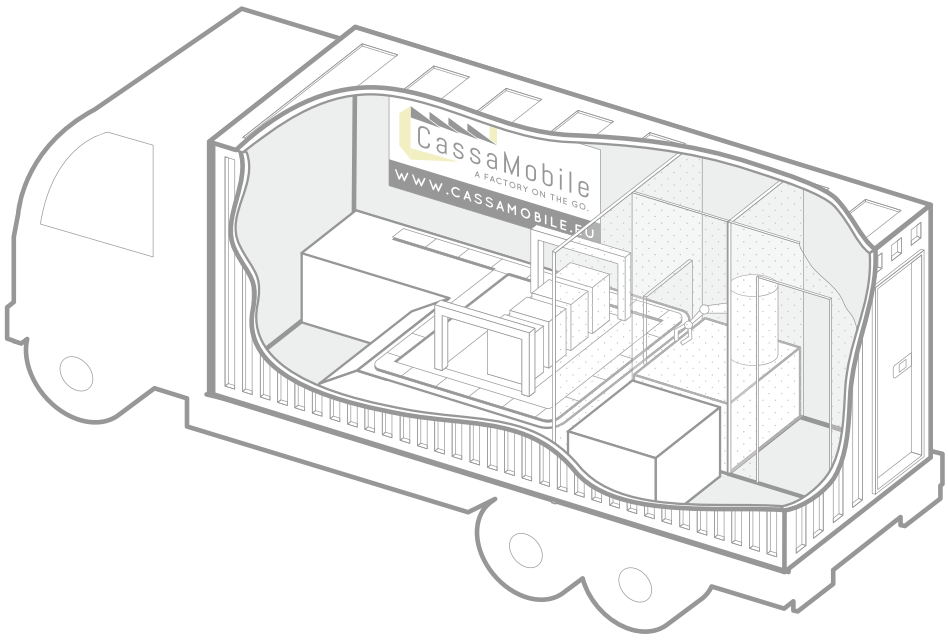
CassaMobile

A FACTORY ON THE GO.

Flexible mini-factory for local and customized production in a container

First Periodic Report
Publishable Summary

1 September 2013 - 28 February 2015



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Publishable Summary

The main goal of the CassaMobile project is to develop a new kind of local, flexible and environmentally friendly production system for highly customised parts based on a combination of different manufacturing process like 3D printing, CNC-milling and 3D-assembly technologies up to cleaning in cleanroom environment inside an enclosed unit such as a container. To reach the goal of the project major developments have been achieved within the first period of the project: Starting with the "Integration Methodology Workshop" and the "Industrial requirements" over the process module specification to a first system concept and architecture, a set of specifications was derived in order give guidance to all upcoming development actions. These developments include all specifications for each process module as well as the complete container equipment. All those processes were adapted not only to the needs of the use cases but also to certain necessary boundary conditions to achieve the complete system integration of all processes into an all-in-one flexible manufacturing system.

In parallel to those process developments, a generic "Product Demonstrator" has been developed for testing all processes before the actual system integration starts. The "Product Demonstrator" fits to the requirements of all three use cases. Both – the developments and the generic "Product Demonstrator" – lay the basis for a first system mock-up which will be used in the upcoming months to proof feasibility by producing test-parts that were defined as part of the specifications at the beginning of the project. Since month eighteen all process modules were available with basic functions so that the system integration can start without delay.

Another part of this mock-up is the software part which contains HMI, main control and a workflow manager. For all software parts first prototypes are available.

Within March 2014 (M6), the official project website was launched and during the last months the project's content as well as the project's goals was presented to a broader audience. Therefore the main idea of the CassaMobile approach as well as first results was published in different trade journals, on fairs and conferences with several presentations in order to address a wider community.

CassaMobile consortium

The CassaMobile consortium gathers 11 partners – research institutes, SMEs, companies, universities and is composed of the following organisations:

1. Fraunhofer Institute for Manufacturing Engineering and Automation
2. AFT Automation & Feinwerktechnik GmbH
3. University of Stuttgart
4. Critical Manufacturing
5. Materialise
6. TNO
7. Loughborough University
8. SCHUNK
9. COLANDIS GmbH
10. Peacocks Medical Group
11. SCIPROM

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Modular System Architecture (WP1)

Work package 1 "Modular System Architecture" started in September 2013 (M1) and consisted of four distinct tasks which forms the framework for the whole project. As a fundament for the project the industrial requirements from the use cases 1 – 3 were collected and summarized in a report. Based on those requirements necessary production processes for the use cases are analysed, the modular design of the complete CassaMobile processes chain were specified and the "System concept" developed. The comprehensive overall system concept is implemented in all R&D work packages 2 – 5. Due to many dependencies between the technical elements of the project, as top part of the surrounding framework, the project is scientifically coordinated and supervised out of work package 1 to ensure successful cooperation of all participants. Relevant standardisation, regulation and pre-normative research aspects were considered throughout the industrial requirements and the system concept.

