

# Professional TEL 4.0

## Performance Augmentation for Industry 4.0



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Performance Augmentation Lab

# Overview

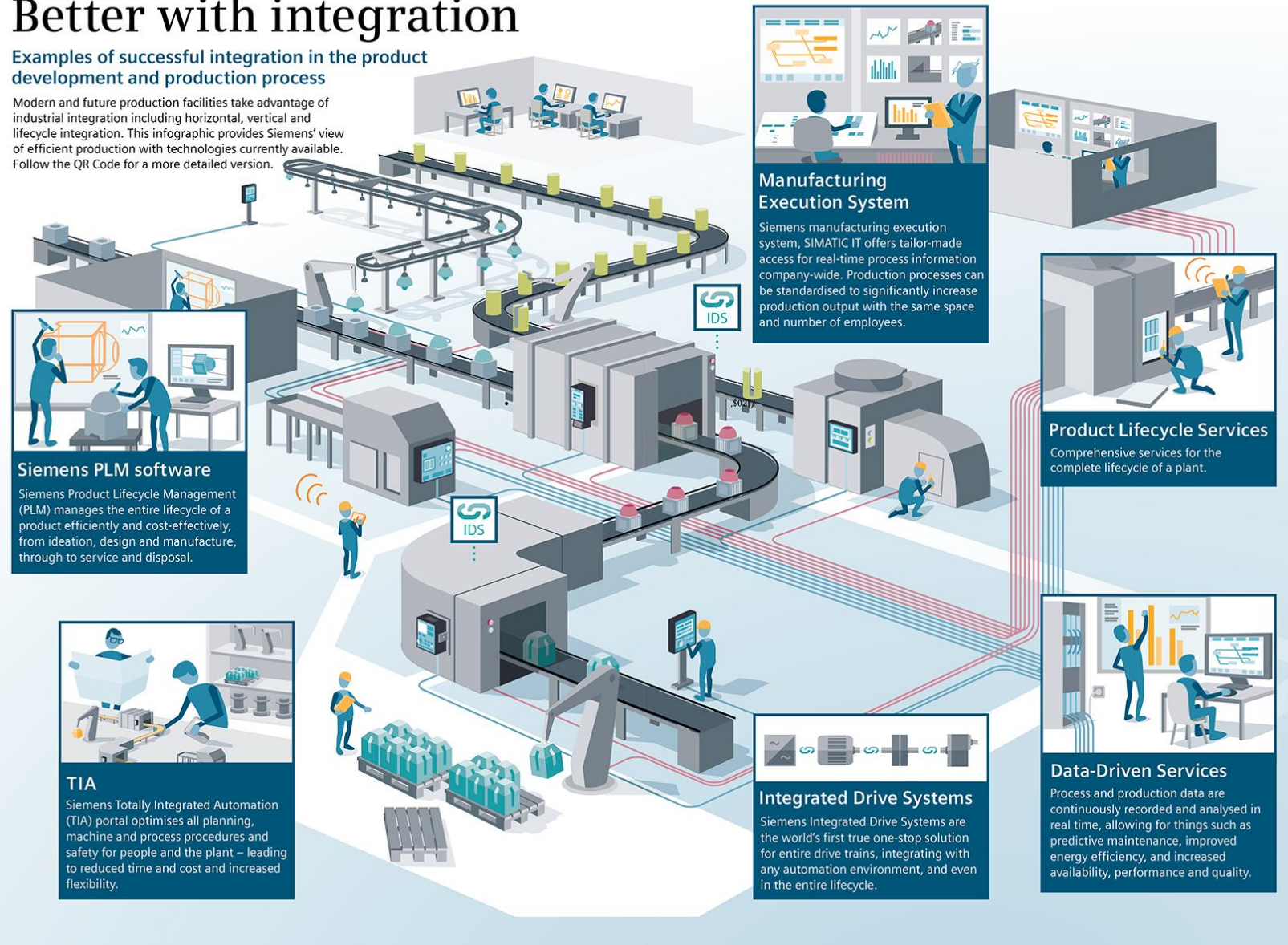
- The context: Work 4.0
- The solution: Human **Performance Augmentation**
- WEKIT
  - Framework
  - Reference Architecture
  - Standards
  - Garment
  - Film
- Findings

**Context (aka 'the problem')**

# Better with integration

## Examples of successful integration in the product development and production process

Modern and future production facilities take advantage of industrial integration including horizontal, vertical and lifecycle integration. This infographic provides Siemens' view of efficient production with technologies currently available. Follow the QR Code for a more detailed version.



**Siemens PLM software**

Siemens Product Lifecycle Management (PLM) manages the entire lifecycle of a product efficiently and cost-effectively, from ideation, design and manufacture, through to service and disposal.

**TIA**

Siemens Totally Integrated Automation (TIA) portal optimises all planning, machine and process procedures and safety for people and the plant – leading to reduced time and cost and increased flexibility.

**Manufacturing Execution System**

Siemens manufacturing execution system, SIMATIC IT offers tailor-made access for real-time process information company-wide. Production processes can be standardised to significantly increase production output with the same space and number of employees.

**Product Lifecycle Services**

Comprehensive services for the complete lifecycle of a plant.

**Data-Driven Services**

Process and production data are continuously recorded and analysed in real time, allowing for things such as predictive maintenance, improved energy efficiency, and increased availability, performance and quality.

