

Template for Catalog Info Delivery

Please find the list of section to fill in and short explanations on what detail/clarity level to maintain to have all the profiles in a comparable and standardized form.

More information on pictures and their requirements will be shared soon.



Template for Demonstrator Description



1. Basic information

1.1. Title of the demonstrator

Affective Manufacturing System

The Trinity project team from Mentech and Tegema developed a demonstrator in which an ABB cobot works with an operator while performing complex assembly tasks. Stress detection was integrated to measure operator emotion during a cobot-assisted assembly task for optimal operator engagement (both in terms of operator well-being and productivity).

1.2. Main Objective of the demonstrator

The objective of the project is to demonstrate a smart factory concept, for robotics-based manufacturing of complex photonic products, with in-line operator stress detection for safety and optimized production (in terms of yield and product quality). The demonstration is based on a modular machine platform with robotics functionalities for efficient and customized production of complex photonic systems. The platform has in-line monitoring and quality control functionalities for in-line adaption of production steps. The demonstration includes an appealing showcase in which human factors are successfully included in the execution of a manufacturing process for optimized production, eventually to open the gateway for affective cobots.



1.3. Short description

A robot can take over complex tasks, making the assembly process safer, faster and qualitatively better. The downside of working with a cobot is that the potential loss of control can cause stress for the operator. And stress has a negative impact on well-being, safety and productivity.

The affective manufacturing system has an integrated robotics system for manufacturing of complex photonic systems and contains a sensor system for in-line process monitoring. The platform integrates a novel operator stress detection module, based on measured physiological features of the operator, and artificial intelligence algorithm for stress detection. Production performance and related operator stress is displayed on an interactive dashboard, used for both stress management and process control. The measured stress levels are used in a smart decision algorithm that takes into account all relevant decision factors, such as the stress indications (emotional state) of the individual operators as determined by the measured and analyzed features; information about circumstances (private, work) of the employee; information about the production process, such as the measured performance indicators (product quality, productivity, failure, etc.); and production instructions (such as the complexity of the instruction or work).

1.4 Owner of the demonstrator

Mentech, an Eindhoven-based company, commercializes emotion artificial intelligence platforms based on wearables (for physiology and speech recognition), behaviour models and machine learning to facilitate behavioural change, to improve self-management, to enhance quality of life and happiness. Mentech was founded in 2016 to give a voice to vulnerable people with misunderstood behaviour as they are often insufficiently able to express their emotions. The HUME, an early warning system for stress detection, was initially developed to provide vulnerable people with (intellectual) disabilities and limited opportunities to verbally communicate with a voice. The HUME consists of wearables with built-in electronics and sensors to measure physiological data (such as heart rate, skin conduction, skin temperature and activity), and a data analysis platform to translate these measurements into stress levels and other emotions via smart algorithms and pattern recognition.

www.mentechinnovation.eu

Tegema is a machine builder and system integrator. We improve the production performance of our high tech customers leading to lower production costs, higher production quality and flexibility by providing a unique combination of competence in engineering, production and assembly techniques and automation, and application knowledge in joining and bonding. Products: robotics-based assembly systems; bonding systems for manufacturing of high-precision high quality products, engineering services.

<https://www.tegema.nl/en/>

1.5 Responsible person

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1.6 NACE

C28

J62

1.7 Keywords

Stress management, wearables, artificial intelligence, cobot assisted manufacturing, affective manufacturing.

2. Innovation

2.1 Potential users

Potential user: OEM companies producing machinery and production modules for low-volume high-mix complex products, high-tech assembly applications.

Potential user: ODM companies producing complex high-tech parts.

Potential user: labour-intensive industries, such as manufacturers of goods, process industry, food industry, for stress management and operator happiness.

Potential user: customized equipment for labour-intensive industries, with operators with a mild intellectual disability, labour-assisted manufacturing.

Potential user: automotive companies, manufacturers of transportation systems, like trucks, buses, etc. interested to increase driving performance and safety of driver, passengers, and environment.

2.2 Benefits for the user

Affective manufacturing leads to improved efficiency and productivity, by incorporating human stress factors in the optimization of the production processes. The performance of a process depends on the complexity of tasks and the arousal level the operator experiences. For simple tasks, low arousal (inattention of the operator) leads to poor performance, high arousal leads to high performance. Difficult tasks however require moderate arousal for optimum performance. A too low arousal (inattention or drowsy) as well as a too high arousal (stress) lead to poor performance and should be avoided.