User Machine Interface and CAM software –UMICAM (WP2)

Work Package 2 (WP2) started on February 2014 (M6) and is composed of 3 main tasks: Human Machine Interface (HMI), CAD/CAM System and Quality module (only starts on March 2015 – M19).

Taken into account the goals and requirements of the mentioned tasks, the activities performed up to February 2014 (M18) were mainly focused on UMICAM concept definition, software architecture design and specification, integration concept and specification between the involved components and software implementation.

The HMI is a single page application that should evolve in features and content as the project progresses (M19-M36).

Materialise has further extended their software components to support the medical manufacturing of medical devices using AM. Focus has been on the Build Processor (BP) framework which has been broadened to also generate specific files for the CassaMobile modules (e.g. milling).

Work has started on the CAD/CAM Converter tool which should provide the HMI and Main Control with the CAM data needed depending on which modules are required to produce the specific part.

The integration phase between the HMI, CAD/CAM and Main Control components is currently underway.

Self-Adaptive Control System (WP3)

State of the art control systems are designed to be configured once when the machine is started-up with the need of expert knowledge. Within WP3, a Self-Adaptive control system for the CassaMobile container will be developed which is able to handle the new challenge of modularity created by the modular CassaMobile concept which allows the user an easy interchange of different process modules.

The Main Control of the CassaMobile container is the communication coupler between the HMI/CAD-CAM conversion software and the single process modules and comprises the Configuration Manager, Workflow Database and the Workflow Manager. The Main Control enables an easy configuration of the production system and the product itself, also for an unskilled user. The Workflow-Manager is the central software tool of the Main Control and orchestrates the individual modules via the ModuleViewer (on each module control), and addresses their special needs for small pro-

duction lines in comparison to complex manufacturing execution software. It is designed for the special kind of small productions where short innovation cycles exist, small lot sizes are to be produced, new processes, materials or metrology are to be introduced, and where the production flow is frequently adapted.

A software based coupler system called a ModuleViewer enables the easy and independent integration of modules within a container environment. The ModuleViewer is a general purpose software solution to visualize, control, and automate the process modules. The ModuleViewer is separated into visualization, control, and server applications while the Workflow-Manager co-ordinates the process modules to perform the appropriate job related processes.

The Central Control System (CCS) of the CassaMobile container provides the possibility to operate modules without own control system (PLC). If, a module does not have its own integrated control system, the developed Configuration and Information Memory (CIMory) of the module provides such information to the Configuration Manager, which in turn uses the CCS module to implement a separate, software-based real-time control system for that particular module.

Process Module Development (WP4)

Work Package 4 commenced in December 2013 (M4) and consisted of five distinct tasks. Activities performed up to February 2015 (M18) were focused on the development, set-up, and preliminary testing of the four core process modules; Additive Manufacturing, CNC-milling, Assembly, and Cleaning.

Through the identification of key use-case and operational requirements, the specification of each process module was established. By doing such, module developers were able to identify and benchmark appropriate hardware and software components. A generic demonstrator component was also established to test the performance of a range of activities executed across the various process modules during development. Initial testing of key activities performed within each process module demonstrated successful results, with scope for further development and process optimisation beyond M18.

To facilitate the "plug and produce" integration of modules within the CassaMobile container architecture, a generic module carcass concept was also established to house the hardware and software elements associated with each process module. Activities for the integration testing of the process modules will be performed between March 2015 (M19) to August 2016 (M36).

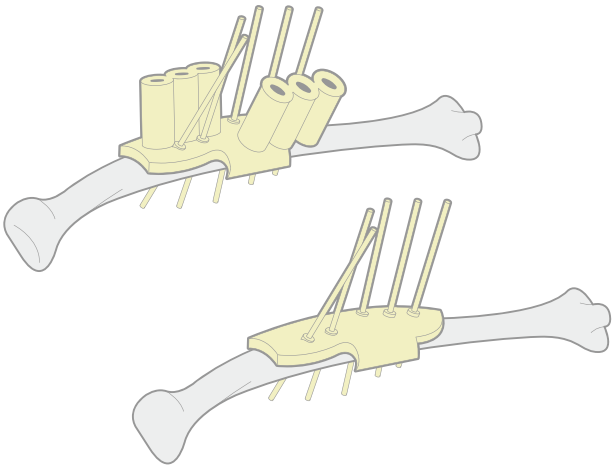
System Integration (WP5)

Work Package 5 (WP5) started in December 2013 (M5). Activities performed up to February 2015 (M18) were focused on the development, design, manufacturing and assembly of the module platform racks and the design of the container system.

A container system design integrating the modular machine and providing supply and filtered air conditioning was proposed. The container is currently being set-up.

A modular machine design was proposed, which is based on modular racks. Each of these racks integrates a process module and can be easily exchanged.