**Integrated Drive Systems**

Siemens Integrated Drive Systems are the world's first true one-stop solution for entire drive trains, integrating with any automation environment, and even in the entire lifecycle.

Source:  
Siemens

# DIGITAL MANUFACTURING



12:15 maintenance needed

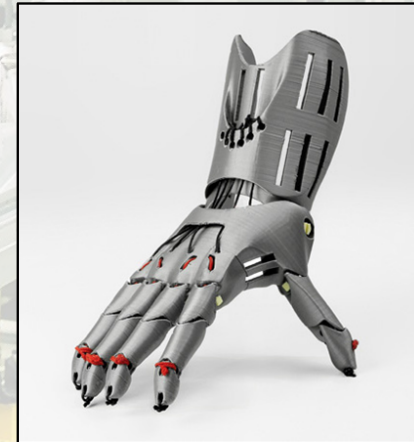
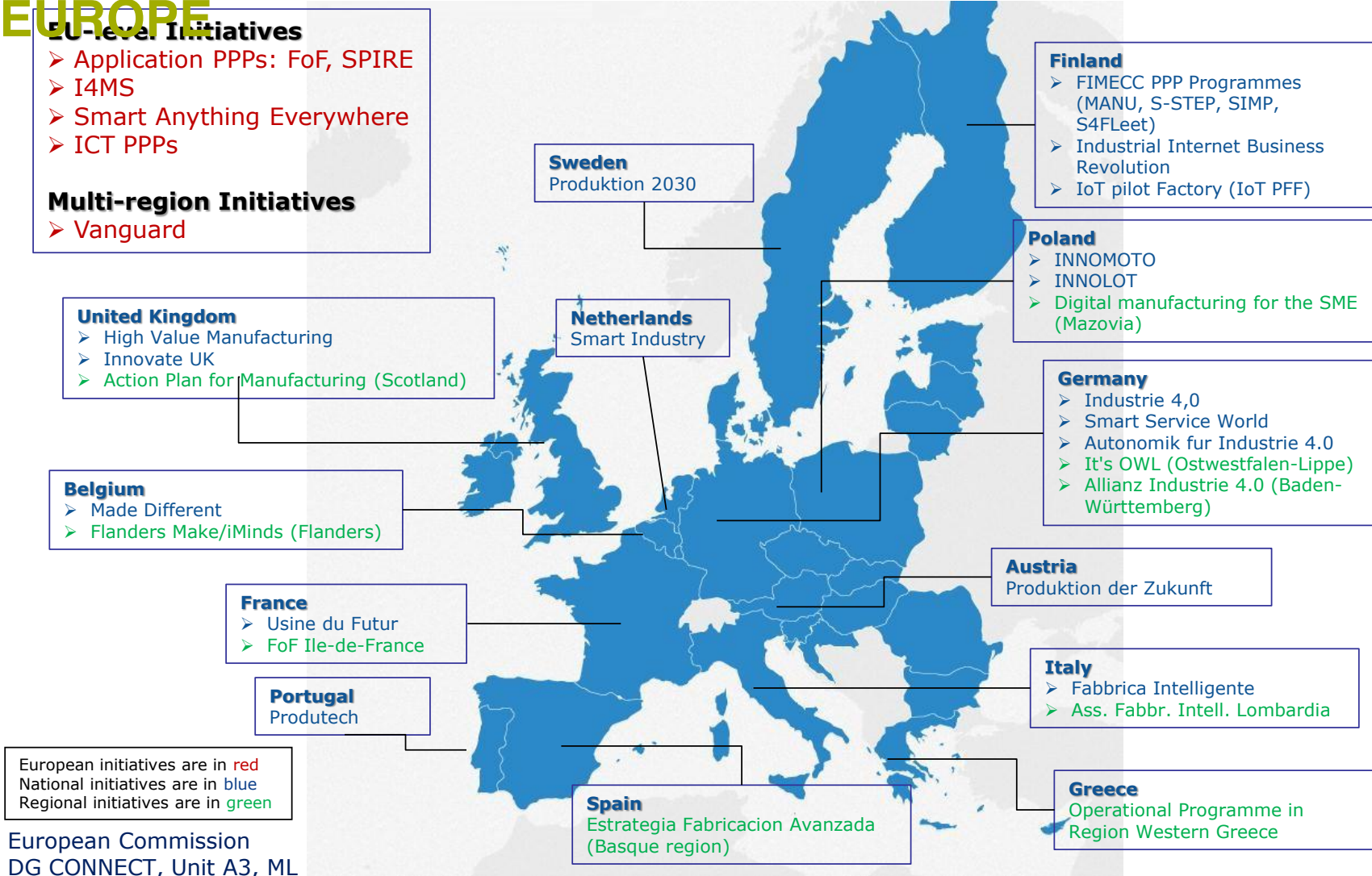


Photo: BMW

# DIGITAL MANUFACTURING INITIATIVES ACROSS EUROPE

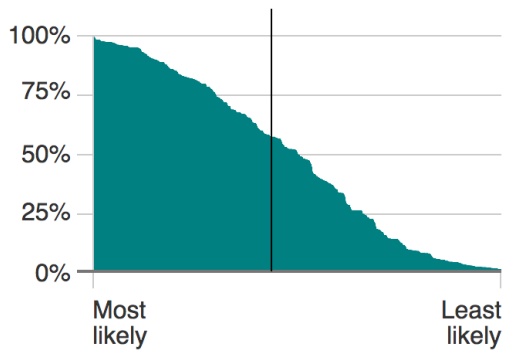


## Van drivers

Likelihood of automation?  
**It's too close to call (57%)**

How this compares with other jobs:

