EUPASS

Evolvable Ultra-Precision Assembly SystemS

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EUPASS

Periodic Activity Report # 5

Project Month 49 - 53

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Purpose of Document	This document is a periodic report on the progress of the work within the EUPASS project to inform the Project Officer and reviewer. This report consists of information on key project actions, as performed during the granted Extension Period.

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Publishable Executive Summary

Summary description of Project Objectives

Notwithstanding recent technological advances, the social and economic situation for assembly-intensive companies in Europe is in serious decline (European outsourcing of assembly at 21% in 2000, predicted over 40% by 2007). The alarming issue behind such forecasts are, among others, the long-term consequences of outsourcing assembly to non-European countries, in spite of the fact that entire industries have already been lost through such practices. Strategically speaking, new technologies such as micro products, and their production systems, could be exploited to turn these threats into opportunities, which has happened outside Europe. To date, no comparable measures have been taken in Europe. Industrialists and some academic partners of the Assembly-Net Thematic Network, propose such an initiative as an Integrated Project titled EUPASS.

Original Objectives

The EUPASS project aims to develop affordable, cost effective and sustainable ultra-precision manufacturing solutions by offering rapidly deployable ultra-precision assembly services on demand. This will be achieved by developing and delivering a number of breakthrough technologies and solutions including:

- European wide pilot infrastructure of depots of micro-assembly modules and integration software, enabling rapid configuration and deployment of flexible precision assembly systems with minimum investment cost.
- Next generation ultra-precision enabling technologies, including modular high-precision manipulators, grippers and feeders.
- Novel micro joining techniques including micro-mechanical joints, nano-dispensing, and laser welding.
- Robust and legacy-compliant knowledge driven methodology, cost models and software tools to support the offering of rapidly deployable ultra-precision assembly services with low investment cost, high capacity utilisation and improved equipment reusability.
- New standards for seamless integration of precision assembly modules and control systems using open architecture approach.

Following the recommendations of the PMT, AT and Roadmap & Strategies group, EUPASS has re-structured its original objectives as given below (full description will be given later).

- Focus on the rapid deployment of modular systems, through:
  - referential architectures,
  - advanced interfaces, and
  - evolvable/distributed control solutions.
- Develop modules, standards and interfaces that may support adaptability, evolvability and fault-tolerance.
- Establish and develop its main deliverable: a methodology that describes how one may achieve an evolvable system solution.

EXTENSION OBJECTIVES:

The main objectives set for the extension may be summarised as follows:

1. *Complete and finalise the standardisation work.*
2. *Bring the exploitation and dissemination activity to a broader and more self-sustaining level.*

The activities were planned and set at the Final GA in Windisch (Oct.2008), in accordance with the PMT. The standardisation work would continue for another five months, but would receive extra support through the development of a collaborative network. The aim of the establishment of such a collaborative network was to primarily increase the critical mass behind the work to be done.

The Extension Group has, therefore, developed such a network and finalised the standardisation work.

Contractors involved

List of Participants (Extension group highlighted)						
Partici - pant. Role*	**Partici-pant. Numbe r**	**Participant legal name** (Previous in project used name)	**Participant short name**	**Country**	**Date enter project* ***	**Date exit project****
CR	2	Feintool automation AG	FTA	CH	1	48
CR	3	FachhochschuleNordwestschweiz , University of Applied Sciences	FHNW	CH	1	48
CR	4	Ecole Polytechnique Fédérale Lausanne	EPFL	CH	1	48
CR	**5**	**Tampere University of Technology**	**TUT**	**FI**	**1**	**53**
CR	6	Robert Bosch GmbH	Bosch	D	1	48
CR	7	Festo AG & Co. KG	Festo	D	1	48
CR	8	IEF Werner GmbH	IEF	D	1	48
CR	9	Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V	FhG	D	1	48
CR	**10**	**Forschungszentrum Karlsruhe GmbH**	**FZK**	**D**	**1**	**53**
CR	11	Elektro Beckhoff GmbH	Beckhoff	D	1	48
CR	13	Electrolux Home Products Italy S.p.A	Electrolux	IT	1	48
CR	14	Masmec S.r.l.	Masmec	IT	1	48
CR	15	Istituto di Tecnologie Industriali ed Automazione	ITIA	IT	1	48
CO	**16**	**Kungliga Tekniska Högskolan**	**KTH**	**S**	**1**	**53**
CR	17	TQC Ltd.	TQC	UK	1	48
CR	**18**	**The University of Nottingham**	**UNOTT**	**UK**	**1**	**53**
CR	19	Université de Franche-Comté	UFC	F	1	48
CR	**20**	**UNINOVA - Instituto de Desenvolvimento de Novas Tecnologias**	**UNINOVA**	**P**	**1**	**53**
CR	21	FlexLink AB	FlexLink	S	1	48

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A Public Project Website has been made available and is located at,

http://www.eupass-fp6.org/pages/index.jsp

The Final, Collaborative Website has been developed during the Extension and is available at:

www.eas-env.org

1 Project objectives and major achievements during the reporting period

Please note that the EUPASS project has obtained an Extension. The reasons for this extension, and the work that would be involved, are detailed in the chapters 2.6 Management Activities as well as Appendix Plan of Use & Dissemination of Knowledge.

1.1 Overview of general project objectives and State of the Art

The original EUPASS objectives are detailed in the preceding chapter. The major point of debate, throughout the four-year project, has been based on two issues:

- The idea of having depots of modules throughout Europe, and
- Evolvability: what it is and how it should be applied.

So, from the very outset, EUPASS relied on the business idea of creating a series of component depots around Europe, through which end-users could rent, re-use, and quickly deploy their systems. Beyond the problem that such a European-wide solution would require to establish (4-year project unrealistically short), and the fact that such a technological breakthrough normally requires 5-10 years, the idea itself presented strong opposition from both module suppliers and end-users. The bottom line is that it would be enormously difficult to form a separate "EUPASS" company that could establish, consolidate, and run a series of module warehouses throughout Europe in just 4 years and without strong financial backing. Furthermore, most module providers were against the idea of having their products simply "lie-in-wait" at some remote location when the end-users are aggressively demanding such components on a global scale and at incredibly short notice: basically, the modules would go directly from one end-user to the next, provide the integration and configuration of such modules was truly fast & reliable. Finally, in a rapidly developing market, the modules would also become obsolete rather soon, leaving the disposal/replacement issue open.

Therefore, the true need was found to be for *truly interoperable modules* that can be reliably re-configured at very short notice, in a robust manner, and for a variety of applications: Services in the form of *standards, interfaces, methodology, architecture,* all of which allow for reconfiguration and evolvability.
Hence the discussion on evolvability. EUPASS and its Architecture Team have now consolidated the idea that Evolvability is to be defined as given in the deliverables 4.10, 1.5, and scientific literature[1,2]. That is, evolvability is NOT the ability to adapt assembly sequences and layouts but, rather, the ability to achieve adaptable system components that may self-configure, self-diagnose, self-heal and ultimately assist the user in attaining an evolution of the system.
EUPASS therefore assumed the recommendations of its Roadmap and Strategies activity to enforce its objectives, which may be summarised as:

- Focus on the rapid deployment of modular systems:
  - referential architectures,
  - advanced interfaces, and
  - distributed control solutions.
- Develop modules, standards and interfaces that may support adaptability, evolvability and fault-tolerance.
- Establish a common vision and develop its main deliverable: a methodology that describes how one may achieve an evolvable system solution.

