited to design and engineer a new class of control systems to operate at the factory plants addressing the current requirements of modularity, flexibility and reconfigurability. This paper introduces the main principles of a multi-agent system approach to support the integration of production and quality control processes in washing machines production lines being developed under the EU FP7 GRACE project.

- INDIN 2011 is the IEEE 9th International Conference on Industrial Informatics, focusing on the state of the art and future perspectives of industrial information technologies, where industry experts, researchers, and academics share ideas and experiences surrounding frontier technologies, breakthrough and innovative solutions and applications. The aim of the conference is to bring together researchers and practitioners from industry and academia and provide them with a platform to report on recent developments, deployments, technology trends and research results, as well as initiatives related to industrial informatics and their application.

Conference Venue and Date: Lisbon (Portugal), July 26-29, 2011

GRACE Contribution:

Title: Simulation of Multi-Agent manufacturing systems using agent-based modelling platform

Authors: Paulo Leitao (IPB), José Barbosa (IPB)

Abstract: Multi-agent systems (MAS) are driving the way to design and engineer control solutions that exhibit flexibility, adaptation and reconfigurability which are important advantages over traditional centralized systems. The understanding, design and testing of such distributed agent-based approaches, and particularly those exhibiting self-* properties, are usually a hard task. Simulation assumes a crucial role to analyse the behaviour of MAS solutions during the design phase and before its deployment into the real operation. Particularly, Agent-Based Modelling (ABM) tools are well suited to simulate MAS systems that exhibit complex phenomena, like

emergent behaviour and self-organization. This paper discusses the simulation of agent-based manufacturing systems and introduces the advantages of using ABM tools. The NetLogo platform is used to illustrate the benefits of such tools in the manufacturing world on the specification of a MAS system for a washing machine production line.

- IECON 2011 is the 37th Annual Conference of the IEEE Industrial Electronics Society, focusing on industrial and manufacturing theory and applications of electronics, controls, communications, instrumentation and computational intelligence. The objectives of the conference are to provide high quality research and professional interactions for the advancement of science, technology, and fellowship.

Conference Venue and Date: Melbourne (Australia), November 7th -10th , 2011

GRACE Contribution:

Title: Towards the integration of process and quality control using Multi-Agent technology

Authors: P. Castellini (UNIVPM), C. Cristalli (AEA), M. Foher (SIEMENS), P. Leitao (IPB), N. Paone (UNIVPM), I. Schjolberg (SINTEF), J.Tjønnås (SINTEF), C.Turrin (WHIRLPOOL), T. Wagner (SIEMENS)

Abstract: The paper introduces a vision on design of distributed manufacturing control systems for production using the multi-agent principles to enhance integration of the production control with the quality control processes. It is highlighted how agent technology may enforce interaction of manufacturing execution system and distributed control system, enhancing the exploitation of the available information at the quality control and process control levels. A specific focus is made on a suitable engineering methodology for the design and realization of such concept. Innovation is also presented at the level of adaptive process control and self-optimizing quality control, with examples related to a home appliance production line.

- ETFA 2011 is the 16th IEEE International Conference on Emerging Technologies and factory Automation. The ETFA conference series is the prime and largest IEEE-sponsored event dedicated to factory automation and emerging technologies in industrial automation.

The aim of the ETFA conference series is to provide researchers and practitioners from industry and academia with a platform to report on recent developments in the newly emerging areas of technology and their potential applications to factory automation.

The GRACE contribution was accepted at the **Special Session on Engineering Processes Exploiting Mechatronical Thinking**

Conference Venue and Date: Toulouse (France), September 5-9, 2011

GRACE Contribution:

Title: Development of a method to analyze the impact of manufacturing systems engineering on product quality

Authors: Matthias Foehr (SIEMENS), Arndt Lüder, Tobias Jäger, Alexander Fay, Thomas Wagner (SIEMENS)

Abstract: Product quality is a key performance indicator for manufacturing systems with growing importance. Among others it strongly depends on manufacturing properties and parameters defined within the engineering process of the manufacturing system creating these products. Thus, manufacturing systems engineering quality directly influences product quality. To control the reachable product quality within the engineering process, the dependencies between engineering process, manufacturing system, and product have to be known and used within the engineering process as guidance. Within this paper a method is described to be used to analyze the dependency of product properties and, thereby, product quality from engineering activities.

- Conferenza Nazionale AIVELA 2011 is the Italian event devoted to non-contact measurement techniques and non-destructive diagnostics.

Conference Venue and Date: Bertinoro (Italy), December 1st -2nd , 2011

GRACE Contribution: only an oral presentation; full paper submission is required by March 31st 2012; conference proceedings will be published later in 2012.

