Nantes, France, 15/01/2013: Testing the Next-Generation CNC machine-tool

Exploiting Legacy-ISO and STEP-NC data in an expansive multi-machine, multi-process, multi-controller environment.

What is the best way to implement and test the Next-Generation CNC machine-tool? FoFdation believes the best way is to use a tried and tested method: use past and present verified technology with a sprinkle of new and exciting software and hardware developments. Recently EC-Nantes dedicated one of its functioning industrial CNC machines, the Cincinnati Milacron 'Sabre' milling machine with a NUM controller, in an effort to give a glimpse into the manufacturing future. A future that will answer the question of *what should the Next-Generation CNC machine-tool look like?* To this end, a prototype platform was created using currently available tools and new developments to build an Open-NC platform that will showcase functionalities expected in future CNC machine-tools. These developments were guided by the FoFdation Smart Machine Controller Open Architecture (FSMC-OA).

As hinted at in the FoFdation Press Release: Realizing the Next-Generation CNC machine-tool the platform has undergone several updates and extensions. (http://www.fofdation-project.eu/downloads/news/fofdation-press-release-ecn.pdf), Along with the original NUM-750 CNC and the recently added LinuxCNC open controller, the platform now houses the legacy CNC134 controller from Fidia as well. This means that at present, 3 different CNC controllers are all cohabiting within a single machine-tool, sharing the same physical configuration. With the guest (Fidia and LinuxCNC) controllers now active, one can easily select which of the 3 controllers to use for controlling the Sabre's 3-axes. Using a physical switch, signal sources are diverted to the respective guest CNC for complete control over the machine's axes (spindle, linear machine axes and handwheel). The switch also changes the signal sinks of the output signals that are sent out by encoders and limit switches to ensure full awareness and control.

The Integrated Platform: NUM-750, LinuxCNC-ISO, LinuxCNC-STEP-NC and Fidia-134

The Integrated Test Platform (ITP) was created to realize and demonstrate the evolutionary steps and benefits of STEP-NC. Furthermore, it serves as a unique all-in-one station to concretely illustrate how current legacy CNC controllers can, in the short term, benefit from and eventually migrate to the STEP-NC paradigm in the medium term. It also sets the stage for long term future developments towards the Next-Generation self-learning, intelligent and efficient CNC controllers. It is made up of 4 different CNC machine controller environments: NUM, LinuxCNC-ISO, LinuxCNC-STEP-NC and Fidia.

NUM: The NUM controller is capable of conventional 3-axis CNC machine control and milling similar to any industrial vertical milling machine. The simple controls and wide use and manipulation of this controller make it a good candidate for conventional milling activities.

LinuxCNC (ISO + STEP-NC): The LinuxCNC controller possesses 2 separate operational modes thanks to its Linux OS and Windows OS on-board computers. It can be used as a conventional ISO-code CNC controller providing state-of-the-art 3-axes control for the Sabre's axes thanks to its Linux based real-time kernel. The Windows extension PC means that a host of software from CAD, CAM to algorithms and in-house developed software can be used with this CNC. It can also be used as a STEP-NC compliant controller with the addition of the EC-Nantes' SPAIM platform for advanced STEP-NC programming and control.

Fidia-134 CNC: The Fidia controller is also a conventional CNC platform based on Windows OS with Fidia developed servo drives, PLC and other I/O peripheries. It provides state of the art CNC functionalities and advance control. The fact that it operates within the Windows environment means that software additions

such as CAD/CAM are possible. This fact also makes it a good candidate to demonstrate STEP-NC compliancy and for this the EC-Nantes' SPAIM platform will be embedded. The extent of the relative 'openness' of this controller is being investigated to determine if and how supplementary functionalities can be added to it.