Affective manufacturing leads to improved product quality. One of the requests is error-free production through a self-learning production method in which the system responds autonomously to any errors. The addition of affective strategies will further be strengthening this self-learning and will cause a paradigm shift in smart manufacturing. It will create higher standards of production, and more operator and happiness.



Affective manufacturing leads to improved safety, by preventing under-alertness or drowsiness.

Affective manufacturing leads to improved self-control and operator satisfaction/happiness.

2.3 Innovation

Mentech and Tegema demonstrate an affective production platform for high-quality production of low-volume high-mix products. The demonstration is based on a modular machine platform with robotics functionalities for efficient and customized production of complex photonic devices. The platform integrates operator stress monitoring to harmonize productivity and operator happiness.

The platform comprises a pick-to-light module and a cobot module for cobot-assisted assembly. The pick-to-light module consists of several manufacturing bins with LED indicators to guide the operator through the assembly tasks. The sequence of assembly is indicated by the subsequent switching on and off the LED indicators. The bins also contain proximity sensors to measure the completion of the different assembly tasks. A cobot platform is integrated in the assembly line to assist the operator with complex assembly tasks. Multiple assembly sequences can be uploaded to the system, making the system a flexible manufacturing platform.

The operator stress is determined from real-time measured stress features, like heartrate, skin conductance and face expressions. A trained neural network model makes a prediction of the stress levels of an operator during assembly based on the measured physiology and recognized patterns.

A dashboard visualizes the system metrics, like the required time for assembly tasks, assembly errors and cobot performance, and the measured operator stress. Based on the dashboard outcome, system and operator interventions can be initiated.

The AMS showcases that a hybrid manufacturing platform with a decision algorithm based on operator stress levels will harmonize production and increase yield and production quality.

2.4 Risks and limitations

Stress measurement – the measurement of distinct stress levels is difficult in a dynamic high-tech environment. Mentech has a lot of experience with the development and training of personalized stress models. The stress model used in the Affective manufacturing system were trained with personal data obtained in a well-conditioned reference setting. After training, the model was applied to the operator setting.

Operator Acceptance - Measuring operator physiology can also backfire. He or she may experience this as a check by the manager. The merits of operator stress measurement are both operator/machine safety and productivity. Particularly, safety is a key selling feature for acceptance of stress detection.

Reliability / Accuracy - The stress detection models must be accurate enough to be integrated as a feature for increased safety and productivity. Inaccurate predictions of stress levels might lead to reduced



productivity of reduced safety. The development and training of models in reference setting, with the addition of face expression, contributes to accurate stress detection capability.

Acceptance by operator – The affective manufacturing system will not be accepted by the operator/customer. The benefits of stress detection, also for operator safety and happiness, need to be made explicit. The privacy of operators need to be secured via a privacy statement.

2.5 Technology readiness level

TRL 7

3. Exploitation

3.1 Sectors of application

Tooling industry: equipment manufacturers (OEM), addition of human-machine interface to improved product quality and system productivity;

Transportation industry: manufacturers of cars/trucks/busses/trains/planes/etc., including affective strategies for road safety and driving performance (economics like action radius and energy consumption, passenger comfort);

Making and processing / food industry: optimization of production, increase of operator engagement (happiness and arousal);

Labour-intensive industries, with operators with a mild intellectual disability, labour-assisted manufacturing.

3.2 Potential sectors of application

All segments in which human-machine interfaces are relevant, like manufacturing, system control, production control, operation of machines and systems.

3.3 Patents / Licenses / Copyright

Mentech owns IP in the field of models and hardware for stress detection and regulation.

Tegema owns IP in the field of high-tech equipment development including pick-2-light and robotics systems and control hardware/software.

3.4 Trainings

Customized training programs are offered.

3.5 Hardware / software

The Affective manufacturing system (AMS) consists of the following elements



- Cobot-assisted Pick to light assembly unit with manufacturing bins, consisting of control electronics and software, LED indicators, proximity sensors and assembly tools for complex products; with an integrated Cobot assembly unit.
- HUME stress detection platform, consisting of wearables and trained models (operating in the cloud), optionally a camera system for face recognition and stress detection can be integrated.
- Dashboard which visualizes the production metrics (like productivity, production times, production errors) and operator stress levels.