Title: Vibrometro Laser Doppler Adattivo per la Diagnostica Industriale (Adaptive Laser Doppler Vibrometer for industrial Diagnostics)

Authors: Nicola Paone (UNIVPM), Stefano Serafini (UNIVPM)

Abstract: It is presented a self-adaptive laser vibrometer designed to maximize optical signal amplitude when measuring on any optically rough surface. The system makes use of scanning mirrors for slightly displacing the laser beam on the target surface, so to search for a spot where optical signal is maximum; this process is controlled by a down-hill optimization algorithm. The same scanning mirrors allow to perform target point search and pointing, under the control realized by a camera based pattern matching strategy, so to compensate target object mis-positioning, as it is typically necessary on a production line.

7. Project Technical Meetings

An important role of the scientific and technical coordination is the organization of Coordination and Technical Meetings, in order to solve and facilitate the communication among the partners.

The list of technical meetings organized in the first year of activity of the GRACE project is reported below.

Date	Meeting	Location	Participants
2 July 2010	Preliminary coordination meeting	AEA	AEA, UNIVPM, WHI
21 Sept. 2010	Technical meeting	WHI-Cassinetta	AEA, UNIVPM, WHI
29-30 Sept. 2010	Technical meeting	WHI Cassinetta	ALL
2–3 Nov. 2010	Technical meeting + visit to factory	WHI-Naples	ALL
23 Nov. 2010	Technical meeting	AEA	AEA, UNIVPM

2 Dec. 2010	Technical meeting	AEA	AEA, UNIVPM (WHI and SINTEF by conf. call)
26-27-28 Jan. 2011	Technical meeting at factory	WHI-Naples	AEA, WHI, UNIVPM
27-28 April 2011	Technical workshop	WHI-Cassinetta	WHI, SIEMENS
3-4 May 2011	Technical meeting	WHI-Cassinetta	AEA, WHI, SINTEF
13-14 June 2011	Technical meeting	IPB	IPB, WHI
20-21 Sept. 2011	Technical meeting	UNIVPM	UNIVP, AEA, IPB, SINTEF, WHI
10 Nov. 2011	Technical meeting	Australia	SIEMENS, IPB
14-16 Nov. 2011	Technical meeting at factory	WHI	WHI, AEA, UNIVPM

The Plenary technical Co-ordination meetings organized are the following and were held every 6 months approximately, as from the workplan.

List of Project Co-ordination Meetings

Date	**Co-ordination Meeting**	**Location**	**Participants**
22-23 July 2010	Kick-off meeting	AEA	ALL
8-9 Feb. 2011	Co-ordination meeting	IPB	ALL
21-22 June 2011	Co-ordination meeting	SINTEF	ALL
6-7 Dec. 2011	Review meeting	SIEMENS	ALL

Meeting presentations are available to all the partners on the website reserved area.

8. Deliverables and Deliverable Summaries

One of the principal dissemination means of the GRACE Project, both internal and external, are Project deliverables which are technical reports describing the activities carried out and the main outputs obtained in the various workpackages. The Task leaders are in charge of producing and revising those technical documents related to their specific tasks, with the contribution of all the project partners. As stated in the “Description of Work” document, public deliverables and deliverable summary documents are made available for download on the GRACE public website right after the EU Commission has accepted them.

At the end of Month 18 (December 2011), a total of 8 Deliverables have been produced (5 Public, 3 Confidential, not considering the present deliverable D6.2). Public deliverables

and summaries of the confidential ones are available for download at the "Download" page of the GRACE website (http://grace-project.org/index.php/download/).

Here follows the list of Deliverables with a summary of their content .

8.1. Public Deliverables List

Deliverable 1.1 "Report with the requirements of multi-agent architecture for line production system and production on-demand"

Date of Submission: November 2010

Task Leader: IPB

Task: T1.1 "Analysis of characteristics and requirements of the multi-agent architecture for line-production systems and production on demand"

Deliverable Summary:

Task 1.1 had two main objectives:

- Definition of the needs and requirements for the Distributed Manufacturing System (DMS) and the desirable features it provides.
- Description of the production process for the washing machines that will be used in the specification of the multi-agent system architecture.

Deliverable 1.1 is organized in two main parts. The first part provides a contextualization of the problem addressed in this document and some definitions to clarify important concepts used during the project. This guarantees an easy reading and understanding of the different contributions coming from the different partners and representing different domains.

The second part is dedicated to the specification of the requirements for DMS, with particular attention to the line-production systems. The requirements are numbered and specified by using a common approach which facilitates its understanding and the posterior analysis. The discussion of these requirements will lead to their classification into different categories, according to their dependencies and similarities.

Deliverable 1.2 "Specification of the multi-agent architecture for line-production system, integrating process and quality control"

Date of Submission: October 2011

Task Leader: IPB

Task: T1.2 "Specification of the multi-agent architecture"

Deliverable Summary:

Task 1.2 aims at giving a complete specification of the multi-agent architecture, integrating the production and quality control processes, and also taking into account the requirements and the process control information defined in the Task 1.1.

