FAST RAMP-UP AND ADAPTIVE MANUFACTURING ENVIRONMENT

FRAME

FRAME is co-financed by the European Commission DG Research under the 7th Framework Programme.

FRAME VISION

FRAME aims to create a new solution for highly adaptive, self aware assembly systems, which will use automated self-learning, dynamic knowledge sharing, highly integrated sensor networks and innovative human machine integration mechanisms. The next generation assembly systems equipped with FRAME technology will be able to proactively support ramp-up, error recovery and operational performance improvement. This will lead to dramatic cost and time reduction of deploying and maintaining complex assembly systems on demand and improve their effectiveness.

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Inside this Issue

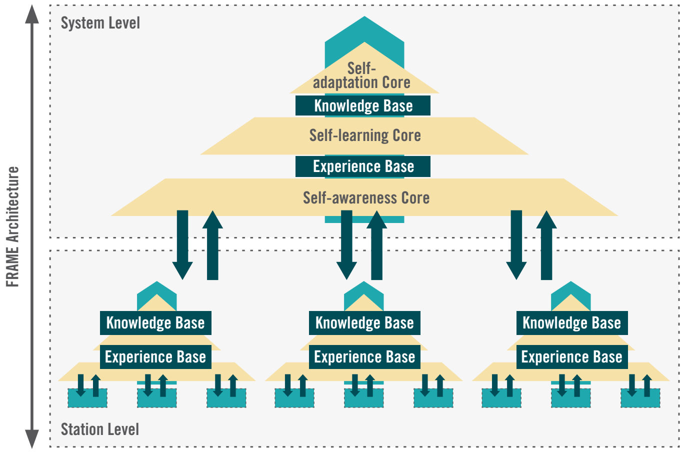
WELCOME TO THE SECOND NEWSLETTER...

...of the FRAME project, aimed to keep you up to date on project progress.

The FRAME project is targeted at the paradigm shift from conventional human-driven ramp-up and system integration to developing a fully automated, self-learning and self-aware production system environment. Since the publication of the first newsletter the project has focused on implementing the FRAME architecture and tools at industrial demonstrator sites. Preliminary results are shared in this newsletter. Look out for the third project newsletter where the value proposition for the application of FRAME will be both discussed and explored.

The FRAME project welcomes any external interest. Should you wish to understand more about the project or participate in the Industrial User Groups please do not hesitate to get in contact with the Project Coordinator or Dissemination Manager.

Editorial: The challenge continue



FRAME Architecture

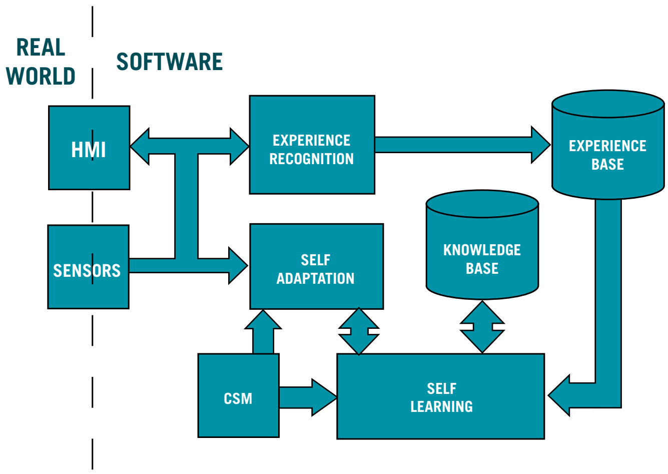
Architecture

The common vision of FRAME has been formalised and disseminated between partners both as architecture requirements and a common reference model. The initial FRAME architecture has been drawn up and released in collaboration with all project partners with a clear focus on the underlying industrial needs. Further iterations of the architecture are planned reflecting the developments that enable compatible solutions for the self learning and self adaptation cores.

Self Learning

One of the cornerstones of the FRAME concept is extending the functionality of assembly stations and systems with the capability to learn from experience. The FRAME self-learning core makes the inherent knowledge of the ramp-up, operation, and error detection and recovery process available and accessible for future decision-making.

The development of the self-learning core was amongst the most challenging technical features of the FRAME project. It provides the underlying mechanism for both learning from experience, and adapting that knowledge to new, similar situations. Remaining work relates to the refinement of the knowledge objects including affinity/similarity metrics and improved machine learning algorithms that can better predict reward.