4. Media

4.1 Thumbnail image



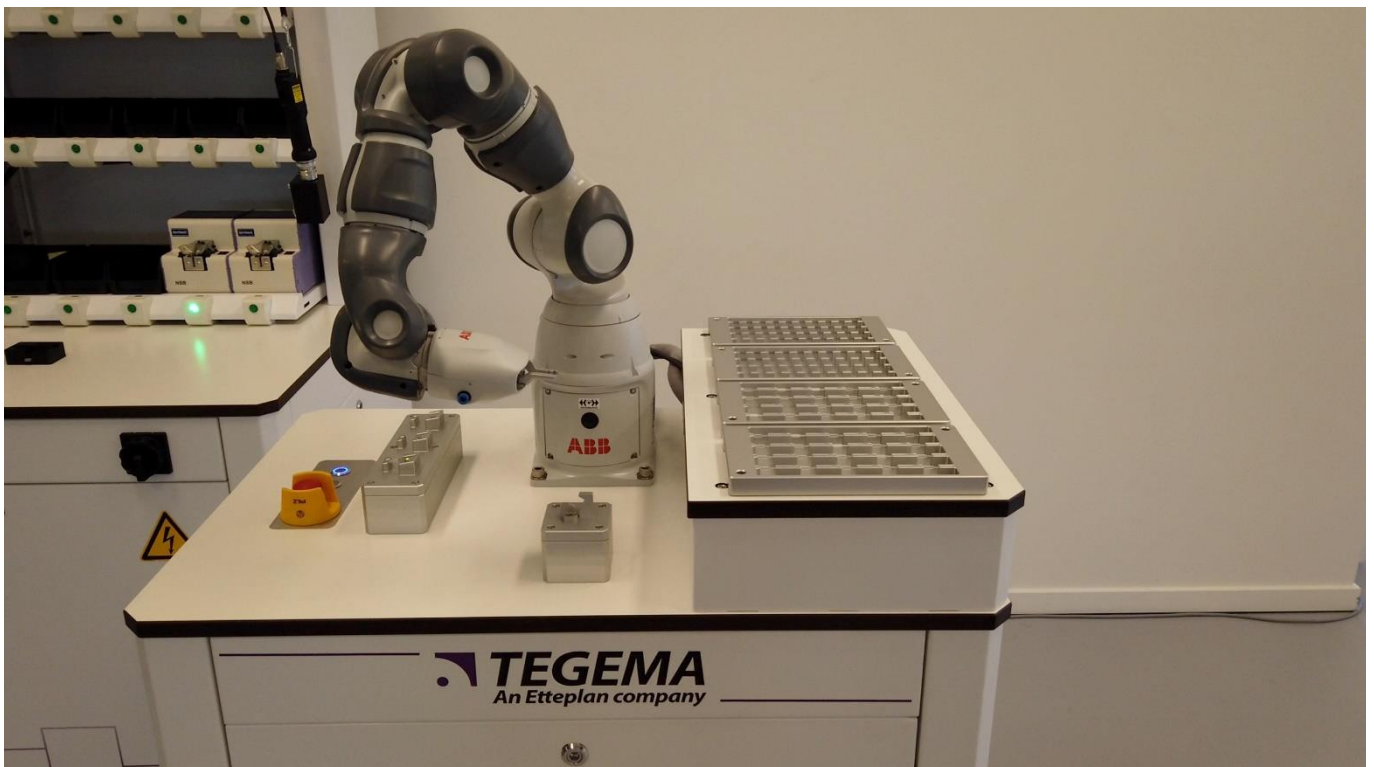
Overview of the cobot-assisted affective manufacturing system.



4.2 Photos



Overview of pick-2-light production cell with manufacturing bins, LED indicator and proximity sensors.