Several methodologies were introduced in the literature to support the specification and engineering of multi-agent systems, such as AALAADIN (Ferber and Gutknecht, 1998) and GAIA (Wooldridge et al., 2000), which is probably the best known methodology. These methodologies have their principles on object-oriented programming, and present some limitations, namely they neither directly deal with particular modelling techniques and nor deal with implementation issues. In this way, the methodology used to specify the GRACE multi-agent architecture follow the one proposed in ADACOR (ADAptive holonic COntrol aRchitecture for distributed manufacturing systems) (Leitão and Restivo, 2006), which is composed of three main steps:

- The identification of the types of agents and their roles and functions (based on the analysis of the requirements elaborated in Task 1.1).
- The specification of individual behaviours (by using a formal language, namely the Petri nets formalism that is suitable to model dynamic, concurrent behaviours).
- The specification of the interaction patterns and cooperation/coordination mechanisms (by using Unified Modelling Language (UML) sequence diagrams and communication diagrams) for modelling the overall behaviour of the multi-agent system that emerges from the interactions among its individuals.

The definition of the multi-agent architecture follows the IEEE FIPA (Foundation for Intelligent Physical Agents) specifications (see http:www.fipa.org/) which is a standard in the field of multi-agent systems.

Deliverable 3.2 "Self-optimizing/self-adapting quality control agents"

Date of Submission: December 2011

Task Leader: UnivPM

Task: T3.2 "Development of self-optimization at the level of measurement system in order to reduce measurement uncertainty and to increase output information confidence level"

Deliverable Summary:

This Deliverable outlines the main characteristics of the prototypes of quality control (QC) systems that have been developed during this first part of the GRACE project.

The *Measurement System* term is used to globally denote the hardware and software components able to acquire a physical quantity, such as sensors and transducers and the relative mechatronic devices used to handle the measurement, the data acquisition electronic boards for the signal A/D conversion and the software environment for the setting of the system parameters (like sampling frequencies, acquisition time windows, gains, sensor set-up, etc.). The output of the Measurement System is the Measured Signal (numerical representation of the physical quantity object of the measurement).

A fundamental prerequisite to obtain the highest level of confidence on the output of a quality control station is to **minimize measurement uncertainty**. Therefore, the problem of choosing the optimal set of parameters of a measurement system can be considered, by all means, as an Optimization/Optimal estimate problem. In this context **optimization** algorithms can be used to find the optimal configuration of the measurement system parameters, in optimal (theoretical) measurement conditions. Those algorithms can be used

off-line both during the QC system design and set-up phases and periodically, during the normal activity of the production line.

Self-adaptation is a concept employed to denote the search for the optimal configuration of system parameters, subject to real measurement conditions, that usually differ from the theoretical ones and can be seen as local displacement of the optimal solution. Adaptive techniques can therefore be employed on-line, during normal functioning of the production line, in order to iteratively approach the local minimum of the measurement uncertaintywhich depends on specific measurement conditions.

The main characteristic of the QC systems developed in GRACE project is that they are designed to exhibit self-optimizing and self-adapting behaviours. The QC system selected for demonstration of the GRACE project were:

1. Drum geometry control station
2. Vision inspection stations
3. Vibration and noise control station
4. Functional testing

Each of them is described in Deliverable 3.2.

Deliverable 4.1 "Document defining the engineering process reference model"

Date of Submission: March 2011

Task Leader: SIEMENS

Task: T4.1 "Definition of the engineering process reference model"

Deliverable Summary:

In WP4 a new engineering methodology for decentralized manufacturing systems based on the GRACE Multi-Agent System platform will be developed. The main objective here is to identify the impact of GRACE new control concepts on manufacturing engineering activities,

to create suitable and effective engineering concepts for decentralized automation, and to render them applicable for industrial applications.

Subject of task 4.1 is the definition of a general engineering process reference model for manufacturing systems which is developed and evaluated in domains like automotive production lines and its adaptation/extension towards a detailed GRACE specific engineering process for home appliance production lines including process and quality control.

This deliverable has been split in two parts. **The first part** will contain the definition of a general engineering process reference model, which is applicable for a high number of engineering domains in factory automation like automotive, home appliance, consumer goods, etc. This first part is available as a public document. The **second part** contains

- Analysis of washing machines Whirlpool factory : process, production line structure, equipment, process and quality control functions
- Analysis of engineering workflows for home appliance production lines using Whirlpool factory example or similar examples in the same domain (using expert interviews and documentation)
- Structured collection of critical factors in engineering based on an existing standardized criteria catalogue
- Integration of analysis results to engineering process reference model for home appliance production line

The second part of the document is only available to the project partners due to confidentiality of Whirlpool specific information.

Deliverable 6.1 “Project presentation”

Date of Submission: December 2010

Task Leader: AEA

Task: T6.1 “Dissemination of results”

Deliverable Summary:

The specific objective of D6.1 “Project Presentation” is to describe the activities carried out during the first semester to promote the organization, the objectives and the main activities of the GRACE project.

To the purpose, the GRACE logo, created by the joint collaboration of the technical committee and a professional designer, is presented in Chapter 2, where its meaning is also explained. Chapter 3 describes the GRACE poster and brochure that are available for download on the website and will be used as printed material to disseminate GRACE vision and objectives in international conferences, workshops and other public events.