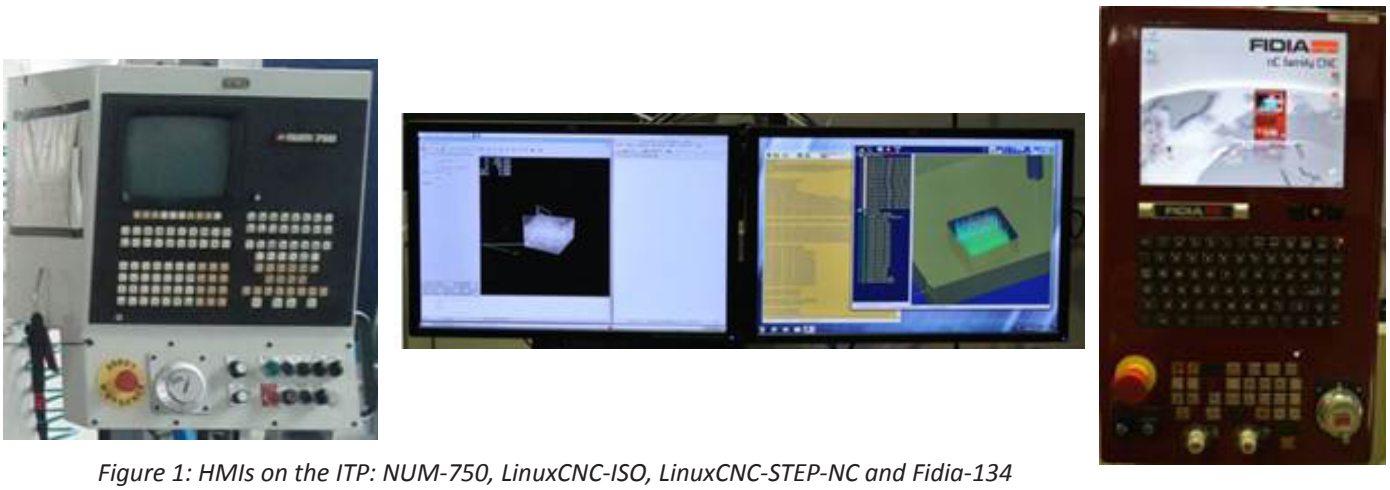


Figure 1: HMIs on the ITP: NUM-750, LinuxCNC-ISO, LinuxCNC-STEP-NC and Fidia-134

Focused Solutions - The ITP will focus on addressing 3 main solutions in FoFdation:

1. STEP-NC programming evolution in 3 stages : Use the unique multi CNC controller environment provided by the ITP to demonstrate the first (Interpreted) and second (Integrated) STEP-NC evolution stages while continuing the evolution of the third stage (Advanced) in STEP-NC advanced programming.
2. Real-time process data : Combine the flexibility of STEP-NC provided by SPAIM with algorithms and the EC-Nantes ICAM methodology developed for toolpath programming optimization based on real-time process to produce better and more accurate parts.
3. NC-Interpolation and trajectory planning : Perform smoother and more accurately controlled toolpaths driven in part by optimization research activities at EC-Nantes coupled with LinuxCNC developments performed by EC-Nantes and CADCAMation as well as Arais Robot Technology Inc and the entire LinuxCNC development community.

SPAIM was developed and implemented for multi-process machining supervision. It is a platform in which interactions between CAD, CAM, CNC, optimized and simulated data are seamlessly integrated to provide global access to data across multiple manufacturing processes (Figure 2). This is a primary playground for developing and testing CNC functionalities with the hardware on the Sabre ITP required of a future controller for continuous evolution with changing industrial needs.