Data flows between the FRAME components

Self adaptation

The self adaptation core's primary responsibility is to interact with the HMI and the self learning core to provide the user with decision support during the ramp-up process. The nature of the adaptation system is to provide decision support for a user, to allow that user to benefit from the experience of FRAME during ramp up. In that sense, the self adaptation core is a positive tool, informing the user of the relative merit of previously experienced adaptations, rather than a corrective tool attempting to correct poor choices or automatically making decisions on behalf of the user. Work that remains on Self Adaptation includes high scale testing of the KPIs and further development of the interfaces to other components (such as the behavioural model) to ensure the best predictions are made available.

Demonstrator scenarios

The FRAME project has a series of practically driven goals, with the ultimate aim of becoming a useful support tool for industrial ramp-up processes. Data collection based on real or at least physically grounded manufacturing devices is crucial at the development stage, in order to ensure that the software is fit for purpose and is capable of processing data with the volume and characteristics of a real manufacturing system. Two demonstration devices are the focus of the FRAME project development, one provided by Bosch and the other by Mikron, with a series of scenarios defined related to each to outline how FRAME interacts with the user.

Data collection from real production trials

Fast Ramp-up on Station-Level

The incorporation of FRAME concept on station level serve as the main operational interface between human operators and the embracing system level, and also bridge the gap between global system objectives and tangible day-to-day shop floor reality. Over the first 24 months, the activity has mainly focussed on the self-awareness level of the Station by implementing components such as: i) Time-to-Event Transformation (T2ET), ii) Pro-active Human Machine Interface (HMI) on station level and iii) Smart Tools.

Time-to-Event Trasformation

The T2ET connects the underlying assembly station hardware (Industrial PLC controls) with other FRAME stations. It serves not only as a pure interface but aims to transform time-based signals, counter values and statistics from the PLC into an manageable stream of FRAME Events. In this sense, data reduction/abstraction is conducted. Besides this a sophisticated interactive data analysis is implemented. This enables great potential as operators and engineers are provided with the foundation for transforming PLC data into an event-structure and also classifying events based on their origin. This allows for novel approaches to further use the raw material data in smart Production-IT systems. Operators are able to benefit immediately from the T2ET as it allows the display of data in an agile and interactive manor. Correlations, which may not be detectable at the machine, can be easily highlighted in the graphical representation.

Pro-activa Human Machine Interface on station level

The Pro-active HMI provides “user-tasks” to the human operator/ engineer and acquired data as FRAME Events. This component acts as the primary interface between the human operator/ engineer of an assembly station and the flow of FRAME Events inside a FRAME station. In order to best follow-up the ramp-up process, the FRAME core, as identified in WP2, needs observations not only from technical interfaces but also from users. The Pro-Active HMI follows ongoing operations at the assembly station and ‘encourages’ the user to provide as much knowledge as possible. To achieve this, the component tracks a list of “user-tasks”, which are called by the FRAME core in order to obtain more specific human input. The Pro-Active HMI shall orchestrate human interaction in a manner that does not either distract or annoy the user.

Human Machine Interface on station level

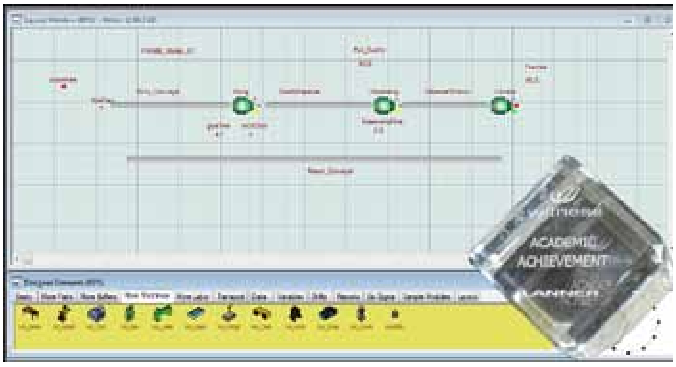
Smart Tools

The Smart Tools component addresses advanced tool & station tracking techniques. It provides further technical interfaces to the FRAME station to help the station to track changes which are not “measurable” by the T2ET. Implemented technologies include RFID 2D barcode reader and a tracking of code repositories. This component will use further sources of information (in addition to T2ET, HMI) to track ongoing activity within the assembly station. A vast variety of different tools and techniques to track will be investigated.

The self-learning and self-adaption functionalities have also been considered based on the current gathered results and have been partially implemented. The self-learning and self-adaptation functionalities considered include the following elements: Experience Recognition & Experience Base, System Level Interface, Self Learning & Knowledge Base, Self Adaptation and Behavioural Model Engine

System-Level

The implementation of FRAME “Brain” at the system level allows to evolve the methodologies and procedures developed at the station level and to produce a system that can assist in the ramp-up phase of work stations that are not controlled by the same infrastructure. The quaintly of information at system level is lower than that which is available at the station level and thus the development of the self-learning and self-aware cores will be even more challenging.
Referring to this activity, the University of Sheffield has recently presented the automatic generation of a WITNESS model from a mind map developed in Freemind at the Lanner academic showcase in Birmingham.