Finally Chapter 4 describes the GRACE website, which has been developed and that will be constantly updated with the aim of reporting on the objectives and on the progress of the project and showing the achieved results.

8.2. Confidential Deliverable List

Deliverable 2.1 “Specification for self-adaptation and self-optimization mechanisms in WM production”

Date of Submission: February 2011

Task Leader: SINTEF

Task: T2.1 “Definition of the case study for self-adaptation and self-optimization mechanisms”

Deliverable Summary:

An important objective of the GRACE project is to analyze, develop and implement self-adaptation and self-optimization in manufacturing systems and assembly processes, both at a local and global level. The main motivation for this is to increase process modularity, flexibility and improve the handling of unpredictable changes in the production process.

In this report the focus is on exploring how these functionalities can be implemented at a local level of the factory and by local level is meant the floor and cell levels. Moreover, one or more processes from the Whirlpool production line for washing machines will be used as a case study.

At the local level the project will consider adaptation and optimization of the operation of manufacturing and assembly resources. By resources it is meant machines operating along the production line. Each machine is controlled by local controllers based on simple control functions handled for instance by standard PID controllers. These controllers are often delivered by the system suppliers as part of the total system. More advanced control structures may be implemented on top of the simple controllers by specifying low level references, s in order to achieve more robust systems.

To be able to implement more advanced control structures access to both system measurements and control signals are required. This may in some cases be a challenge as the software and hardware components often are delivered in a closed non-accessible system.

In addition to the process on the shop floor level and cell level, adaptation and optimization of the final product operation will be studied and analyzed.

Deliverable 3.1"Specification for testing and quality control functions in the WM production"

Date of Submission: January 2011

Task Leader: AEA

Task: T3.1 "Definition of quality control functions and specifications of the case study"

Deliverable Summary:

The overall objective of the WP3 is to develop quality control agents which perform the functions of product testing and quality control (measurement, diagnosis and classification), designed to implement adaptive procedures at the level of measurement system and to be

integrated into the multi-agent architecture so to support adaptation at the level of manufacturing system and/or product.

The specific objective of D3.1-"Definition of quality control functions and specifications for the case study" is to define which quality control systems will be the main object of activities during the project, to describe their main characteristics in terms of desired performance and to highlight the mechanisms that will allow to have these systems operating in the Multi Agent Systems (MAS).

A fundamental preliminary step for this selection is an in depth analysis of the production cycle and of mechanisms of data gathering and sharing along the washing machine production line, taken as reference in the GRACE project. This detailed overview will be used as a reference document for the development of the GRACE project all over the different work packages.

The main concepts of optimization applied to quality control systems, which are a combination of measurement systems and post-processing algorithms for signal diagnosis are recalled. The issue of measurement uncertainty which is the main concern when dealing with measurement systems, and of "learning from experience" fundamental to guarantee flexibility, is also highlighted. The level of confidence on the output of a quality control station is strongly correlated to the measurement uncertainty which is therefore a quantity to be known and possibly minimized. Optimization will therefore imply an estimate of measurement uncertainty and its management in order to achieve the required level of confidence on the output from the quality control system.

The deliverable also describes the quality control systems that are candidate for the future development in GRACE project, in WP3. For each of them the specific function, its general architecture, its main characteristics and the possible flow of information will be highlighted.

Deliverable 8.1 "First Technical Report"

Date of Submission: June 2011

Task Leader: AEA

Task: T8.1 “Scientific and technical coordination”

Deliverable Summary:

This report describes the progress and main achievements of GRACE project during the first 12 months. The GRACE project has a total duration of 36 months, therefore this report describes the achievements of the first part of the project; during this first year the main work-packages have started and are progressing in parallel.

In particular, the main overall objective is to realize a cooperative multi agent system (MAS) operating at all stages of a manufacturing system, integrating process control with quality control. This challenging objective requires parallel developments for:

1. the Multi-Agent Architecture which is the object of WP1;
2. the Self-Adaptation and Self-Optimization mechanisms at local and global level, which are dealt with in WP2;
3. the Modular and Self-Optimizing Quality Control which are treated in WP3;
4. the Engineering methodology which is studied in WP4.

All these 4 technical/scientific work packages have started according to the program and have already brought to some Deliverables. These documents contain full detail of the results achieved and the research carried out to reach them. The scope of this report is not therefore to present the same details contained in each Deliverable to which the reader should refer for a comprehensive description of each part of the research; this report is rather intended to provide the overall view on the project progress.

9. Measurement of dissemination activities

An initial set of indicators able to demonstrate the success of the dissemination activities has been identified and they will be monitored for the whole duration of the project.