**159th** of 366



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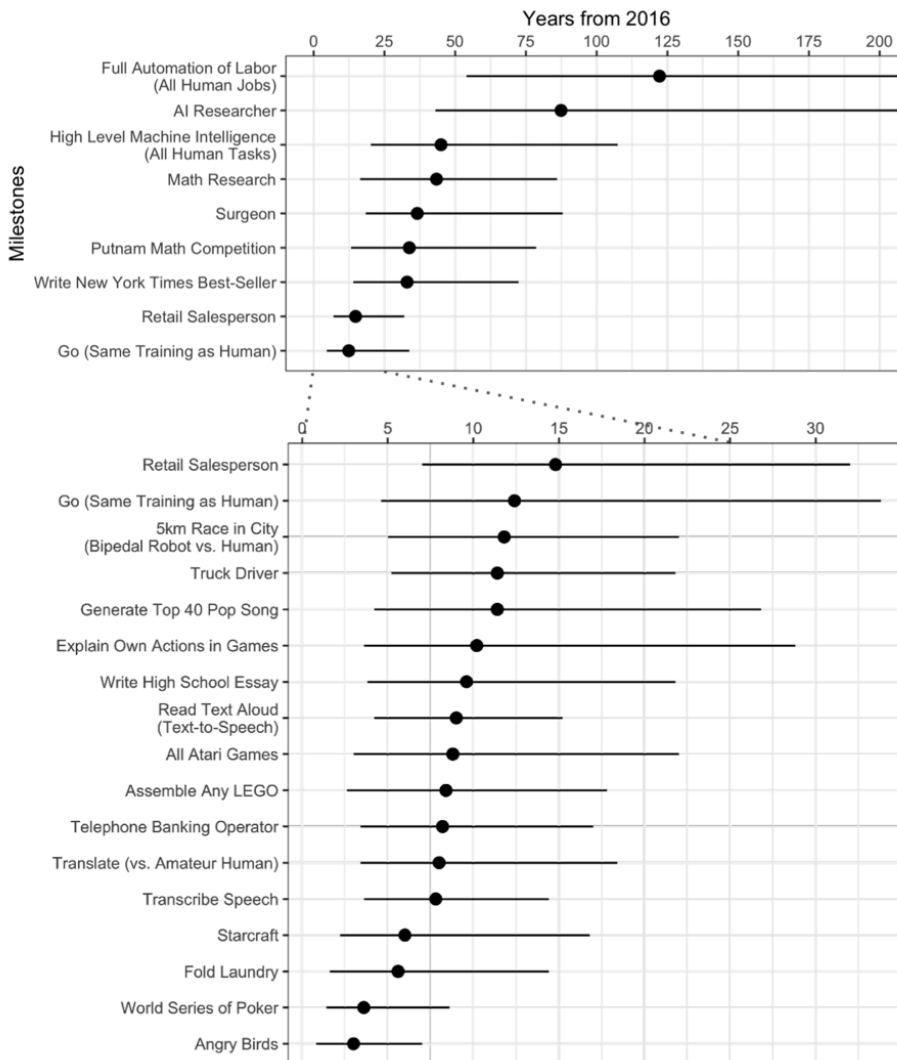
He

Technology

# Will a robot take your job?

11 September 2015 | Technology

<http://bit.ly/jobgone>



(Grace et al., 2017)

# GO WITH THE TIMES OR GO WITH TIME

*“Overall, we find that, on average across the 21 OECD countries, 9% of jobs are automatable.”  
(Arntz, Gregory, & Zieran, 2016)*

# THE SKILLS GAP

## One in four jobs go unfilled due to skills shortage, UKCES reveals

[Vicki Arnstein](#) 28 Jan 2016 0 comments

### Difficulty finding talent directly impacts business finances

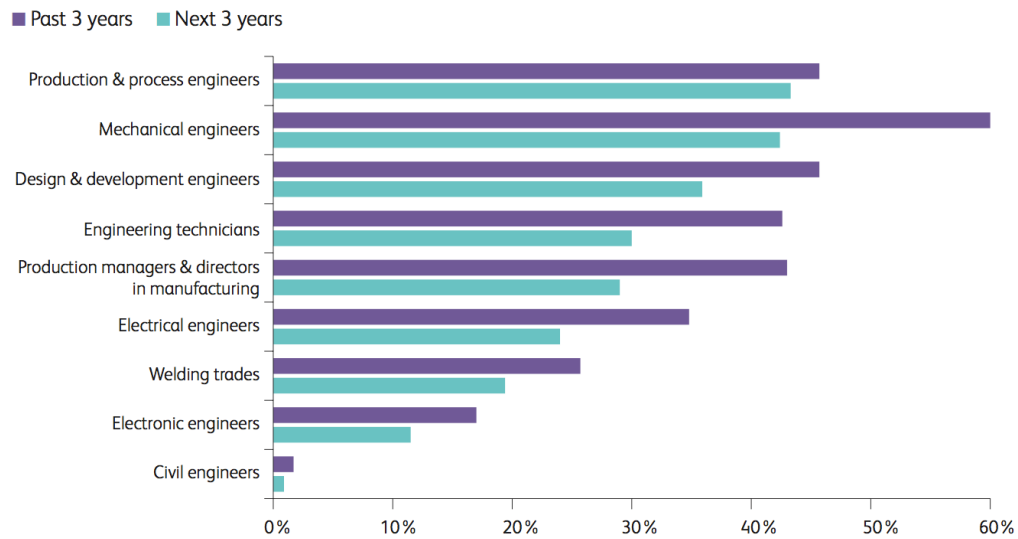
Almost a quarter of job vacancies last year were caused by the widening skills crisis across the UK, while 14 per cent of employers report skills gaps in their existing workforce, a report by the UK Commission for Employment and Skills (UKCES) has found.