[1] "Evolvability and the Intangibles";C.Hanisch and G.Munz; Journal of Assembly Automation, Emerald Press, Vol.28, No.3, 2008

[2] "Applying Evolvable Assembly Systems"; M.Onori, J.Barata, R.Frei; Proceedings of the 7th IFIP Conference on Information Technology for Balanced Automation Systems in Manufacturing and Services, BASYS06, Niagara Falls, USA, September 2006.

1.1.1 Current status regarding state of the art systems

Most of the reviewed assembly systems (see Roadmaps D1.5a-1.5c) denote some flexibility or reconfigurability characteristics. In general, most of the discussed solutions are based on modular constructions for building up the system. In fact, mechanical excellence does not seem to be the problem, and solutions at the present state-of-the-art exhibit excellent mechanical characteristics. It can be said that the size of the modules is large (granularity aspect), thus limiting the reconfiguration and flexibility of the systems. The assembly cells allow the user to reconfigure the cell layout, for example, by adding or removing new feeders; however these actions are often predefined and the usable module types are limited. The standardized interfaces used in most solutions are in-house (internal) and no real, global, standards are used for allowing true multi-vendor solutions. Therefore, the real issue is that of control.

For improving the re-usability of modules, the following issues are proposed as vital to EUPASS (Nov.2005-see document D1.5b):

- global standards for the interfaces should be applied to as great an extent as possible, or developed.
- the solutions to date provide attempts at short reconfiguration time from a mechanical point of view, but to achieve truly fast production changeovers, more focus should be given to the control aspects (due to the needs posed by emergence; see next section).
- finalising the set-up of the assembly systems underlines the importance of information aspects (configuration & control), since configuration & control lie at the heart of emergence (poor process knowledge = failure).
- each system module should provide a description of its skills in computer understandable format; this would allow faster module selection for the user needs and simultaneously provide vital information for the configuration of the assembly system.

In this respect (see section 1.1) the revised EUPASS objectives represent a clear step forward relative to current state-of-the-art, and could place EUPASS in a leading R&D position.

1.2 Previous Reviews

Besides informal meetings with recommendations, no official reviews took place yet during the final 12 months.

1.3 Month 49-53

1.3.1 Objectives for the reporting period

Below, you will find a short summary description of the work packages.

Table 1. Work package list (5 month plan)

Work package list (5 months period month 49-53)		
No	**Work package title**	**Lead contractor**
WP1	Roadmapping, specifying industrial needs & technology in precision assembly- Final Roadmap	KTH
WP5	Standardisation: foundations for standards,	TUT, FZK
WP5	Innovation-related activities: IPR and exploitation, knowledge dissemination and training	TUT, UNOTT
WP5x	Development of a Collaborative Network/Interactive website, for the support of standardisation & dissemination	UNINOVA, KTH, FZK
WP6	Project management	KTH

The objectives of the reporting period are well reflected in the deliverable list of section 2.7.

1.3.2 Work performed

Objectives see DOW

see chapter 2 for each WP

1.3.3 Contractors involved

Not applicable

1.3.4 Main achievements

WP1

- External Roadmap delivered and disseminated to a broad spectrum of professionals.
- Assisted WP5 in forming special sessions at International Conferences.

The Roadmap results are currently being analysed by publishers for potential development into a book.

WP2

In the reported extension period, there were no planned WP2 activities.

WP3

This WP was terminated in the period 3.

WP4

In the reported extension period, there were no planned WP4 activities.

WP5

WP5 is of strategic importance to found the generated knowledge and conclusions into guidelines and standards. During the previous periods the awareness and importance of standardisation issues has been highlighted to the community - and the importance of it has been recognised in the project. The information collection from the partners has been continued and the results of this work have been recorded into the document of the existing standards. This information helps in avoiding creation of new ones and duplication of the earlier efforts, and to spread the awareness of standards available for use.

The Working Groups have not continued their work as such during the extension as the work has focused on its new objectives:

- Finalising the standardisation work (mainly at international level).
- Creating a collaborative website for the creation of large interactive workgroups.

This work will be detailed later but represents a considerable effort as the existing standards/emplacement website had to be integrated within a larger interactive website structure with greater functionalities.

1.4 Problems and Corrective Actions

No delays, problems or corrective actions are to be reported.

2 Work Package Progress of Project Month 49-53

2.1 WP1 Roadmapping

2.1.1 Workpackage objectives

Objectives

The WP1 objectives for the upcoming period remain fairly constant to previous ones, and may be summed up as:

- To monitor, develop strategies and vision for the successful development and application of evolvable precision assembly technologies with emergent behaviour.
- To keep the EUPASS members informed of the key industrial needs, new solutions, and disruptive technologies that have a bearing upon evolvable precision assembly (short, medium and long-term).
- Indicate threats, opportunities and objectives that lay on the path to attaining beyond the state-of-art in sustainable, fault-tolerant, cost-effective assembly systems, including control systems and innovative, supportive, technologies.

The work package will continue to delve into the intricacies of emergent behaviour and their inter-relation with ultra-precision, whilst monitoring the work, results and comments provided by academic, industrial and research institutes around the world and in several industrial sectors. The resulting Roadmaps will reflect the immediate needs of the project and its members, all the while maintaining a future perspective. An established industrial screening procedure will ensure the viability and realistic nature of the proposed strategies and paths.

The EUPASS Roadmap has now attracted substantial external interest. In this respect the Final Roadmap will develop a new layout and a more detailed analysis of the needs, gaps, and essential technologies that are envisaged for successful adaptive assembly in the near future.

2.1.2 Technical Progress

WP1 basically re-edited its Final Roadmap and included some new issues that had not yet been covered within the last edition. It has also reviewed its layout entirely in order to better exhibit its content within a potential external book release format.

Due to the final year of the project, the three WP1 tasks have merged in support of the Final Roadmap. The tasks were:

1.1- Information retrieval

1.2- Roadmapping & Strategies

1.3- Glossary

The final version of the Roadmap, due to being produced by a small group (mainly a final edit), has not maintained this Task subdivision. WP1 as a whole has produced its final version, “Outlook Report”:

The Outlook Report has included new analyses of the Resources sector, such as water and oil. It has also completed its review of current trends by including interview results and analyses of the latest developments in South East Asia.

2.1.3 Deviations from plan WP1

No deviations from plan have been reported.

2.2 WP2 SW Support, cost and sustainability

2.2.1 Workpackage objectives

No action planned for this WP during Extension Period.

2.2.2 Technical progress

No action planned for this WP during Extension Period.

2.2.3 Deviations from plan WP2

No deviations from the intended plan are foreseen beyond M48. All objectives have been met.

2.3 WP3 Modular “plug & produce” devices

2.3.1 Workpackage objectives

No action planned for this WP during Extension Period.