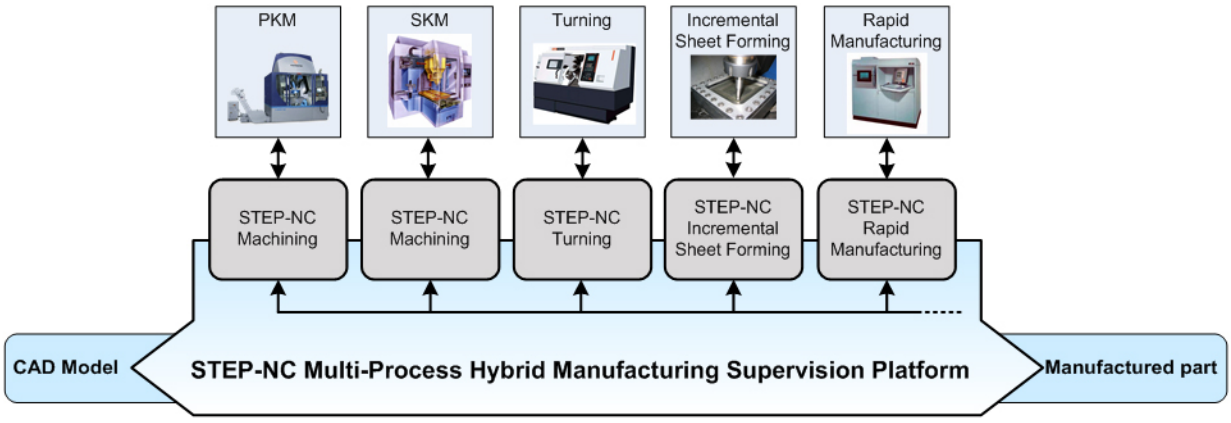
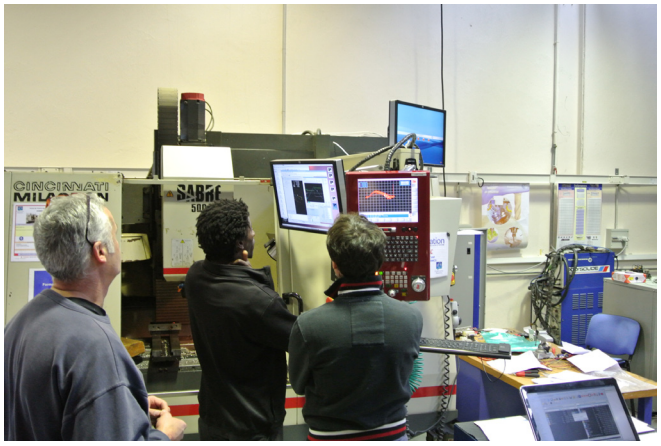


Figure 3: Prototype Platform - Electrical cabinet, LinuxCNC motion hardware, CNC source switch

Why is this Integrated Test Platform and STEP-NC compliancy important?

This platform is important as a tangible demonstrator for manufacturers to understand how they can begin to benefit with STEP-NC, today! It will also serve to show the steps necessary to make a legacy CNC machine-tool STEP-NC compliant. Manufacturers will be encouraged to see and make use of some of the many benefits of STEP-NC today on their existing machine tools and NC controllers. They will benefit by being able to: 1) read & execute the same part program on multiple machines by using the high-level non-specific data in STEP-NC; 2) modify part geometry and machining parameters directly on the shop-floor; 3) transfer knowledge and information from CNC to CAD/CAM and improve efficiency; 4) optimize machining parameters and toolpaths with new methods made possible by the data model; 5) improve internet-based collaborative manufacturing with the relatively small but high-level data files. In conclusion, high flexibility, process optimization and efficiency can be obtained with high knowledge and information transfer when and where it is needed.

Researchers can also benefit from this unique machine-tool with multiple controller environments. It is well known that no two machine-tools or CNC controller, even from the same manufacturer, are ever the same. This makes it difficult to make substantial comparison between different controllers and machines. Therefore, having a single machine configuration with multiple controllers permits a more appropriate comparison that is not hindered by large machine to machine variation. The ITP allows this to happen and it will be accessible for tests and research activities ranging from comparing machine and controller performance, to STEP-NC developments and milling process optimizations.



Installing and training on the Fidia CNC controller as part of the ITP [EC-Nantes]

Realizing FoFdation's SMC Legacy and Open-CN Architectures on the ITP [EC-Nantes]

Finally, we would like to welcome everyone to come and see the ITP and other solutions in the FoFdation Living Lab "Innolab" that will be created at EC-Nantes. This space will be instrumental in demonstrating, instructing and informing the manufacturing industry and general public of the problems that FoFdation is trying to tackle. More importantly, it will be used to showcase prototype solutions and architectures developed to solve those problems.

For more information about the FoFdation project visit **http://www.fofdation-project.eu** and the project's social media pages, including Facebook (**#fofdationproject**) and Twitter (**@FoFdation**).

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For further information please visit:
http://ec.europa.eu/research/industrial_technologies/factories-of-the-future_en.html