(CIPD, 2016; UKCESS, 2015)

# SKILLS GAP: RISING DEMANDS

**Chart 1: Past and future recruitment of engineering professionals**

% companies reporting they have recruited engineering professionals in the past 3 years and plans to recruit in the next 3 years

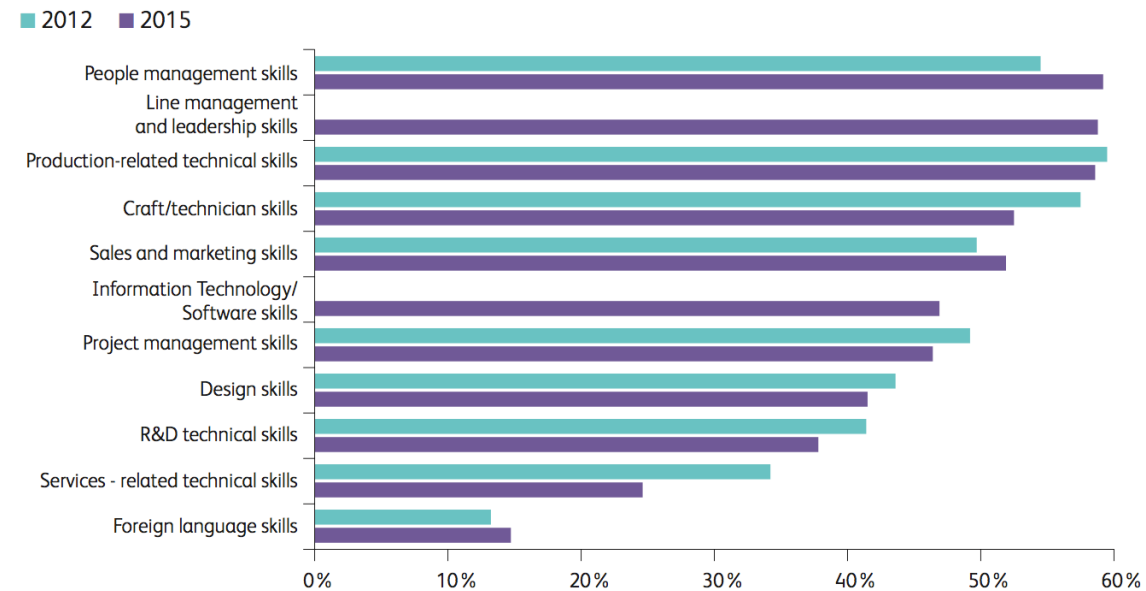


<sup>5</sup>EEF, Executive Survey 2016 <sup>6</sup>Ibid

Source: EEF Skills Survey 2015-16


**Chart 5: Increased demand for skills continues to reflect manufacturers' growth priorities**

% companies expecting demand for skills to increase in the next three years

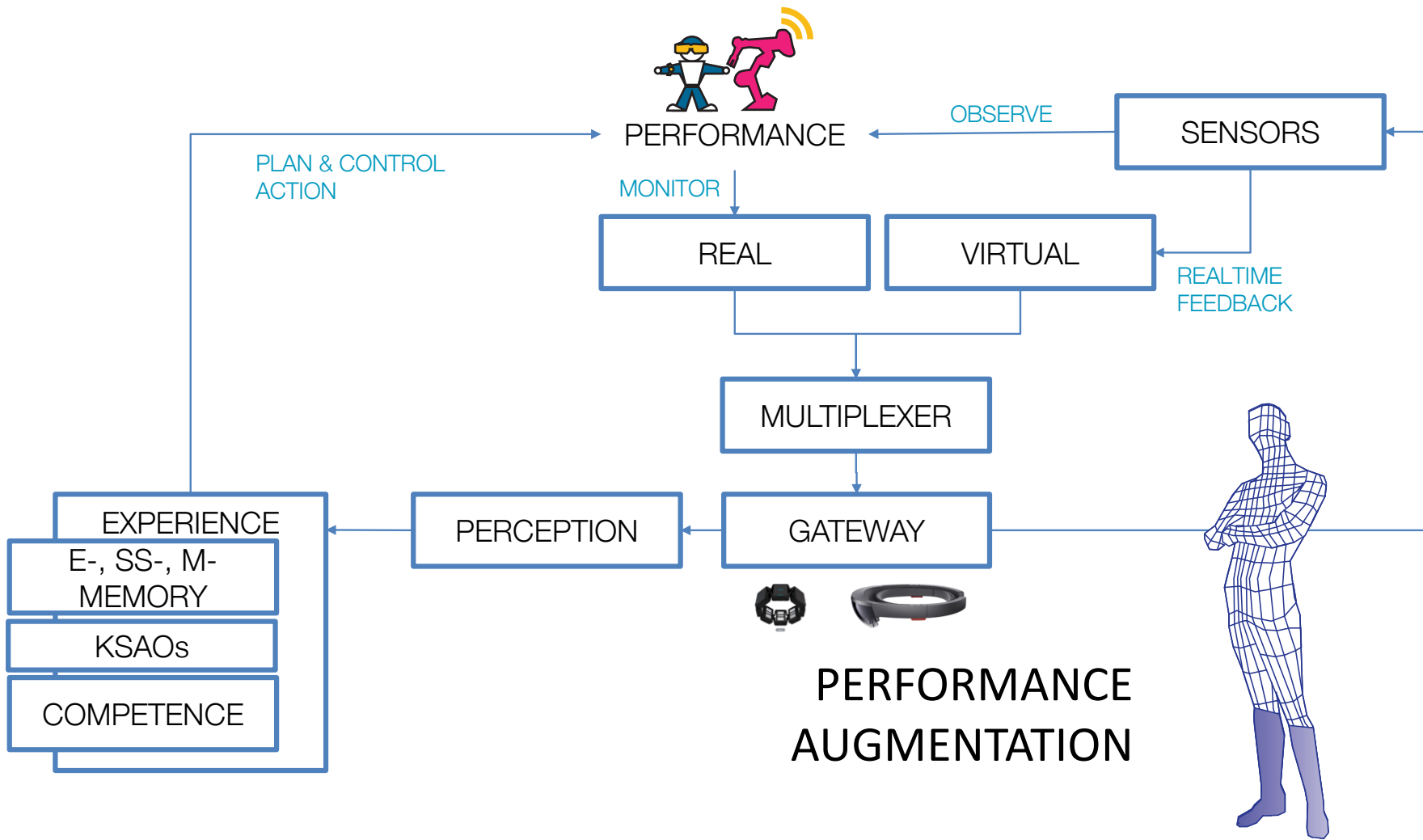


Source: EEF Skills Survey 2015-16 and 2012

# Solution: Performance Augmentation

- 
- A young woman with a braid is wearing a Microsoft HoloLens AR headset. She is in a workshop or factory setting, with a blue machine and a brick wall visible in the background. She is wearing a dark blue t-shirt with a red and white logo and the word "TECHAS" on it. Her right arm has a large tattoo. She is adjusting the headset with both hands.
- **Smart Assistance:** Intelligent Training and Guidance Systems
  - **Healthy workplaces:** ergonomic, safe, facilitating fitness
  - **New work models**

# HUMAN PERFORMANCE AUGMENTATION

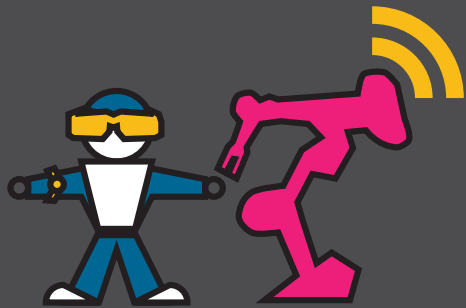


A person in a white astronaut suit is shown floating in a room with bookshelves. The suit is detailed with patches and a large clear visor. The person is in a dynamic, floating pose, with one leg bent and arms slightly out. The background consists of wooden bookshelves filled with books, some of which are visible on the shelves. The overall scene is a mix of the real world and a digital overlay, representing Augmented Reality.