New indicators will be added taking into account the new dissemination activities planned for the next year.

a. Numbers of conferences and feedback received

This parameter is able to show the presence of the project in the research and innovation scenario. From the beginning of the project 5 conferences has been attended, as outlined in Section 6

Positive feedbacks and interest have been received after the presentations.

b. Number of scientific publications

This is another parameter able to demonstrate the presence of the project in the research and innovation scenario. Since July 2010, scientific publications have been published on conference proceedings.

c. Web statistics

The GRACE website, powered by Wordpress, is registered at Google Analytics, so it is possible to check and register information about the visitors' access to the website.

Thanks to the analytics service it has been possible to monitor the website visits from December 2010 to December 2011.

The most significant indicators that have been analysed are the following:

- 1817 visitors

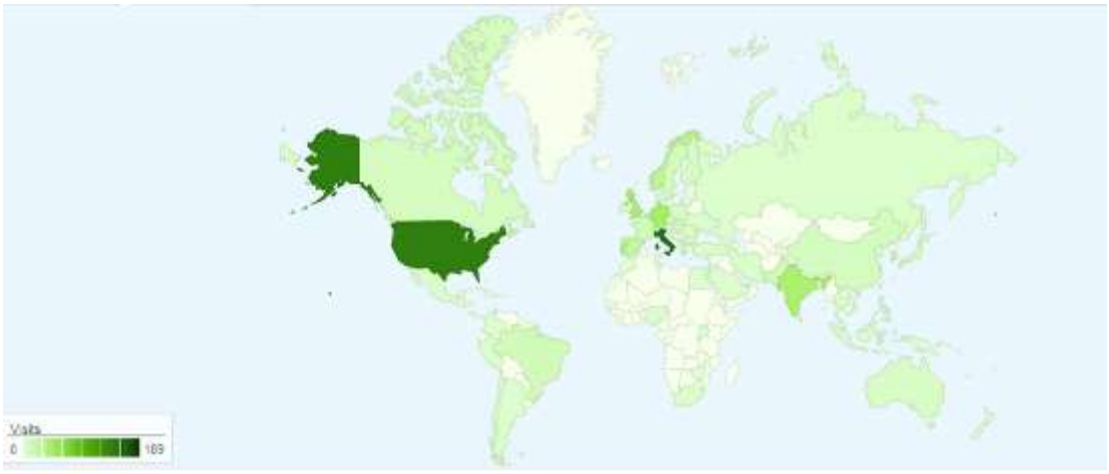
- 4818 page-views

- several visits from countries not involved in the GRACE project, especially from United States.

This is an important result if we consider that limited promotional activities for the website have been put in place.

Visits	1.817	
Unique Visitors	1.303	
Pageviews	4.818	
Pages/Visit	2,65	
Avg. Time on Site	00:02:24	
Bounce Rate	58.56%	
% New Visits	1.299	71.49%
%Returning Visitor	518	28.51%

Country/Territory	Visits
Italy	540
United States	249
Portugal	108
Germany	100
India	74
Norway	73
United Kingdom	69
Belgium	56
Spain	35
Russia	35
South Korea	23



A comparison between the number of visits of the first six month and the last six months of 2011 has been also performed and, as it is possible to see, the visits are increasing.

	01.01.2011 - 30.06.2011	**01.07.2011 - 28.12.2011**
Visits		
Search Traffic	377	**658**
Direct Traffic	188	**312**
Referral Traffic	144	**138**
Unique Visitors		
Search Traffic	294	**546**
Direct Traffic	124	**207**
Referral Traffic	104	**110**
Pageviews		
Search Traffic	790	**1310**
Direct Traffic	830	**1200**
Referral Traffic	356	**332**
Pages/Visit		
Search Traffic	2,1	**1,99**
Direct Traffic	4,41	**3,85**
Referral Traffic	2,47	**2,41**
Avg. Time on Site		
Search Traffic	00:01:21	**00:01:16**
Direct Traffic	00:04:28	**00:04:51**
Referral Traffic	00:02:21	**00:02:18**
% New Visits		
Search Traffic	73,21%	**79,48%**
Direct Traffic	59,57%	**63,14%**
Referral Traffic	65,97%	**69,57%**

Focusing on the Countries, there is a particular increase in visits from South Korea.

Visits	01.01.2011 - 30.06.2011	**01.07.2011 - 28.12.2011**
Italy	199	341
United States	111	138
Germany	28	72
India	30	44
United Kingdom	33	36
Portugal	40	68
Spain	14	21
South Korea	4	23
Norway	35	38
Netherlands	13	16

d. Number of contacts

These parameters are related to the number of contacts derived from the website visits.

An interesting contact is the one from the German University of Cairo to the Università Politecnica delle Marche that brought to have a student at the Università Politecnica delle Marche for a three months stage related to the GRACE topics. The student, Samar El-Baharawi, was interested in mechatronics and discovered about the project by browsing on the web; she was then involved in image processing for on-line diagnostics of appliances.

10. Dissemination plan for 2012

2012 will be a very important and challenging year for the GRACE Project dissemination activities. Indeed, the beginning of this year corresponds with the halfway mark of the project and it represents the moment in which all the four technical and research workpackages (WP1, WP2, WP3 and WP4) have reached a consolidated level of maturity in their activities and consolidated scientific results. Therefore, those results can be now shared with both the industrial and the scientific communities, at a European and at an international level.