2.3.2 Technical progress

No action planned for this WP during Extension Period.

2.3.3 Deviations from plan WP3

Completed without deviations.

WP4 EUPASS technology platform

2.3.4 Workpackage objectives

No action planned for this WP during Extension Period.

2.3.5 Technical progress

No action planned for this WP during Extension Period.

2.3.6 Deviations from plan WP4

No major deviations or delays noted.

2.4 WP5 Innovation-related activities

2.4.1 Workpackage objectives

2.4.1.1 WP5.1: Standardisation:

TUT is the work package leader, as an impartial participant that will not lead into industrial-dependent interests. The Work Package participants have connections to various standardisation bodies. These connections are maintained and new ones shall be created. Like TUT with IPC and via it to IEC & SMEMA. FZK with DIN {especially micro-systems DIN NA 027 03-03 AA}, ISO {TC 39 / WG 16} and SEMI MEMS. The main input for the standardisation work will be the work of the EUPASS architecture team (AT), not either forgetting the development work made by the WP2 and WP3. These activities define the main requirements and needs for the standards. General directions will also come from the work of WP1. All participants will produce under their own work packages their input for the standardisation requirements and standard documents. The task of WP5.1 is to work as a coordinator and information hub combining these requirements and information together and keeping them consistent. The WP5.1 is contributing to the standard documents when possible. TUT is leading the work with the support of other standardisation partners (mainly FZK).

Under the reported period the focus was set in four objectives. Giving more weight to the later ones as the time evolves.

- Investigation of the existing standards related to the field will continue on. The work shall be based on the real needs of the project consortium. All participants should bring their input for narrowing the standardisation focus and should supply their information on the standardisation issues.
- Standard development will be divided into parallel Working Groups (WG) of AT and other WPs of the project, each of which will focus on standardisation activity around a selected topic. Firstly to investigate and evaluate the suitability of existing standards for the topic and secondly to start the standard development, if the requirements are not met by the existing standards.
- Development of the standard specifications for the areas identified important for the success of the EUPASS project.
- Disseminating the availability of the developed standards.

Starting point:

The starting point of standardisation in the beginning of this period was that the EUPASS standards were technical sense in finished or near to be finished conditions. Remaining was to take all of open ones into finished state and disseminate the information on wider audience.

Quite comprehensive information of existing standards useful for this industry was listed in the *D5.1.2 Study of existing standards and standardisation organisations* and in its later updates.

2.4.1.2 WP5.2: Dissemination and Knowledge Transfer

- Promote supportive measures towards the wide-spread industrial application of EUPASS results
- Collaborate with external networks and other projects in order to ensure and enforce EUPASS
- Feasibility studies for the creation of spin-offs
- Organize conferences, workshops and Web-based activities to transfer EUPASS knowledge & technology.

For Extension:

Creation of a specifically developed interactive website for the development of standards and other EUPASS results-a collaborative website/network.

The EUPASS extension project developed EASET (Evolvable Assembly Systems Environment Tool), a collaborative environment tool which aims at promoting EAS dissemination and bring forth improvements through the raise of critical mass. Critical mass can support future developments, enhancing the research process and assisting in validation/falsification of EAS paradigm, being therefore this project of major importance to the EUPASS group. This collaborative environment tool's requirements were thoughtfully analyzed and handled by the EUPASS group contemplating EAS' needs and the more suitable technologies resulting in:

Figure 1 - EASET (Evolvable Assembly Systems Environment Tool)

EASET compiles a Website, Forum, Wiki, Blog, Emplacement Web service and a Remote Monitoring and Control tool. All the functionalities have specific (and different) purposes and are properly integrated with the intention to promote a user-friendly interaction between the actors present in this collaborative environment.

The website mission is to give the user a clear picture of what are Evolvable Assembly Systems, what are the main accomplishments to date and what is being developed. A marketing approach is considered in the website and a skype integrator module is available to enhance user communication. The website is integrated with the EAS Wiki enabling the user to have clear vision of EAS concepts. The EAS wiki is in read-only format ensuring that the concepts, methods and models presented are correct accordingly with the EUPASS group. The forum promotes interaction between users, leaving an opening for discussion into a wide scope of topics regarding Manufacturing and Assembly Systems. The blog assumes a more informative mission, transmitting EAS paradigm authors' opinion about latest topics regarding Manufacturing and Assembly Systems. The Emplacement Web Service is integrated with the website enabling the user to access Blueprint and Emplacement files and to use several tools *(see Emplacement Web Service, page 20).* The Remote Monitoring and Control tool aims at showing the user the evolvability of systems in real-time. This tool enables the user to monitor the behavior of modules or the overall system and change some conditions in the operation enabling the re-configurability of the system.

EASET is based on open source platforms such as Linux+Apache(Web Server), Joomla! (Website), PHPBB (Forum), TIKIWiki (Wiki and Blog) and PHP and Java (Emplacement WS). The exception is the Remote Monitoring and Control tool that is currently under development and is based on Microsoft .Net.

2.4.1.3 WP5.3 – Training activities

The EUPASS training activities will be led by well-established academic partners UNOTT, TUT, KTH, EPFL, UFC, FhG IPA and ILT and ITIA. UNOTT is the coordinator of the FP6 Microsapient CA and is one of the premier academic institutions in UK in precision manufacturing. TUT has already formed summer schools and other activities through the FP5 Assembly-Net Thematic Network, a collaboration that is to be expanded. KTH will elaborate on adequate academic courses, the initial steps having already been taken with a joint project (financed by Swedish foundation) with UNINOVA. IPA will provide some of the professional training expertise available within the Fraunhofer society. ITIA leads a large scale nationally funded training programme, which it will bring in to the project. The existing links to national and international initiatives LASSI, PROPER, WOXÉN, Marie Curie funding, and international contacts will be deepened to consolidate and further develop these schemes, and industrial contacts will be engaged to develop specific training courses for all levels of personnel in industry. Note that the enhancement of production engineering knowledge, process knowledge and the industrial application of the methodologies are key EUPASS objectives.

2.4.2 Technical progress

2.4.2.1 WP5.1: Standardisation

During the past periods the WP5.1 has promoted the importance of the standardisation as one of the key success factors for the project after its end. This has taken place both project internal and external dissemination. The liveliness of the EUPASS message and idea after the end of the project can only be ensured with a proper set of well defined standards documenting the developed interfaces, methods, processes, etc.

The Work Package participants have strong connections from the past to various standardisation bodies. These connections were maintained and strengthened during the reporting period. EUPASS partners have actively participated to the work done under the ISO / TC 39 / WG 16[3]. This ISO working group has been led by FZK. Other partners like TUT has joined the ISO / TC39 / WG16 to strengthen the EUPASS impact on the international standard development and for ensuring that the requirements of EUPASS will be reflected better on these forthcoming ISO standards. The main item on the agenda of the WG16 have been the drafting of ISO 29262 End-Effector interface (Origin from DIN 32565 E) which has been taken into stage Draft International Standard (DIS) and commenting period at global scope is ongoing. The other proposal, ISO 29261 Tray (Origin from DIN 32561 pallet and EUPASS carrier) needed to be withdrawn because of lack of industrial interest and drive.

