Proposal title:	**Flexible Handling for Plug and produce**
Acronym:	**FLEX4PAP**
Call identifier:	FP7-ICT-2011-9: Objective 2.1(b): Cognitive Systems and Robotics
Call topic:	Cognition and control in complex systems
Call deadline:	17 April 2012 17:00 CET
Project duration:	36 months

Outline of Project Proposal

The interdisciplinary field of cognitive sciences investigates - beside many other aspects - also information processing of perception, memory, reasoning and how this is represented and transformed into behaviors of humans or machines. Part of cognitive processes of primates including humans is to learn via information fusion from different sensory channels about situations and objects that are perceived and recognized to stimulate and synthesize processes as actions like handling or maintenance of simple but also very complex items.

In particular the eye-hand coordination plays an important role at both stages, i.e. analysis of situation(s) and object(s) and synthesis of (re-)actions. Turning parts by hands in the field of view is the typical start-up situation for any further use of this part. In fact, additional sensory measurements are usually included in complex decision and planning procedures resulting from the multi-sensory description and abstract representation of information before decisions or reactions are expressed and stimulated, accordingly.

In automation and machining, people are often faced with quite different situations and items that make a considerable amount of re-configuration necessary although the new tasks contain a high degree of similarities of underlying principles that can be preserved and (re-) used. However, it is not always obvious and often needs long-term experience in a very narrow field of application. To replace this human-type knowledge processing by automatic procedures needs similar approaches starting e.g. from eye-hand coordination.

A simple example: a mechanical machine part is handled and machined by a robot gripper and machining tools. Change of size, lengths, surface or any other kind of functional element makes usually necessary to start any processing steps like gripping, path planning, tool selection, machining sequence from scratch e.g. by a complete new teach-in phase of a robot or a new numerical program for processing by particular tools. All of this might be necessary although the machine part consists of the same material, the same tools are used and the order of size has not changed drastically. However, most robots or machines are "blind" w.r.t. recognizing the potential for reuse and are far away from being able to "plug and produce" new items.

Considering all necessary steps as a collection of functions that can be mapped onto a set of agents, the coordinated interplay of all such elements remains a non-trivial concert that has to be conducted by appropriate approaches in cognition and control. Moreover, the cautious yet throughput-efficient handling of fragile or delicate objects requires novel and adaptive handling tools in order to outperform the conventional human handling of these parts. An up-to-date example is the time-efficient handling of silicon wafers during solar cell production steps with a minimum error/destruction rate to compete with the labor costs in non-European countries.

The application could be the following: within a machining station the handling system has a set of grippers and tools available to pick and place mechanical parts that are individually machined and processed. Planning of individual processing steps in a sequence, selection of appropriate grippers, choice of optimal gripping points from different visual aspects depending on and likely changing over the progress of the entire processing sequence is done upon mainly visual feedback but enriched by additional sensory data and measurements. Trajectory planning for the handling and machining subject to process and object constraints such as fragility and tolerances, selection of processing tools depending on the level of finishing, path tracking and control of manipulators and tools is done automatically for a limited set of different products to be produced at the same machine without human inter-action or re-programming of the processing station to achieve a situation for "plug and produce".

This enables:

- Scalable extension of the system capabilities through addition of new components, especially if the components consist of the same material and keep the order of size;
- Reconfiguration of the system functionality whenever new components are introduced will considerably be reduced because the new components are machined starting from a level of similarities to already known parts;
- Reuse of manufacturing equipments on all levels, i.e. grippers and tools;
- Migration and transition of the manufacturing systems to a modern architecture with the objective to reduce commissioning effort or ramp-up time because of reuse of known gripping or path planning fragments of previously machines parts;
- Customization of products by flexible manufacturing, e.g. for an easy extension of product portfolio.

Partners: Germany (University): non-linear robot control issues

Sweden (University): visual servoing of robots, arm-eye-coordination

Norway (industrial SME): 3D robot vision

Germany (industrial LE): 2D vision on networked smart cameras

Requested partners: any country:

(industrial LE or SME): robot grippers / end effectors

(industrial LE or SME): robots

(industrial LE or SME): manufacturer in end-user role requesting pick-and-place solutions for products of small lot or large variations targeting “plug and produce”