# PRESENTING DATA IN CONTEXT: AR

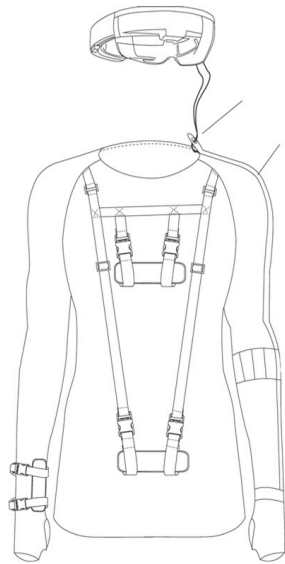
*“Augmented Reality refers to enhancing human perception with additional, artificially generated sensory input to create a new experience including, but not restricted to, enhancing human vision by combining natural with digital offers.”*

(Wild et al., 2016, ARLEM spec)

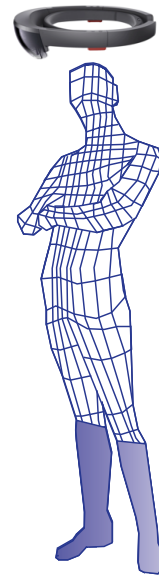


## Wearable Experience for Knowledge Intensive Training (WEKIT)

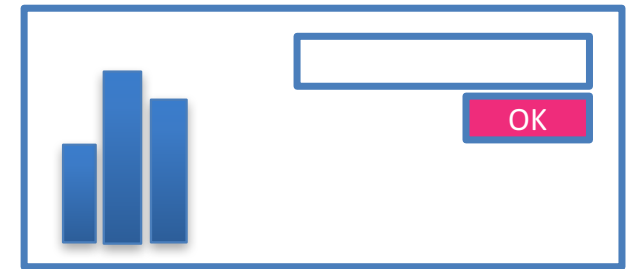
OXFORD  
BROOKES  
UNIVERSITY



capture expert  
experience



trainees wear expert  
experience



analysis and post  
processing

# WEKIT FRAMEWORK: Task x Transfer Mechanisms

References	Task						
Transfer Mechanisms	Perceptual ability	High Memory	Collaborative ability	Decision making	High speed	Motor performance	High precision
Interactive virtual objects		Seichter, H., (2004)	Nilsson et al (2011)				Lahanas V et. al. (2014)
		Quarles et. al. (2008) a					Rhienmora et al. (2010)
		Evans et al. (2014)					
Haptic feedback						Rozenblit et al. (2014)	Lahanas V et. al. (2014)
						Matassa & Morreale (2016)	Khademi et al. (2012)
Highlight object of Interest	Roads et. al (2016)	Hahn et al. (2015)		Kotranza et al. (2009)			
Directed Focus	<b>Jarodzka et al. (2013)</b>						
	Henderson & Fernier (2011)				Biocca et al. (2006)		