The electrical hardware plc, software and safety components are determined, designed and is currently set up. To facilitate the "plug and produce" integration of modules within the CassaMobile container architecture, control cabinet and further supply elements are associated with each process module. Activities



for the integration of the process modules will be performed between March 2015 (M19) and August 2015 (M24).

Use case 1 (WP6)

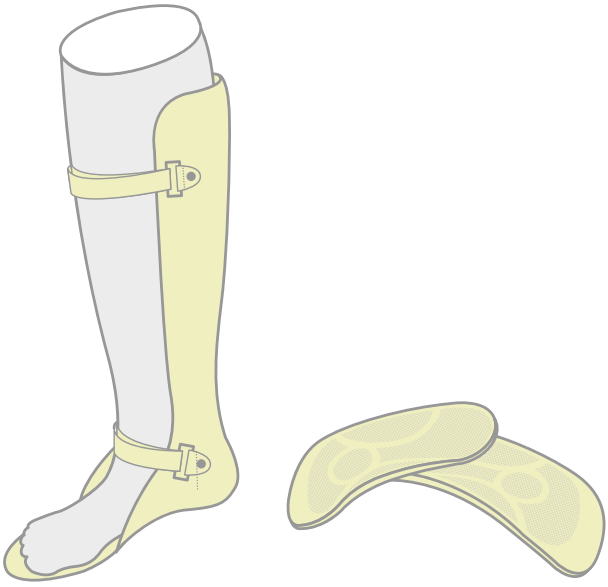
The main goal of this work package is to demonstrate the working principle and the potential of the mini-factory in production on the basis of the local production of bone drill guides. The work package started at September 2013 (M1) and ends at September 2016. First of all the necessary information have been collected to create a requirement list. These have been discussed in several workshops and consortium meetings and resulted in a report. Out of this report the industrial requirements were derived which specify the needed material properties, software tool, equipment etc.. Furthermore, the current production process of the use case scenario has been analyzed. Out of this data the possible future CassaMobile production processes was created in several meetings.

In task 6.2 the first exercises have been done how the design of the CassaMobile container needs to be tuned to for the local production of the guides. It has been also defined which AM process is sufficient and also software concepts have been created. Additionally first drafts have been made on which modules should be contained in the CM container for the Materialise use case.

Use case 2 (WP7)

WP 7 is part of demonstration portion of the project and work will be carried out throughout the whole duration of the project. Within this WP, PEA will utilise the new mini-factory for producing orthotic devices. Three significant objectives of this work package have been identified as to fully define material and product description and requirements for orthotic devices, to develop a new orthotic concept concurrently to the manufacturing system development and to validate the concept by produce developed devices with the mini-factory. A comprehensive material and product investigation was carried out in order to establish requirements for the orthotic products. Results were shared with consortium and particularly system developers. At the beginning the industrial requirements were documented in form of a report which was due and delivered in December 2013 (M04). This report outlines system specifications and requirements for manufacturing orthotic devices on-site in a container including both materials and products requirements.

In order to achieve “A preliminary description or the modular orthotic concept”, PEA has been considering different additive manufacturing processes. Different processes were investigat-



ed to establish any potential process satisfying requirements. Based on results of close collaboration between PEA, UoL and FhG-IPA and the choice of AM an additive manufacturing process was selected for orthotics use case. Based on this selection, different 3D-printers were compared and the most suitable one was chosen. The device was modified by FhG-IPA to reach required specification by PEA. Milling choices has also been considered and required milling machines were purchased.

Preliminary design concepts have been developed for both FO and modular AFO devices and initial prototypes have been built for validation with both the additive manufacturing printer and Milling equipment. Additionally in order to test the final products' performance and fatigue properties which could be related to material, process and/or design, testing methods and test rigs were designed. The test rigs are being built and developed accordingly to establish the products' performance.

Use case 3 (WP8)

Work Package 8 (WP8) commenced in September 2013 (M1) and consisted of three distinct tasks. Activities performed up to February 2015 (M18) were focused on the requirements and specifications for individual grippers and the development of concept for generic customizable grippers.

Through the identification of key use-case and their requirements, the specification of customizable grippers was established. By doing such, the members of WP 8 were able to define the range of expected grippers and the definition of a process leading to an automated virtual adaption of the tools depending to the handling object.

The industrial requirements have been described and prioritized, leading to the specifications of demonstration case 3. They were described in detail and also three different strategies for getting useful individual grippers in the container scenario have been developed.

SCHUNK has done some further development in the planned use-case, which contains three different concepts of "individual grippers". Besides the main use cases, a generic demonstrator component was created to get fast results for the single process modules. Most of the done handling-tests were made with the generic product demonstrator to get quick and comparable results. The further developments of all three different concepts are planned till the end of August 2015 (M24).

Activities for the validation of the demonstration production will be performed between September 2015 (M25) to August 2016 (M36).