Investigation of the offerings of the existing standards has been going on in parallel over the reported period of time. Collection of information has been continued at background. New standards have been added in case some interesting and promising standard has popped up. The standards found applicable for EUPASS have been discussed in the deliverable *D5.1.2 Study of existing standards and standardisation organisations* which is a living document. The whole deliverable has been updated time to time and the associated standard table (Appendix I) more frequently. The latest table is available in the projects web page under the members area and the WP5.1 section as an appendix of the *D5.1.2* and from www.EAS-env.org. At the moment the table lists 208 possible standard candidates (or parts of them), of which 111 have been pre-evaluated.

[3] ISO / Technical Committee 39 : machine tools / Working Group 16 : Production equipment for Microsystems.

EUPASS Standards

Many developments aiming to EUPASS standard (specification) documents have been continued till finish. The original objective was to take some of these proposals into the pipe to be having the status under some recognisable standardisation organisation. Like passing the proposals on hands of ISO and having the status of ISO Publicly Available Specification (PAS). However this intention needed to be scaled down because of unexpected recession and changed economical and operational focus of industrial companies. Thus the developed set of standards remains published by the EUPASS organisation through www.EAS-env.org pages. The currently available EUPASS standards and their latest versions are listed in the following table:

EUPASS ID	Name	Version	Description	Responsible
0001	EUPASS Carrier	0.4	EUPASS Carrier Interface Specification	Göran Abbestam / Niko Siltala
0002	EUPASS Bay Interface	0.3.0	EUPASS Bay Interface Specification	Hans-Rudolf Helfer / Niko Siltala
0003	EUPASS Workstation Framework	0.2.1	EUPASS Workstation Interface Specification	Hans-Rudolf Helfer / Niko Siltala
0004	EUPASS Emplacement Specification	1.0.1	Emplacement Specification and Guideline	Niko Siltala
0006	EUPASS Blue Print Specification	1.0.1	Blue Print Specification and Guideline	Niko Siltala / Ralf Heitmann
0007	Assembly Process Terminology and Ontology Specification	1.2	EUPASS Assembling Process Ontology	Niels Lohse
0008	Equipment Terminology and Ontology	1.0.1	EUPASS Equipment Terminology and Ontology	Niels Lohse
0009	Product Ontology	0.2.1	Product Ontology	Niels Lohse
0010	EUPASS Glossary	1.0.1	EUPASS Glossary	Jose Barata
0011	*EUPASS Feeder Interface*	*N/A*	*EUPASS Feeder Interface*	*Bosch / Niko Siltala*
0012	EUPASS Reference Architecture	4.0.1	EUPASS Reference Architecture	Mauro Onori

The *D5.1.6b EUPASS Specifications* collects these standards together as they are at the end of the project.

Emplacements

The developed concept of Emplacement/Profile specifications have been one original and large effort in the project. The Emplacement and the enclosed Profiles are the standard specifications of the modules serving the objective of interchangeability and virtual operations (selection, simulation, system creation and controls) of the module. They will specify the available interfaces, functionality and parameters of the module in a standard format. The ten Emplacement specification drafts available at the moment are following:

Level	Emplacement ID	Emplacement Name	Empl_Description	Number of Profiles
CELL	cell.1	Cell	Cell framework specification	1
DEVICE	axis.1	Axis	One DOF axis specification	1
DEVICE	feeder.1	Feeder	Feeder and component supplier specification	5
DEVICE	gripper.1	Gripper	Gripper specification	5
DEVICE	vision.1	Vision	Vision module specification	3
ELEMENT	carrier.1	Carrier	Carrier for assembled items and components	1
UNIT	dispenser.1	Dispenser	Dispenser module specification	2
UNIT	manipulator.1	Manipulator	Manipulator specification. More than 2 DOF.	6
UNIT	pickAndPlace.1	Pick and Place	Pick and Place unit specification	1
UNIT	transporter.1	Transporter	Transporter (conveyor, buffer, crossing) specification	3

Every Profile represents a specification that can be instantiated as a physical module in the EUPASS environment. This means that the EUPASS specification of a Profile is reflected directly in the Blue Print file storing the electronic specification of the real module. The 28 Profiles are available at the moment.

Emplacement Web Service

The Emplacements are published through Emplacement Web Service (www.tut.fi/EmplacementWS/). Main purposes of the EmplacementWS are:

- Distribution of information about Emplacements and Blue Prints
- Assist on use of them
    - All: Documentation of used files on human readable form
    - End User: Supports design & selection process
    - Module Provider: Helps on making the BP file for their module
    - Support for new Emplacement and BP creation process
- Different areas for users with different access rights
- Has application to application integration interface (through WSDL). E.g. Blue Print editor communicate and gets information through this interface.

During the period this web service has been re-programmed on large parts. New features are like:

- New features implemented
    - Listing of available standards and skills.
      Reference list to be used as check point of available interface standards and skills. To be used as reference list once developing new Emplacements/Profiles or Blue Prints, in order to use the same identifiers and terms.
    - Listing of used standards and skills by Empl./BP
      Which are the capabilities and connection methods of specific module?
    - Which Empl./BP uses a specific standard or skill.
      Helps as search tool for user as they will be looking for implementation of certain interface standard or skill.
- Has four different areas
    - Public

  - Intra (was partially already in ver.1)
    1. Main area of the service.
    2. Access to files and using the offered functionalities
  - User / Power User
    1. Managing own account
    2. Submitting Blue Prints
  - Admin
    1. Managing users and companies
    2. Managing application
    3. Maintenance tools and functions
- Integrated with EAS-env.org
  - Joint user database (EAS-env.org used as authentication server)
- Database - based implementation
  - Main information of emplacements, blue prints and users are now stored in database
- Server platform change (Windows → Linux) (origin from TUT internal policy change)
- HTTPS access is available

Blue Prints

The 17 Blue Print files electronically describing the modules of EUPASS PV2 are also published through EmplacementWS.

2.4.2.2 In addition to the list of standard specifications and Emplacements additional activities are going on dealing with development of other standard-like documents, e.g. the AT document *D4.10 EUPASS Architectural Guidelines.*

2.4.3 Deviations from plan WP5

2.4.3.1 WP5.1: Standardisation:

Due the unexpected measures of recession have had some effect on the continuation of standardisation actions at international levels. The involved companies have needed to focus on their survivor, which has meant to limit their resource on secondary activities (like standardisation). The international level standardisation needs support and drive from industrial companies, and universities or research institutions cannot drive it alone. Therefore this objective has been lowered and EUPASS standards are published by EUPASS and provided for use. However this can change in future, when times get better and, if need and interest from industrial companies then arises for having these as International Standards we will be ready for supporting these actions.

2.4.3.2 WP5.2: Dissemination and Knowledge Transfer

Promote supportive measures towards the wide-spread industrial application of EUPASS results

- Collaborate with external networks and other projects in order to ensure and enforce EUPASS
- Feasibility studies for the creation of spin-offs
- Organize conferences, workshops and Web-based activities to transfer EUPASS knowledge & technology.