# WEKIT 4C/ID FRAMEWORK

## Transfer Mechanism

Recording and Re-enactment requirements driven by the Task type

### Learning Task

- AUGMENTED MIRROR
- MOBILE CONTROL
- HIGHLIGHT OBJECTS
- DIRECTED FOCUS
- POINT OF VIEW VIDEOS

### Supportive Information

- OBJECT ENRICHMENT
- 3D MODELS AND ANIM
- X-RAY VISION
- SETTING CUES AND CLUE
- ANNOTATION

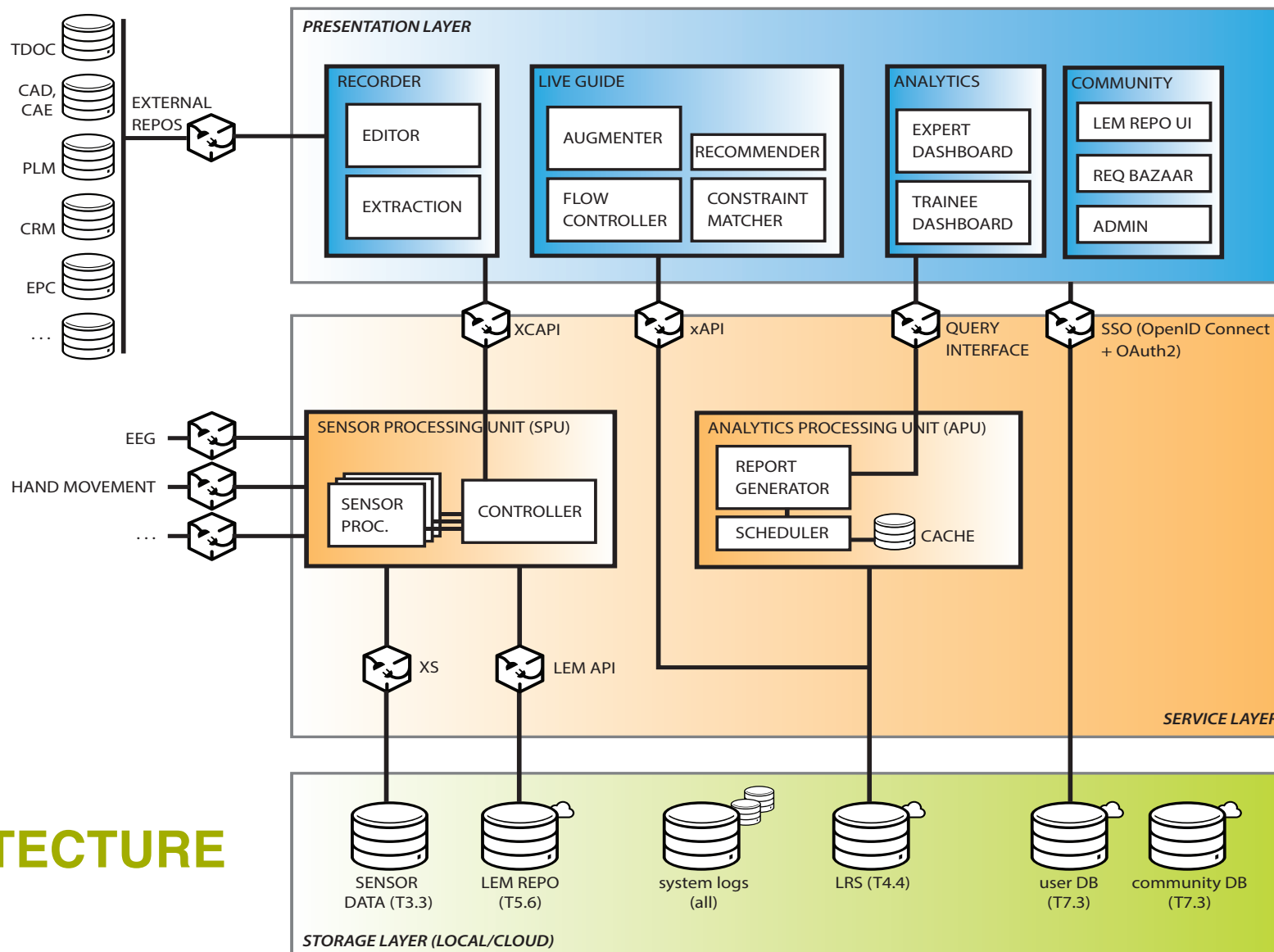
### Procedural Information

- HAPTIC FEEDBACK
- FEEDBACK
- CONTEXTUAL INFORMATION

### Part Task Practice

- GHOST TRACK
- AUGMENTED PATH
- INTERACTIVE VIRTUAL OBJECTS

<https://vimeo.com/channels/pal/226297643> (0:00 to 0:55)



# ARCHITECTURE

P1589/D1, May 2017  
Draft Standard for Augmented Reality Learning Experience Model