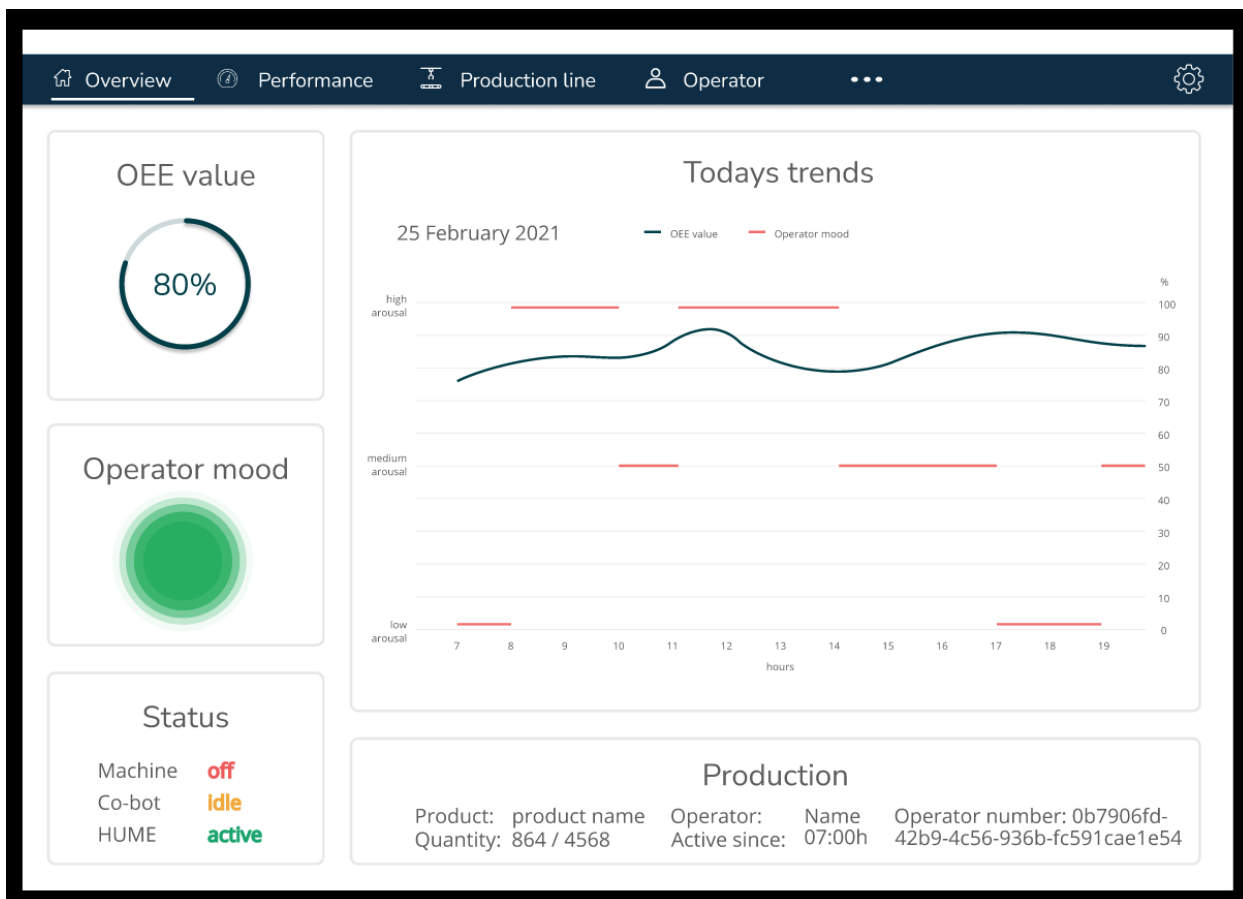


Overview of cobot production cell for assisted assembly.