Task 5.2.1 Organisation of conference sessions and workshops

A special session on EUPASS has been organised as part of the 9th International IFAC Symposium on Robot Control in Gifu, Japan (September 9-12, 2009). 5 papers have been submitted and accepted. Furthermore, a special session on evolvable assembly systems is planned for the 2009 DET/CIRP International Conference on Digital Enterprise Technology in Hong Kong, China (9-12 December, 2009). A number of papers are in preparations by KTH, FZK, UniNova, UNOTT, and TUT. In addition

there are papers being prepared for the 2009 IEEE International Symposium on Assembly and Manufacturing in Seoul, Korea (November 17-20, 2009), and currently talks to organise a special session/workshop on evolvable assembly systems as part of the Fifth International Precision Assembly Seminar in Chamonix, France (February 14-17, 2010).

Task 5.2.2 Dissemination in scientific publications and professional journals

The EUPASS concepts and results have been successfully published in a number of international journals and peer reviews scientific conferences. The publications in the final year included those listed below:

Journal Publications:

1. *"Voltage/frequency proportional control of stick-slip microsystems"*, Rakotondrabe M., Haddab Y., Lutz P., IEEE Transactions on Control Systems Technology.
2. "Miracles take a Little Longer"; M.Onori, Viewpoint, Journal of Assembly Automation, Emerald Press, Vol.28, No.2, 2008
3. "Evolvable Assembly Systems: coping with variations through evolvability"; D.semere,M.Onori, A.Maffei, R.Adamietz; Journal of Assembly Automation, Emerald Press, Vol.28, No.2, 2008
4. "Evolvability and the Intangibles";C.Hanisch and G.Munz; Journal of Assembly Automation, Emerald Press, Vol.28, No.3, 2008
5. " Development, sub-step modelling and control of micro/nano positioning 2DoF stick-slip device",M. Rakotondrabe, Y. Haddab, P. Lutz, IEEE/ASME Transactions on Mechatronics, Accepted in May 2008
6. "Plurilinear modelling and robust control of a nonlinear piezoelectric cantilever"M. Rakotondrabe, Y. Haddab, P. Lutz, , IEEE Transactions on Control Systems Technology, Accepted December 2007, in press (the paper is accessible with IExplore)

Conference Publications:

1. "A new approach for microparts feeding system based on inertial force"; M. Paris, Y. Haddab, P. Lutz ;, International Workshop on Microfactories, IWMF 2008, October 2008, Evanston, USA
2. "Practical Characterization of the force friction for the positioning and orientation of micro-components", M. Paris, Y. Haddab, P. Lutz : Proc (DVD ROM) of IEEE/RSJ International Conference on Intelligent Robots and Systems, IROS 2008, Nice, France
3. "Achieve functions of microrobotics environment to succeed in micro-assembly: the case of the feeding function", Philippe Lutz; workshop on Grand Challenges in Microrobotics and Microassembly, 28th June, 2008, RSS conference, Zurick, Switzerland
4. "A Low Cost Coarse/Fine Piezoelectrically Actuated Microgripper with Force Measurement Adapted to EUPASS Control Structure.",Kanty Rabenorosoa, Yassine Haddab, and Philippe Lutz; IPAS 2008, Chamonix
5. "Evolvable Assembly Systems: applications and developments"; D.Semere, M.Onori, J.Barata; Proceedings of the 9th IFIP Conference on Information Technology for Balanced Automation Systems in Manufacturing and Services, BASYS08, Oporto, Portugal, Kluwer Academic Publishers, Sept. 2008
6. "Evolvable Systems – Towards Self-X Production Systems ", D.Semere, M.Onori, B.Lindberg; Proceedings of the Swedish Production Systems Symposium, SPS 2008, Stockholm, Sweden.
7. EVOLVABLE PRODUCTION SYSTEMS : MECHATRONIC PRODUCTION EQUIPMENT WITH PROCESS-BASED DISTRIBUTED CONTROL; M.Onori, J.Barata; SYROCO 2009, 9th International IFAC Symposium onRobot Control, Gifu, Japan, September 2009
8. From Flexibility to Evolvability: ways to achieve self-reconfigurability and full-autonomy; A.Maffei, K.Dencker; SYROCO 2009, 9th International IFAC Symposium onRobot Control, Gifu, Japan, September 2009
9. Multi-Agent Architecture for Self-Configuring Modular Assembly Systems; N.Lohse, S.Ratchev, P.Ferreira; SYROCO 2009, 9th International IFAC Symposium onRobot Control, Gifu, Japan, September 2009

10. Emplacement and Blue Print; An Approach to Handle and Describe Modules for Evolvable Assembly Systems; A.Hofmann;N.Siltala; SYROCO 2009, 9th International IFAC Symposium onRobot Control, Gifu, Japan, September 2009

Task 5.2.3 Creation of EUPASS Industrial User Group

Completed Period 4.

Task 5.2.4 Publication of EUPASS-Newsletter sections

Completed Period 4.

Task 5.2.5 Demonstration Activities for Month 18 Platform

Completed Period 3.

Task 5.2.6 Marketing material for dissemination of results

Completed Period 4.

2.4.3.3 WP5.3: Training activities

Completed Period 4.

D5.3.12 4th lectures on Precision Assembly developed & delivered as part of existing modules

During this period EUPASS academic partners increased the number of courses where EUPASS developments have been presented. The deliverable presents the different courses delivered by the partners. The period also shows an increase of the number of courses where EUPASS developments are included. A brief overview of the courses currently exposing EUPASS work is given below:

- "Dimensional Analysis"; EPFL; This course turns around the importance of assembly processes when the components dimensions become very small, as this will have a great influence on the capability of the processes and their yield.
- "Production Engineering and Management (TPRMN)"; KTH; is a basic course which introduces students to the manufacturing area, creating student's interest for manufacturing. The course covers EUPASS results.
- "Automation Technology (MG2032)"; KTH; is an advanced course of 6-ECTS credits. The course provides knowledge in the development of assembly systems.
- "Evolvable Production Systems Methodologies" F4K5304;KTH; PhD course on topics highly related to EUPASS, such as evolvability, complex systems, emergence, etc.
- "Assembly Automation (TTE-5026)"; TUT; This course covers the most actual advances of EUPASS.
- "Microfactory and micromanipulation (MT9MFACT)" ; UFC; is a 5 ECTS course where students are introduced to the microsystem technology and the problems encountered in the fabrication and manipulation of micro components.
- "Microrobotics and nanorobotics (MT9MROB)",
  "Integrated factory 1 (MT9USINT1)" and
  "Design of production systems (MT8ASS)" ; UFC; are offered and include the latest EUPASS developments.
- "Flexible Automated Manufacturing (FAM)"; UNOTT; provides students with a detailed understanding of the important aspects of advanced automated manufacturing principles.
- "Computer Integrated Flexible Manufacturing (MM4CIM)"; and
  "Robotic and Automation Technology (RAT)";UNOTT; are postgraduate modules. The students get into a wide knowledge of advanced manufacturing, implementing the latest technologies.