1 **P1589™/D1**  
2 **Draft Standard for Augmented Reality**  
3 **Learning Experience Model**

4 Sponsor  
5  
6 **Learning Technologies Standards Committee**  
7 of the  
8 **IEEE IEEE Computer Society/Learning Technology (C/LT)**  
9

10  
11 Approved <Date Approved>  
12  
13 **IEEE-SA Standards Board**  
14

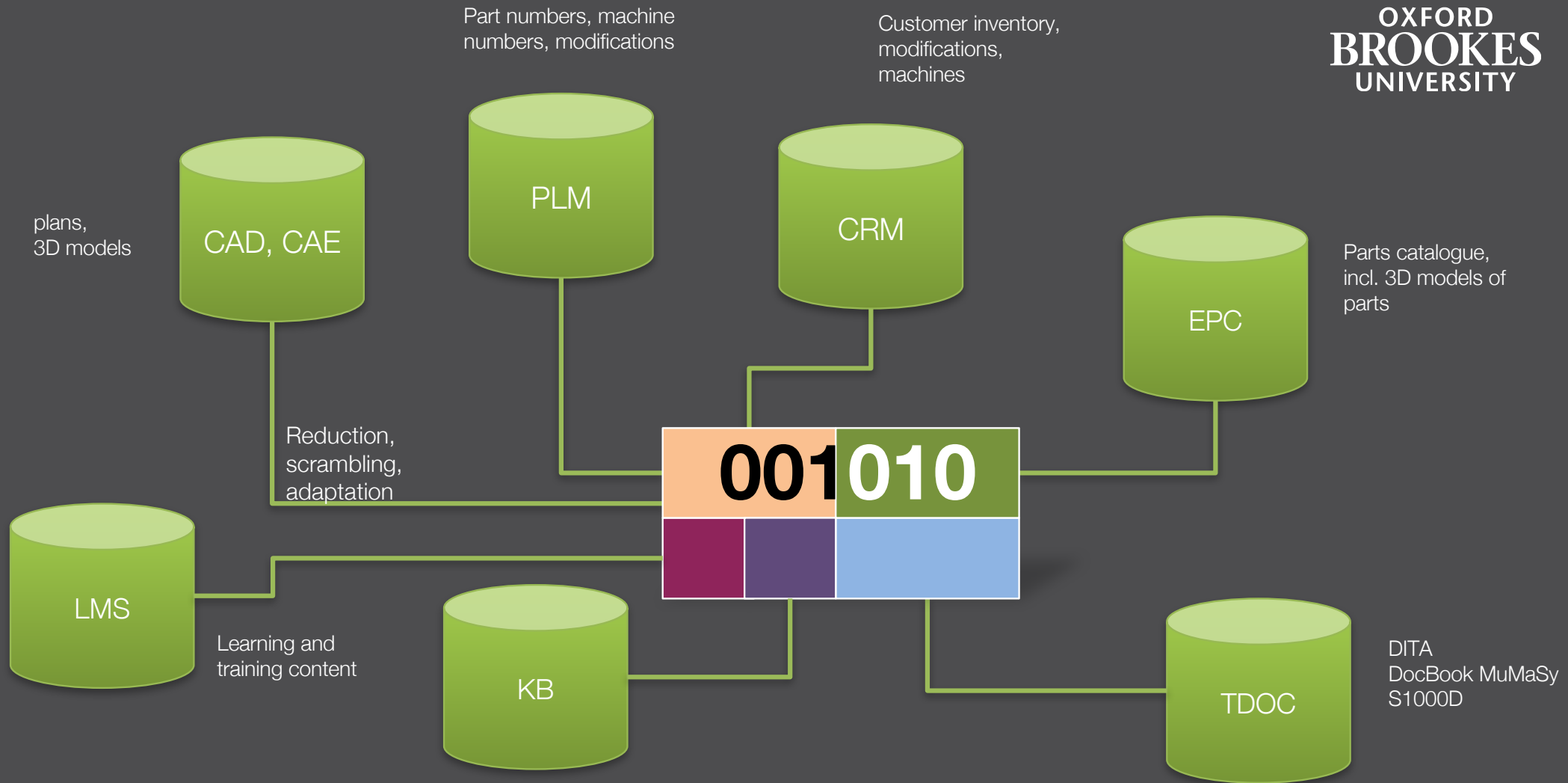
# ARLEM JSON BINDING

## *activity model*

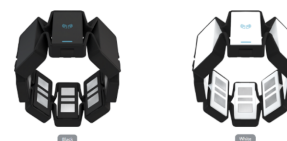
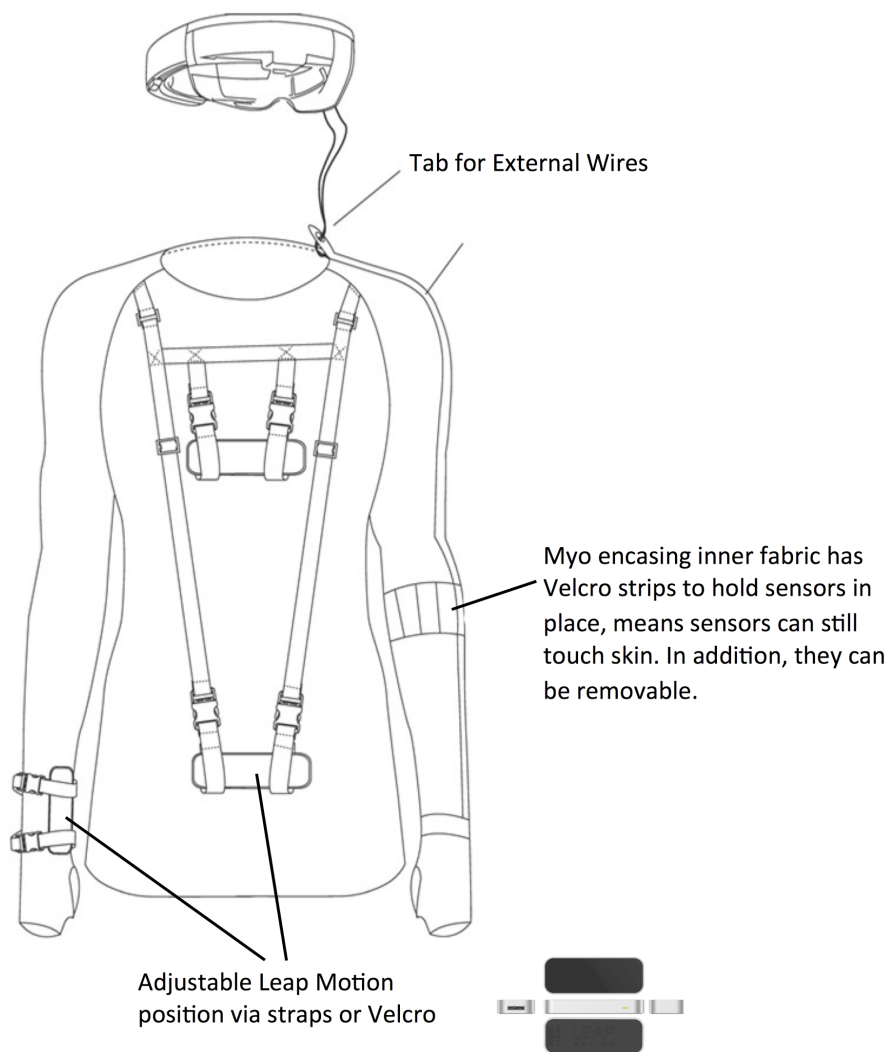
```
{
  "id": "arlem-demo",
  "name": "ARLEM demo activity",
  "language": "English",
  "workplace": "http://192.168.0.1/workplaces/workplace.json",
  "start": "intro",
  "offset": 1.5,
  "scale": 0.75,
  "resolution": 1920,
  "actions": [
    {
      "id": "intro",
      "viewport": "actions",
      "type": "action",
      "enter": {
        "removeSelf": false,
        "messages": [],
        "activates": [
          {
            "id": "ActionsViewport",