For this purpose, dissemination activities already started in the first phase of the project - like website and other dissemination material updating - will be pursued and strengthened all over the next 12 months; in particular, the production of scientific publications for international conferences and journals will be intensified, so as the interaction with other FP7-NMP projects. Moreover, the participation to two international fairs and the preparation of a GRACE video are also planned.

The detailed dissemination plan for 2012 is described in the following paragraphs.

a. Fairs and events

The following International fairs in the field of Industrial automation and Industrial technologies will be attended.

- **AUTOMATICA 2012**, the 5th International Trade Fair for Automation and Mechatronics, is the 5th edition of a biennial event taking place at the Munich Messe in Munich, Germany. AUTOMATICA is the leading European innovation platform for robotics and automation at the highest level. The world of manufacturing industry participate to this event to find future-oriented automation solutions, and this is the reason why the GRACE project will surely gain an interested audience for the dissemination of its results and opportunities for future exploitation.

  Fair Date and Venue: Munich (Germany), May 22nd -25th , 2012

- Industrial Technologies 2012 represents the main event of the European Commission nanotechnology, materials, and new production technologies (NMP) theme. The focus this year is on innovative technologies that boost significantly Europe's competitiveness by 2020. The event is composed of three days of insightful plenaries and conference sessions - revealing the impact of industrial technologies and promoting solutions to improve the environment for innovation in Europe – and an exhibition area, where the GRACE project stand is planned to be present. This event is considered as strategic to create new connections and synergies with other NMP projects in similar fields and to find new contacts.

Event Date and Venue: Aarhus (Denmark), June 19th -21st , 2012.

b. National and International Conferences

The GRACE partners are planning to send several contributions and to participate to National and International conferences during the 2012. Two contributions have been already submitted and the remaining have been planned and they are under preparation.

-AAMAS 2012 is the 11th international conference on autonomous agents and multi-agent systems. AAMAS is the largest and most influential conference in the area of agents and multi-agent systems. The aim of the conference is to bring together researchers and practitioners in all areas of agent technology and to provide a single, high-profile, internationally renowned forum for research in the theory and practice of autonomous agents and multi-agent systems.

Conference Venue and Date: Valencia (Spain), June 4th -8th ,2012

GRACE Contribution:

Title: Multi Agent Systems for manufacturing control: a layered case study

Authors: Sindre Pedersen (SINTEF), Johannes Tjønnås (SINTEF), Ingrid Schjølberg (SINTEF), Bjarne A. Foss (SINTEF)

Abstract: Multi-agent systems present a new paradigm for manufacturing control. Although there have been many publications in this field in recent years there is still an absence of industry adoption. It is argued that part of the reason for this could be that the field to date mostly presents qualitative arguments for its usage. In this paper we investigate the control of a simple manufacturing process using multi-agent systems, putting it in relation to classical control structures. As most current control systems are hierarchical, the analysis is done in a layered top-down fashion to facilitate for a more smooth transition into multi-agent control. Simulation results on the process presents, quantitatively, pros and cons with the introduction of multi-agent control into the manufacturing industry .

- ISIE 2012 is the 21th IEEE International Symposium on Industrial Electronics. IEEE-ISIE is the largest summer conference of the IEEE Industrial Electronics Society, which is an international forum for presentation and discussion of the state of art in Industrial Electronics and related areas. The main topics of the conference are:

- Power Electronics
- Electrical Machines and Drives

- Control Systems, Computational Intelligence and Applications
- Mechatronics and Robotics
- Power Systems, PHEV and Renewable Energy
- Sensors, Actuators, System Integration and Signal Processing
- Industrial Informatics and Factory Automation

The GRACE contribution will be presented at the **Special track on Industrial Informatics and Factory Automation.**

Conference Venue and Date: Hangzhou, Zhejiang (China), May 28th -31st , 2012.

GRACE Contribution:

Title: Modelling and Validating the Multi-agent System Behaviour for a Washing Machine Production Line

Authors: Paulo Leitao (IPB), Nelson Rodriguez (IPB)

Abstract: This paper describes the formal modelling and validation of the behaviour of a multi-agent system that integrates the production and quality control processes in a washing machine production line. The modelling, analysis and validation process uses the Petri nets formalism that provides a rigorous and formal language based on its powerful mathematical foundation, supporting the complete verification of the system correctness during the design phase and before to proceed to the deployment phase. The behaviour models of each agent belonging to the system architecture is edited, analysed and simulated in the PnDK framework.

- IECON 2012

After attending at IECON 2011, the GRACE project will be also present at **IECON 2012**, the 38th Annual Conference of the IEEE Industrial Electronics Society, whose focus and main objectives have been already described in Section 6. Two different contributions will be submitted this year.