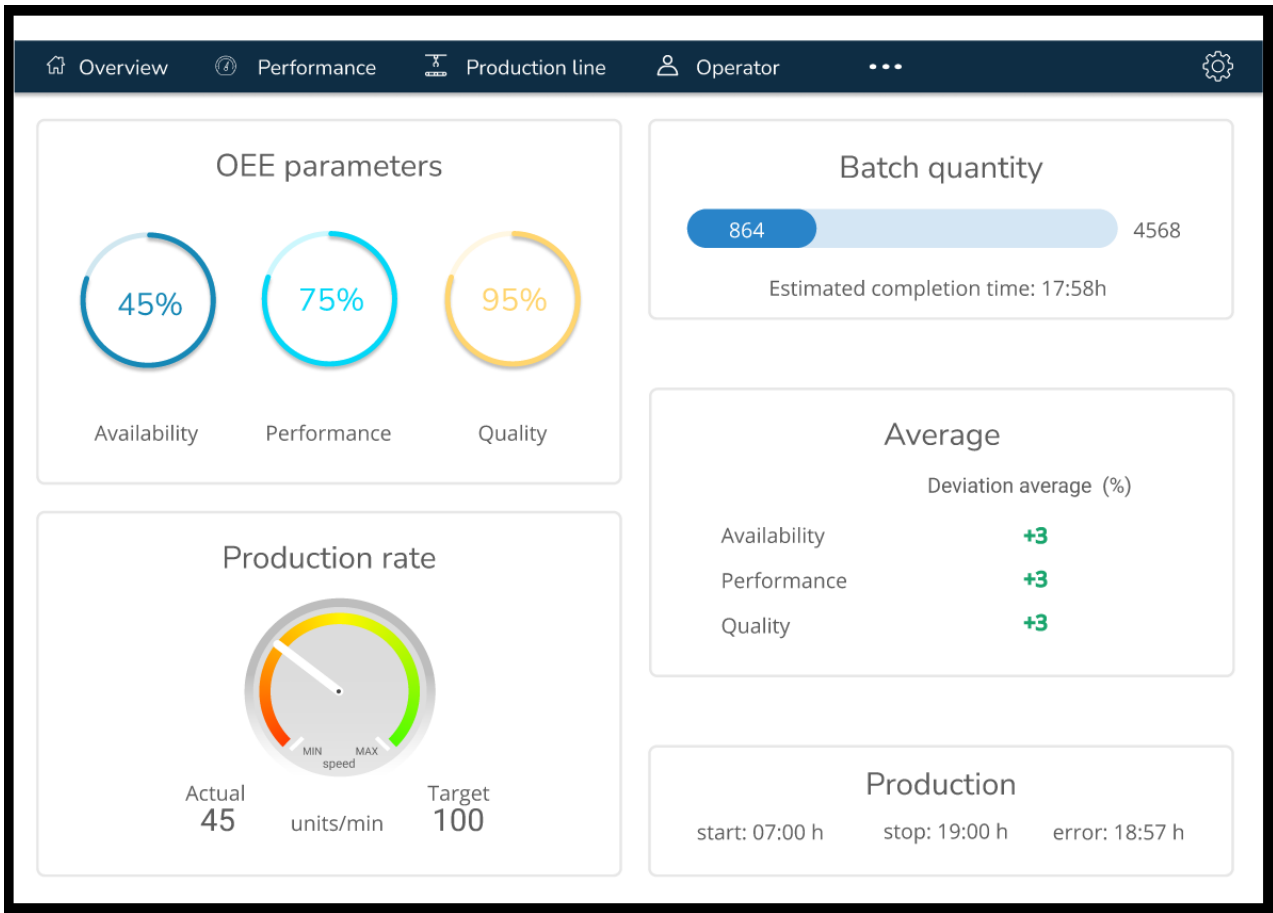


HUME stress detection system, with wearables and interface.

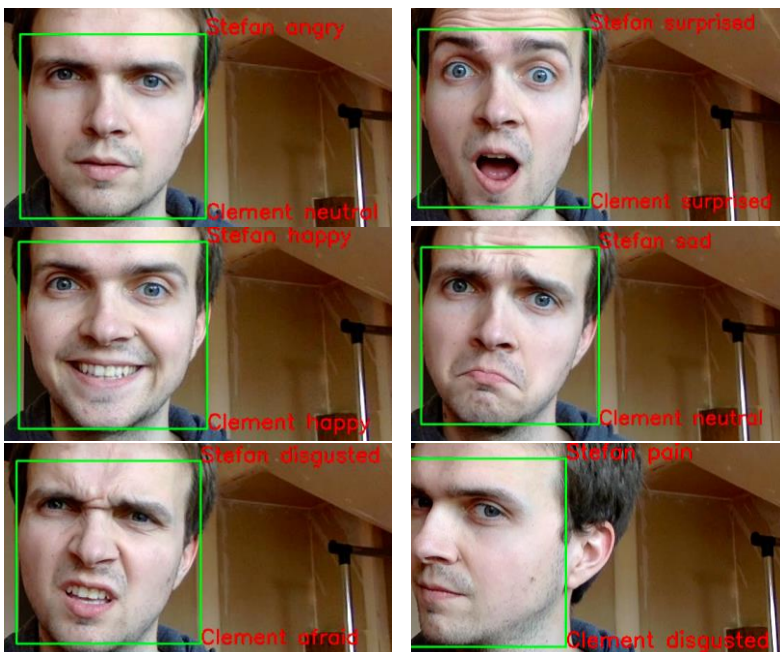


Dashboard to visualize the production metrics and operator stress.





Dashboard to visualize the production metrics and operator stress.



Stress detection based on realtime face recognition.



4.4 Video

<https://www.youtube.com/watch?v=2eOMwksg5sc>