D5.3.8 1st delivery of short courses for industry

Completed Period 4.

D5.3.10 2nd delivery of short courses for industry

Completed Period 4.

D.5.3.11 3rd PhD exchanges taken place

Although the active police of the academic partners to attract PhD candidates, the amount of exchanges have increased with new students from the New University of Lisbon to KTH. The results are summarised as:

- Regina Frei, from the New University of Lisbon to KTH.
- Raphael Adamietz, from Karlsruhe University to KTH.
- Antonio Maffei from Pisa University/Electrolux to KTH.
- Pedro Ferreira from the New University of Lisbon to UNOTT
- Paulo Caetano also from the New University of Lisbon to UNOTT
- Micky Rakotandrab to UFC
- Mickael Paris to UFC
- Pedro Neves from the New University of Lisbon to KTH. 2008
- Tiago Gaspar the New University of Lisbon to KTH. 2008

2.4.4 Deviations from plan WP5

2.4.4.1 WP5.1: Standardisation:

No deviations.

2.4.4.2 WP5.2: Dissemination and Knowledge Transfer

No deviations.

2.5 WP6 Project Management activities

2.5.1 Workpackage objectives

Project Internal Communication

The EUPASS website was transferred during this period from the original IBM communication tool QuickPlace, to an ITIA-based framework on www.eupass-fp6.org . The organisation and structure within the website was taken care of by ITIA, with the supervision of the Project Management Team. This structure and internal organisation was regularly monitored for optimisation and subsequently optimised according to the findings. The transfer occurred during M38-M40 and the only remaining issue is that the original EUPASS project data still exists on the original Philips server.

Meetings on individual basis

Regular individual discussion was organised between single partners and the Project Manager to ensure awareness of the PMT with regard to individual partners opinion. It is acknowledged that one of the major challenges is the positioning of the participants and other stakeholders interests into the overall project goals. Keeping close (face to face) contact and regular communication with partners is chosen as the instrument to optimise this process.

Regular WP meetings

Regular WP meetings were held (see overview chapter 3) for ensuring WP progress. During the first year much time was spent to gain good understanding of the different WP partners' expertise. Minutes were written of each meeting and approval of minutes was gained during meetings of each previous meeting.

Also a project handbook elaborated with a section regarding IPR and publication during the past 12 months. This handbook will support the understanding and usage of the EUPASS procedures.

2.5.2 Technical progress

The PMT has such was dissolved as of M48. Management issues were primarily handled by the Coordinator (KTH), in collaboration with the Project Officer (Andrea Gentili). The Extension Group also handled all tasks as a single unit.

The major issue for the Management was to attain the requested objectives in due time. Regular meetings and a close monitoring of the actions was kept such that the objectives were met. In terms of dissemination, even greater-than expected results were obtained in the short timeframe given (see Dissemination).

2.5.3 Deviations from plan WP6

No deviations from plan.

2.6 List of Deliverables

Table 2. Deliverables list (5 month plan, M49-53)

No	Deliverable title	WP no.	Lead participant	Nature [4]	Diss.[5]	Date	Actual del: date
D1.5 g	Final Roadmap, External	1	KTH/UNINOVA		53		
D5.1.6.	EUPASS Specifications	5	TUT/FZK		53		
D5.2.10	Development of website (update)	5	UNINOVA		**53**		
D5.3.11	3rd PhD exchanges taken place	5	KTH/TUT	As part of Final PAR (nr.5)	53		
D5.3.12	4th lectures on Precision Assembly developed & delivered as part of existing modules	5	KTH/TUT	As part of Final PAR (nr.5)	53		
D6.4	P.A.R., final -progress report - PUDK -PMR	6	KTH		53		

2.7 List of Milestones,

The milestones are identical to the timing of the deliverables.

[4] Please indicate the nature of the deliverable using one of the following codes:

R = Report; **P** = Prototype; **D** = Demonstrator; **O** = Other;

[5] Please indicate the dissemination level using one of the following codes:

PU = Public;

PP = Restricted to other programme participants (including the Commission Services).

RE = Restricted to a group specified by the consortium (including the Commission Services).

CO = Confidential, only for members of the consortium (including the Commission Services).

3 Consortium Management

3.1 Organisational Issues

See chapter 1.4

3.2 Internal Communication

see chapter 2 WP6 description

3.3 Project Meetings

3.3.1 Project-wide Meetings

When	Where	Subject	Organising Partner, Work Package or Concept
Nov.10, 2008	Vaxholm, Sweden	Extension Meeting	KTH
Dec.18, 2008	London, UK	Extension Meeting	KTH
Jan.22-23, 2009	Lisbon, Portugal	Extension Meeting	UNINOVA
March 23, 2009	London, UK	Final EUPASS/ Extension Meeting	UNOTT

Table 3 – Project-wide Meetings

Appendix Plan for using and disseminating the knowledge

A.1 Exploitable Knowledge and its results

Clarifying the exploitation strategy is one of the key priorities of the coming period. To clarify the EUPASS exploitation potential and to determine the exploitation strategy, the PMT convened with the Exploitation Board in Stuttgart (June 2008). It was decided to form a more pragmatic approach and seek an extension for the more Interoperability-linked technologies being developed in EUPASS. The new plan for Exploitation may be summarised as follows:
There are two main categories of exploitation that can be derived at through a joint effort, and on the basis of the EUPASS technological innovation:

- System integration components and facilitators, and
- System to services transformation.

The Joint Exploitation therefore decided on expanding and consolidating these aspects (October 2008), such that a European-wide network (EUPASS.ORG) in support of this form of evolvable assembly may be consolidated. Some of the underlying issues discussed included:

- Services that can be offered: diagnostics, maintenance, energy saving...all available through an interactive, web-based network of suppliers, end-users, and developers.
- Services that guarantee lower implementation needs, programming knowledge, system maintenance know-how. If the network lowers these costs, then EUPASS.ORG has provided a more sustainable system, and the service is given.
- The emphasis must be on the system integrator, not end-user. So, the community of system integrators and suppliers need to adhere to the business model to adapt to the dynamic needs of the end-user, and by doing so with methodologies such as EUPASS, they can also support the provision of diagnostics, maintenance and long-term adaptability and re-use of equipment.
- End user attitude needs to be catered for more efficiently: they are interested in better products with faster TTM, at a reasonable cost. Suppliers have to address the new business models, not end users. So, the bottom line is that the most successful business model is the one that gives end users cheap & fast production, and helps suppliers adapt to this dynamically.
- Evolvability! Reduction of integration costs by 50% is the “driver”. If services are supplied at the same time, it becomes a win-win situation. However, the environment in which the technology is deployed also becomes a key factor. The deployment needs of modules (intelligence req., where it should be,...) is a direct benefit of EUPASS. How the process information can be captured, diagnostics offered, etc. remains a major goal that may be attained through careful provision and interaction at data level.
- System suppliers and integrators must see that offering turnkey systems limits their markets and creates unnecessary competition. By opening cooperation and integration of system supply, the market expands and TTM decreases drastically. The problem is not the technology. It is the mind-set of people involved: see Coopetition (Japan). It is HOW we develop & use things that will create the revolution, not the technology itself.
- EUPASS is particularly interesting to small enterprises that are specialists in a particular process. Big company can request (outsource) this special need (module) from the small company by specifying the EUPASS protocols, standards, etc. EUPASS.ORG supplies the networking.
- Therefore standards, specifications, architecture are main products of EUPASS. Joint research development based on the concept-needs uniform mind-set. Impact of EUPASS can be seen in future requirements stated by most system integrators today: Flexlink, Rohwedder, JOT, Photonics can all request module providers in EUPASS for special units, and these will be integratable with embedded control, standard interfaces, distributed control, etc. All need interoperability, distributed, agile control, etc.
- EUPASS cannot expect to see a EUPASS set of standards used globally within 10 years. EUPASS is proposing a “way of doing things”, a methodology. The tools are there to illustrate