Conference Date and Venue: Montréal (Canada), October 25th -28th , 2012

GRACE Contribution #1:

Title: Synergies and integration approach regarding agent systems and mechatronic units

Authors: SIEMENS – IPB

GRACE Contribution #2:

Title: Identification methodology for reusable holons (mechatronic units + agent)

Authors: SIEMENS

- ETFA 2012

Also in this case, second participation to the EFTA series of international conferences for the GRACE project. **ETFA 2012** is the 17th IEEE International Conference on Emerging Technologies and factory Automation (see conference focus and main objective in Section6, IECON 2011)

Conference Date and Venue: Krakòw (Poland), September 17th -21st , 2012

GRACE Contribution :

Title: Design of an Ontology for Production and Quality Control

Authors: IPB

- AIVELA 2012

AIVELA 2012 is the 10th International conference on Vibration Measurement by laser and non-contact technique. The focus of this conference is the development and application of non-contact techniques for vibration measurement; of particular relevance is laser Doppler vibrometry. This technique is being developed into a self-adaptive measurement method within WP3 of GRACE project, and applied to vibration-based diagnostics of washing machine at the end of the production line.

Conference Date and Venue: Ancona (Italy), June 26th -29th , 2012

GRACE Contribution :

Title: Adaptive Laser Vibrometer

Authors: UNIVPM

- Optimess 2012

Optimess 2012 is the 5th International Conference in Optical Measurement techniques for Structures and Systems and focuses on optical measurement techniques and their applications in research, testing and production. The conference is a forum for researchers developing or working with optical measurement techniques such as interferometry, vibrometry, optical fiber sensors, image correlation techniques, moiré profilometry etc, in application fields such as dimensional metrology, structural mechanics, materials testing, biomedical applications etc.

Conference Date and Venue: Antwerp (Belgium),April 4th -5th , 2012

GRACE Contribution :

Title: Vision system based on a conical mirror for dimensional measurements inside near-cylindrical cavities

Authors: UNIVPM-AEA

- **National Norwegian forum on automation 2012**

August 2012.

GRACE Contribution :

Title: Screw assembly, learnings from the GRACE project

Authors: SINTEF

Finally, a preliminary list of contributions planned for the next year is reported:

- ✓ *"Advances in the screwing process control"* (SINTEF)
- ✓ "Special session on reusable agent architectures" (SIEMENS)
- ✓ *Self learning of test plans in vision control stations (AEA)*
- ✓ *Robot Vision for Quality Control (UNIVPM-AEA)*

For the above contributions, the most appropriate conferences have not been selected yet. However, the best choice for each article will be made in the following list of International Conferences, or other events selected to match the GRACE project target and objectives:

- **CASE2012** - IEEE International Conference on Automation Science and Engineering, 20th - 24th August 2012, Seoul, Korea (http://www.case2012.org)
- **IROS2012** - IEEE/RSJ International Conference on Intelligent Robots and Systems, 7 – 11st October 2012, Vilamoura, Portugal (http://www.iros2012.org)
- **MECHATRONIKA2012** - International Conference on Mechatronics, 5th – 7th December 2012, Prague, Czech Republic (http://mechatronika2012.cedupoint.cz/)
- **AQTR2012** - IEEE International Conference on Automation, Quality and Testing, Robotics, 24th - 27th May 2012, Cluj-Napoca, Romania (http://www.aqtr.ro)
- **ICMS 2012**- The 45th CIRP Conference on Manufacturing Systems, Athens, Greece, May 16th -18th , 2012(http://www.lms.mech.upatras.gr/ICMS2012/).

c. Scientific Journals and Magazines

For the next year, the following articles are planned to be submitted for publications:

- ✓ *"Formal Specification of a Multi-agent System for a Washing Machine Production Line",* Computers in Industry (IPB)
- ✓ *"Challenges in screw assembly",* SINTEF Gemini Magazine (SINTEF)

d. Dissemination Material

d1. Video

In the first semester of 2012 a project presentation video is planned to be produced.

In the GRACE video the project and its objectives will be presented with interviews to all the partners, explaining their contributions to the project.

The video will be planned in two versions: the first one will be ready by April 2012 in a shorter version, so as to be used during the fairs planned in May and June.

The second version will be ready by July 2012 and will include the interviews with the partners. Other videos, concerning technical topics and first results of the GRACE project, will be realized later on.

All the videos will be uploaded in the GRACE website, on YouTube channel and will be used in occasion of fairs and conferences.

d2. Electronic newsletter

In 2012 it is planned to integrate the dissemination activity with another important tool: **the electronic newsletter**.

Once defined the interested target, a newsletter will be distributed in order to notify the progresses of the project.

There are basically two ways to define the target:

- ✓ **The network**: each partner will draw up a list of stakeholders, using relationships and contact networks.
- ✓ **The website**: anyone interested in the project can subscribe to the newsletter on the GRACE website. The newsletter subscription will also be an indicator of the level of diffusion, knowledge and interest about the GRACE project.