Automatic generation of a WITNESS model

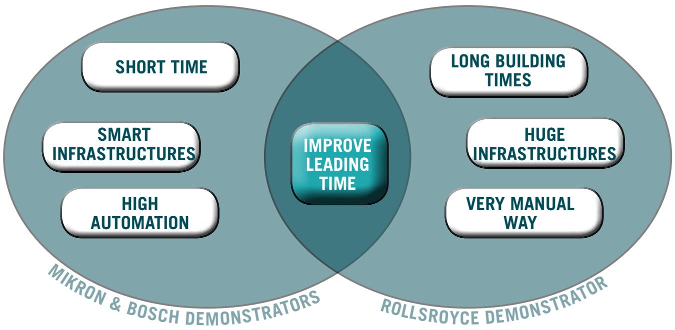
Industrial Requirements and Demonstrators

Industrial requirements

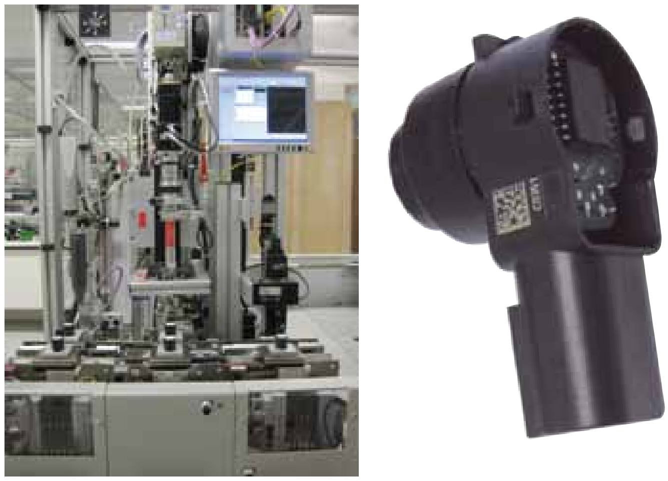
The three industrial partners of the project (Bosch, Mikron and Rolls Royce) have each proposed a test case. A common system life cycle comprising the phases design, development, build, production and end, has been identified. During the first 24 months of project, it has been identified different requirements: functional, technical, operational and quality. It is expected that FRAME will enable lead-time to be reduced during the system build phase and ramp-up reduced during the production phase. A common evolution of the Overall Equipment Effectiveness (OEE) within this lifecycle has been defined. The OEE remains at zero until the commencement of the build phase. A maximum value is achieved upon completion of the Factory Acceptance Testing (FAT) and Site Acceptance Testing (SAT).

Three ramp-up scenarios have been identified in the system life cycle phases. These are related to the OEE:
1) Build phase at the manufacturer's site.
2) Installation at the customer's site.
3) Production phase at the customer's site due to failures or reconfiguration.
The overall aim is to achieve the maximum OEE possible, through decreasing both the lead-time to market and ramp-up during production. And for that purpose, three demonstrator are provided to show FRAME capabilities:

FRAME DEMONSTRATORS



The FRAME objectives with respect to self awareness and self learning had been tested and proved during the second year of project and applied to two industrial demonstrators. The Bosch test case is an assembly process very close to those in use within automotive production environment and designated to mount ultrasonic distance sensors in different desktop manufacturing stations. The demonstrator's implementation includes gluing and dispensing processes and visual inspection to check the preceding steps. The pharmaceutical aspect of FRAME is covered by the Mikron demonstrator, which contains a production environment for medical devices. This test case includes feeding, mounting and inspection processes that represent common steps in the assembly of injection pens and focuses on high speed production. Within different sessions, the framework of FRAME had been applied to the two demonstrators which will show the self-learning principles of FRAME especially during ramp-up.
The third demonstrator is closely connected to an aerospace project within the University of Sheffield (AMRC) and represents a typical drilling process with several thousands of holes. It will show the FRAME idea with respect to self-adaptation based on result/vision data by means of process parameters.
The key target for all three demonstrators is to introduce the FRAME principles into the applications in order to illustrate their feasibility and quantify their effect.



Bosch Demonstrator:
Two dedicated desk-top modules

Mikron G05 Demonstrator Cell:
Designed & equipped with four processes

Rolls Royce Demonstrator:
Fully mounted Trent engine

FRAME Consortium

The **FRAME** Consortium is composed of 10 member organisations from 5 countries, bringing together academic partners, independent research institutes, large industrial companies and SMEs.

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