how this may work. The tools will evolve in time to suit the needs of all the actors involved, but the methodology may remain the fairly the same. Hence the “philosophy of system design” has changed with EUPASS: architecture and guidelines, which remain independent of control solution, specific interface, etc.

The Concept:

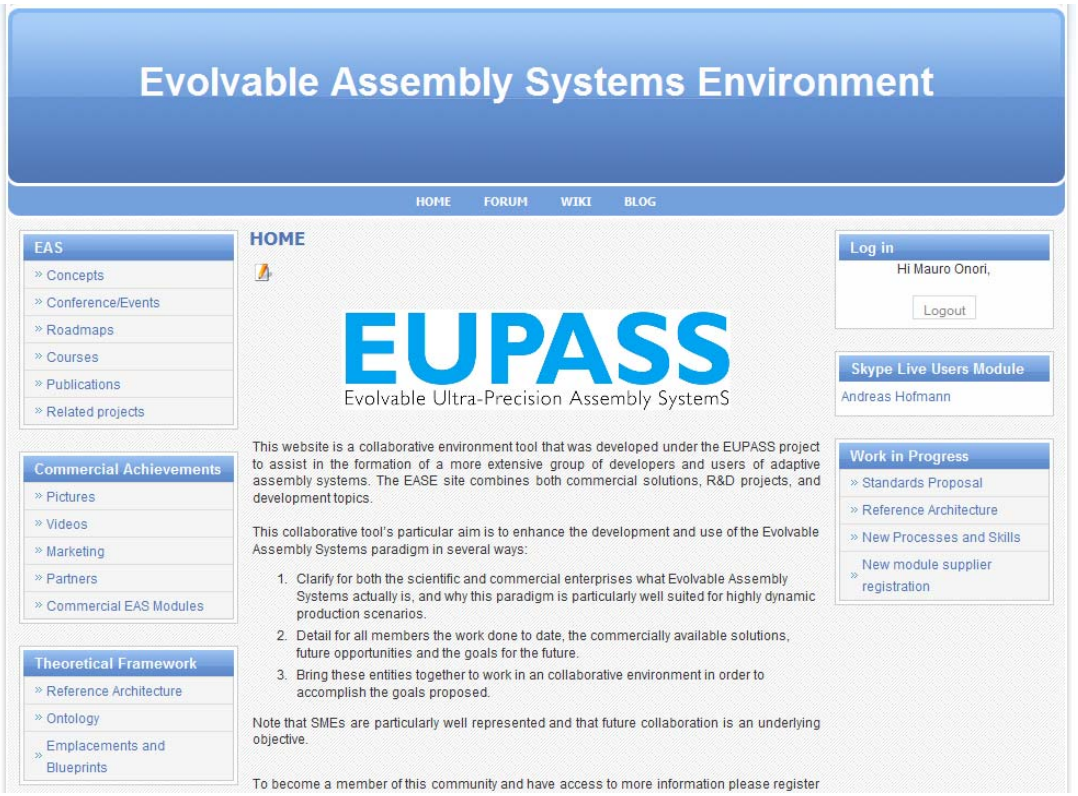
The requirements to developing interoperable, Evolvable Assembly Systems include the development of web-based services that can assist the deployment of systems by providing standards, interfaces (emplacements), architectural guidelines, etc.. Research teams in Europe and around the world are working in developing such models, standards and services, along with the practical implementation of their work.

The main problem is the poor information sharing between working groups, which usually get the information through scientific publications. Once the reader processes the information, a practical implementation of the model is necessary. This implementation, many times in form of a software module, is re-created since the first time was carried out by the primary researcher. If one considers the integration of assembly systems, the concept becomes even more serious as any duplication of the engineering work is production down-time and longer TTM. In order to avoid such duplication of effort, Eupass proposes the Evolvable Assembly Environment Tool-EASET activity that will enable different users and developers to collaborate by creating a virtual repository of applications. These would then be available for use, along with the related information (blueprint files, guidelines, source code, publications, etc.) for them to develop their own applications based on the original methodologies using the original implementations. In return, they would assist in the further development & consolidation of the technology, giving a competitive advantage to the European assembly sector through a virtual collaboration group.

In order to create the EASET, techniques for the verification and validation of the model "containers" are necessary, as well as the virtual environment for the repository.

The Implementation:

The extension group finally developed the WWW.EAS-ENV.ORG collaborative website, based on the objectives set above. The basic outline is given in the figure below.



The www.eas-env.org website fulfils all of the objectives set from the beginning, which were:

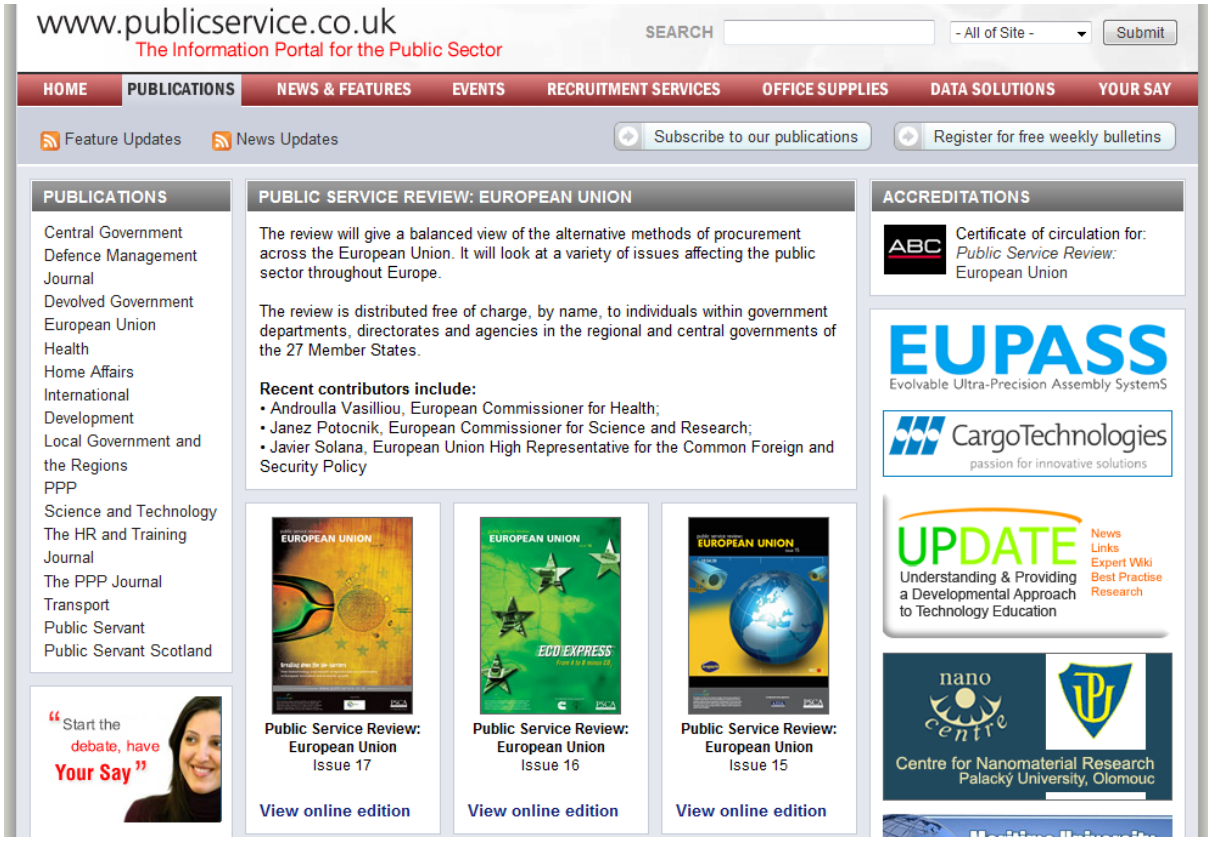
a. Networking, integration with MINAM. Network will evolve out of the connection of our ideas to other existing projects/networks-form a common platform of thought. This will link a group of projects at their end and create a continuation for their efforts (Masmicro, Eupass, Express,etc.).
b. The basic network will be developed out of the existing website but will be developed into a more collaborative technology platform with Architecture, Guidelines, Systems & modules, Standards and protocols being offered. It will link together forces into a community of thought. Standards may be a vehicle to demonstrate the ideas being offered.
c. Academic agenda is enforced through the further development of current R&D ideas. A "Community of Knowledge" becomes a realisable goal. Agenda of companies is hidden but may continue to exist to distill their results into interfaces; note- machines which are not open per se but can be easily integrated. Hence the "community" must be expanded in context: not only development of concepts but usability of results such that company-specific data is not revealed.
d. Consortium will be borne out of this. EAS-ENV.ORG companies will demonstrate the exploitation to date. EAS-ENV.ORG academics will demonstrate the continuous development scheme. Integration of other IPs is the strength behind this. Goal is to change long-term policy by setting practical, industrially-viable examples.

A.2 Dissemination of Knowledge

When	Where	Presentation Title	Presenting Person(s)	Presenting Partner(s)
21.4.2008	Hannover	Hannover Fair	Dr. C. Hanicsh	Festo
20.-26.4.2008	Hannover, Germany	Hannover Fair	Many	All
10.6.2008	Stuttgart, Germany	Forging Links - event	Many	Festo, TUT, UNOTT, KTH, etc.
2.9.2008	Vantaa, Finland	SISU2010 and EUPASS – Topical Workshop on Light Assembly	Prof. R. Tuokko, Dr. M.Onori, Dr. C. Hanicsh, Dr. N. Lohse, N.Siltala	TUT, KTH, Festo, UNOTT
8.9.2009	Gifu, Japan	SYROCO/IFAC 2009, Special Session on Evolvable Assembly Systems	M.Onori, N. Lohse, N.Siltala, J.Barata, A.Hofmann	KTH; TUT;UNOTT; FZK;UNINOVA
09.12.2009	Hong Kong, China	DET/CIRP International Conference on Digital Enterprise Technology	A.Maffei, N. Lohse, N.Siltala, J.Barata, A.Hofmann	KTH; TUT;UNOTT; FZK;UNINOVA

Table A.1.1. Presentations

Furthermore, through a special offer attained with PCSA International Ltd. (http://www.publicservice.co.uk/pub_selectissue.asp?publication=European%20Union), EUPASS is now represented within an external weblink (see below), and will be part of their Issue 18 publication due autumn 2009.



Title	Presenting Partner(s)
"Voltage/frequency proportional control of stick-slip microsystems", Rakotondrabe M., Haddab Y., Lutz P., IEEE • Transactions on Control Systems Technology.	UFC
"Miracles take a Little Longer"; M.Onori, Viewpoint, Journal of Assembly Automation, Emerald Press, Vol.28, No.2, 2008	KTH
"Evolvable Assembly Systems: coping with variations through evolvability"; D.semere,M.Onori, A.Maffei, R.Adamietz; Journal of Assembly Automation, Emerald Press, Vol.28, No.2, 2008	KTH
"Evolvability and the Intangibles";C.Hanisch and G.Munz; Journal of Assembly Automation, Emerald Press, Vol.28, No.3, 2008	FESTO
" Development, sub-step modelling and control of micro/nano positioning 2DoF stick-slip device",M. Rakotondrabe, Y. Haddab, P. Lutz, IEEE/ASME Transactions on Mechatronics, Accepted in May 2008	UFC
"Plurilinear modelling and robust control of a nonlinear piezoelectric cantilever"M. Rakotondrabe, Y. Haddab, P. Lutz, , IEEE Transactions on Control Systems Technology, Accepted December 2007, in press (the paper is accessible with IExplore)	UFC
"A new approach for microparts feeding system based on inertial force"; M. Paris, Y. Haddab, P. Lutz ;, International Workshop on Microfactories, IWMF 2008, October 2008, Evanston, USA	UFC
"Practical Characterization of the force friction for the positioning and orientation of micro-components", M. Paris, Y. Haddab, P. Lutz : Proc (DVD ROM) of IEEE/RSJ International Conference on Intelligent Robots and Systems, IROS 2008, Nice, France	UFC
"Achieve functions of microrobotics environment to succeed in micro-assembly: the case of the feeding function", Philippe Lutz; workshop on Grand Challenges in Microrobotics and Microassembly, 28th June, 2008, RSS conference, Zurick,	UFC

Switzerland	
"A Low Cost Coarse/Fine Piezoelectrically Actuated Microgripper with Force Measurement Adapted to EUPASS Control Structure.",Kanty Rabenorosoa, Yassine Haddab, and Philippe Lutz; IPAS 2008, Chamonix	UFC
"Evolvable Assembly Systems: applications and developments"; D.Semere, M.Onori, J.Barata; Proceedings of the 9th IFIP Conference on Information Technology for Balanced Automation Systems in Manufacturing and Services, BASYS08, Oporto, Portugal, Kluwer Academic Publishers, Sept. 2008	KTH & UNINOVA
"Evolvable Systems – Towards Self-X Production Systems ", D.Semere, M.Onori, B.Lindberg; Proceedings of the Swedish Production Systems Symposium, SPS 2008, Stockholm, Sweden.	KTH

Table A.1.2. Publications