A good newsletter will be structured with specific topics according to the different interests of the target.

d3. Press releases

Press release is a short communication spread on a particular media channel, in order to increase the knowledge on a particular topic or to highlight a particular happening.

Depending on the project progress, both type of press release will be used, spreading them on the best media channel, selected according to the type of news and the target to reach.

To date, a press release was issued to communicate the GRACE project by one of the partner (Università Politecnica delle Marche).

In 2012 each partner will increase the dissemination activity through press releases, using the communication channels available to everyone, also taking the opportunity of the participation to the Automatica 2012 and Industrial Technologies 2012 fairs.

e. Interaction with other related EU - NMP Projects

The European Commission strongly encourages collaborations and synergies among EU funded projects dealing with similar themes, so to maximize the dissemination and exploitation of results across Europe.

To this purpose, some interesting ongoing projects financed by the NMP EU programme have been identified and the relative consortia will be contacted in the next months trying to identify possible areas of collaboration. The initial projects that will be contacted are listed and shortly described in the following:

- IDEAS Project - Instantly Deployable Evolvable Assembly Systems

Overview: The project aims at developing self-configuring, highly adaptive (self-diagnosis), process-oriented components, and shifting the technological focus from complex, flexible, multi-purpose systems to a simpler, dedicated machine modules maintained by a highly distributed control system approach. The goal of IDEAS is to provide a prototype industrial assembly system application as a proof-of-concept of this new control approach.

IDEAS Website: http://www.ideas-project.eu

- **Self-Learning Project** – Reliable self-learning production systems based on context aware services

Overview: The strategic objective is to strengthen EU leadership in production technologies in the global marketplace by developing innovative self-learning solutions to enable tight integration of production systems control & maintenance . The project will develop highly reliable and secure service-based self-learning solutions aiming at that integration. The Methodology addressing organizational aspects of such a radical change in production systems, within extended enterprise concept, applying lean principles will be elaborated.

Self-Learning Website: http://www.selflearning.eu

- **Cosmos Project –** Cost-driven Adaptive Factory based on Modular Self-Contained Factory Units

Overview: The main objectives for COSMOS are the design, development and implementation of a distributed control system for the management of a factory with a flexible, modular and evolvable automation approach capable of increasing the assembly factory productivity by 20% without compromising on flexibility. Although the project will focus on the wind turbine assembly process, the conception of the solution will be suitable for other sectors

Cosmos Website: http://www.cosmosproject.eu

11. Exploitation Plan

The main objectives of the Exploitation task are to identify and coordinate the exploitation of the technologies and of the solutions coming out of the project. The Exploitation task 6.2 started at month 13 and in its first phase, a list of exploitable results of the project has been defined.

On the 5th of December, all the partners participated to the **Exploitation Strategy Seminar** organized by the EU whose main objective was to illustrate the methodology and tools for the correct exploitation of the results of the project.

The results arising from the project that have commercial relevance have been identified and described. Those results were the basis for discussion during the Exploitation Strategy Seminar.

During the seminar, the following parts have been addressed:

1. Validation of the list of results:

An Exploitable result is defined as an outcome of the project that meets two conditions:

- It has commercial relevance
- It can be commercialised as a stand alone result

The results identified for the GRACE project have been reviewed following these conditions.

2. Result Characterisation:

For each of the identified results a Characterisation Sheet has been prepared, following the template provided. Quantitative information (e.g. market size, or price) have been valued, even if it is only approximate. Potential customers or competitors have been also identified. The objective of the characterisation is to provide an assessment of the results in a way that their relevance in commercial terms can be understood.

3. Results Knowledge and Exploitation Plans:

This part has two main objectives:

- Have a clear idea of which partner has made a relevant contribution in the creation of each result (it will be very useful to discuss ownership of results);
- Express the future intentions regarding each result, so every partner knows its own strategy and also other partners strategies which will facilitate discussions on commercialisation or intellectual property issues.

In particular, for each result it has been specified if the partner has a CONTRIBUTION WITH BACKGROUND KNOWLEDGE or a CREATION OF FOREGROUND KNOWLEDGE. Then, Exploitation Claims have been specified indicating the intention of the partners to exploit the result by:

- MAKING THEM AND SELLING THEM

- USING THEM INTERNALLY FOR FURTHER RESEARCH OR TO MAKE SOMETHING ELSE

- LICENSING THEM TO 3RD PARTIES

- PROVIDING SERVICES SUCH AS CONSULTANCY, ETC…

As further step of the Exploitation seminar, a risk assessment of the results of the project has been carried out. The definition of the Risk is: the uncertainty of an event occurring that could have an impact on the achievement of objectives. The risk is measured in terms of impact and likelihood. For each of the exploitable results a risk scoring has been prepared.

Based on the results of the Seminar a list of activities has been prepared and they will be carried out during the next months, such as:

-to prepare a complete list of results for IPR management, in particular for the prosecution after the end of the project.

- to better identify the market size and opportunities for each of the identified results

- to prepare the knowledge to be transferred.