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Zenithwings • Fraunhofer AICOS • LIBPhys-UNL (FCT Nova) • Volkswagen Autoeuropa • NST Apparel Lda • FPCEUP • Controlconsul • Universidade do Minho • Institute for Medical Engineering and Science (IMES) at MIT

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FACULDADE DE PSICOLOGIA E DE CIÊNCIAS DA EDUCAÇÃO UNIVERSIDADE DO PORTO

CONTROL CONSUL

Universidade do Minho

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The industrial and service sector in Portugal employs around 23% of active workers, which makes it a highly relevant sector for the National Economy. However, in order to guarantee competitiveness, modernization and internationalization strategies are on demand, especially concerning digital transformation in manufacturing. Systems developed for this purpose need to be flexible to assist the shift from mass production to mass customization, but always keeping workers, their productivity, job satisfaction and health at the centre, so that digital transformation enables sustainable operations.

We propose to develop tools for risk exposure data analysis in the workplace, building on the concepts of Positive Ergonomics, Operator 4.0 and on the Job Quality Indices by the Eurofound, by collecting and visualizing data on aspects such as physical environment, work intensity, working time, social environment or skills and discretion. In particular, technology components will be able to:

- **Perform automatic monitoring of human movements and ubiquitous exposure, with subsequent detailed movement analysis and continuous monitoring promoting the most adequate work methods;**
- **Support mental wellbeing through self-reporting and individual visualizations for worker awareness, education and self-management;**
- **Support asset management (Digital Twin) through automated processes.**

The project's objective is, thus, to approach the Industry 4.0 workplace holistically, but from the workers' point of view, gathering and crossing quantitative and qualitative data, building a richer picture of the workers' wellbeing and enabling better predictive models. We will continuously validate our developed solutions and build large data sets through continuous field work, ranging from short contact sessions during technical development, to long-term trials enabling impact assessment.

The outcome of the research and development process is a product, in the form of a system of technologies, which can be commercialised by the promotor of the project to industrial production units which have gone or are going through the process of digital transformation.

OPERATOR

Digital Transformation in Industry with a Focus on the Operator 4.0

OPERATOR DATA ACQUISITION PROTOCOL

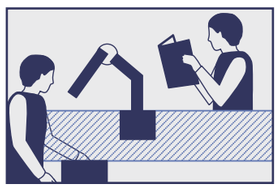
COGNITION • Self-Reporting • fNIRS | **PRODUCTIVITY** • IMU | **ERGONOMICS** • IMU • EMG • ECG

WEEK 1 — **Goal**

Preliminary semi-structured interviews to key stakeholders
• Heads of production & Decision makers
▶ Understand impacts and challenges of technology introduction

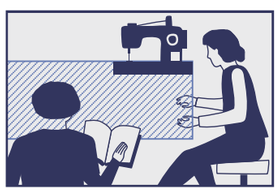
• Operators
▶ Explore self-perception on tasks & personal metrics, social environment & health, attitudes towards technology & attitudes toward monitoring & self-monitoring

Diary study (hand-out)
• Operators
▶ Prompting self-tracking (dimensions: emotional, physical and social wellbeing) Timepoints: before shift, after shift, end of day



WEEK 2 — **Goal**

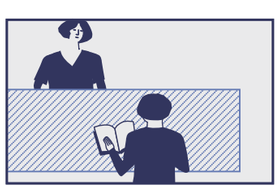
Open in-context observations and verbalizations
▶ Understand operators' real work and appropriate work jargon



WEEK 3 — **Goal**

Systematic in-context observations
▶ Perform task analysis, characterise human-machine interaction and variability in operating modes

Diary study (retrieving diaries)



WEEK 4 — **Goal**

Semi-structured interviews & prompting with diary data visualizations
▶ Debrief observations and explore experiences with, and attitudes towards, self-tracking

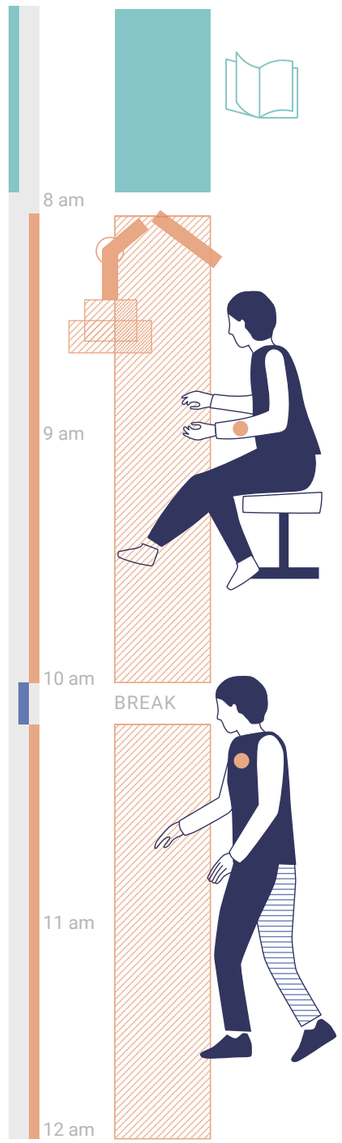
WORKING DAY

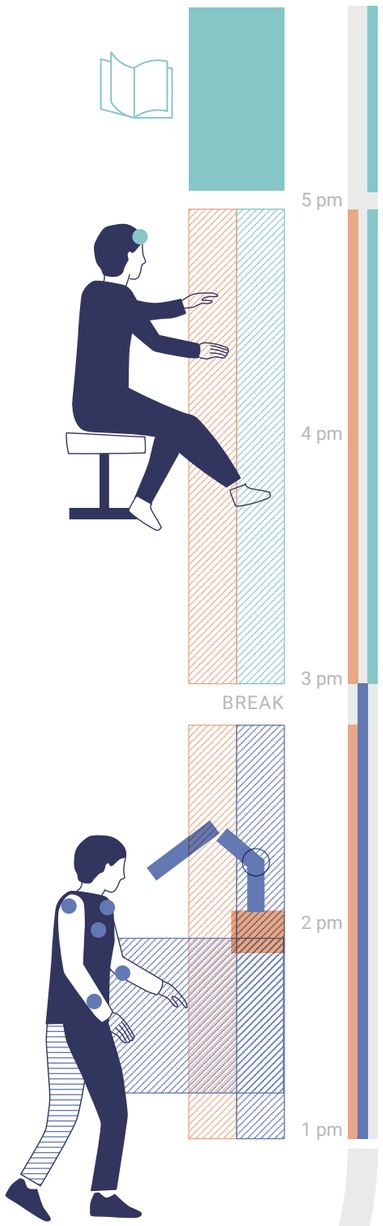
• Self-perceived physical, emotional & social wellbeing

• N° of work cycles
• Average production rate
• Similarity with standard method
• N° of unplanned stops

Acc
Gyr
Mag

8 am
9 am
10 am
11 am
12 am
BREAK
BREAK
LUNCH
5 pm
4 pm
3 pm
2 pm
1 pm
BREAK





• Self-perceived physical, emotional & social wellbeing

• Perceived workload

CH 1
CH 2
CH 3

• Normal sinus recovery time after stress

ECG
HRV

• Ergonomic risk exposure (EAWS, RULA, etc.)
• Fatigue

Acc 1
Gyr 1
Mag 1
(...)

Data acquisition equipment:
• IMU: Xsens MVN Awinda & Sensry Kallisto
• ECG and EMG: Plux MuscleBAN
• fNIRS: Plux fNIRS Explorer