            "type": "tangible",
            "predicate": "M003",
            "poi": "Objects/Symbols"
          }
        ]
      }
    }
  ]
}
```

## *workplace model*

```
{
  "id": "arlem demo workplace model",
  "name": "ARLEM test lab",
  "version": "0.0",
  "things": [
    {
      "id": "samurai",
      "name": "Black Samurai",
      "type": "fixed",
      "radius": 3.0,
      "urn": "/object/samurai",
      "detectable": "samuraiTarget",
      "pois": [
        {
          "id": "default",
          "offset": "0, 0, 0"
        },
        {
          "id": "adjustomatic",
          "offset": "0.047, 0.035, 0"
        },
        {
          "id": "mod1Toggle",
          "offset": "0.107, 0.07, 0"
        }
      ]
    }
  ]
}
```



# WEARABLE SOLUTION



<https://vimeo.com/channels/pal/226297643> (0:55 to 2:15)

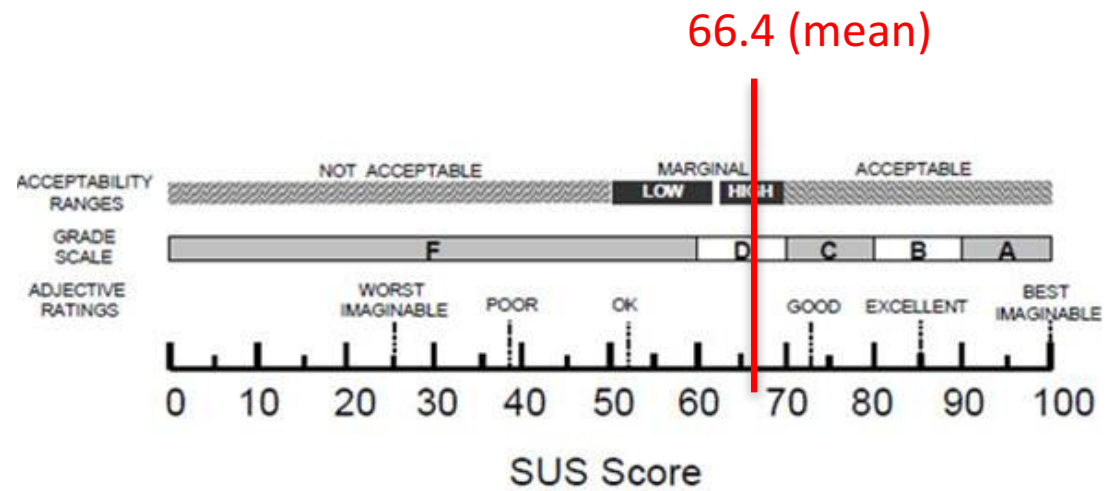
# Findings

## EVALUATION (CYCLE 1)

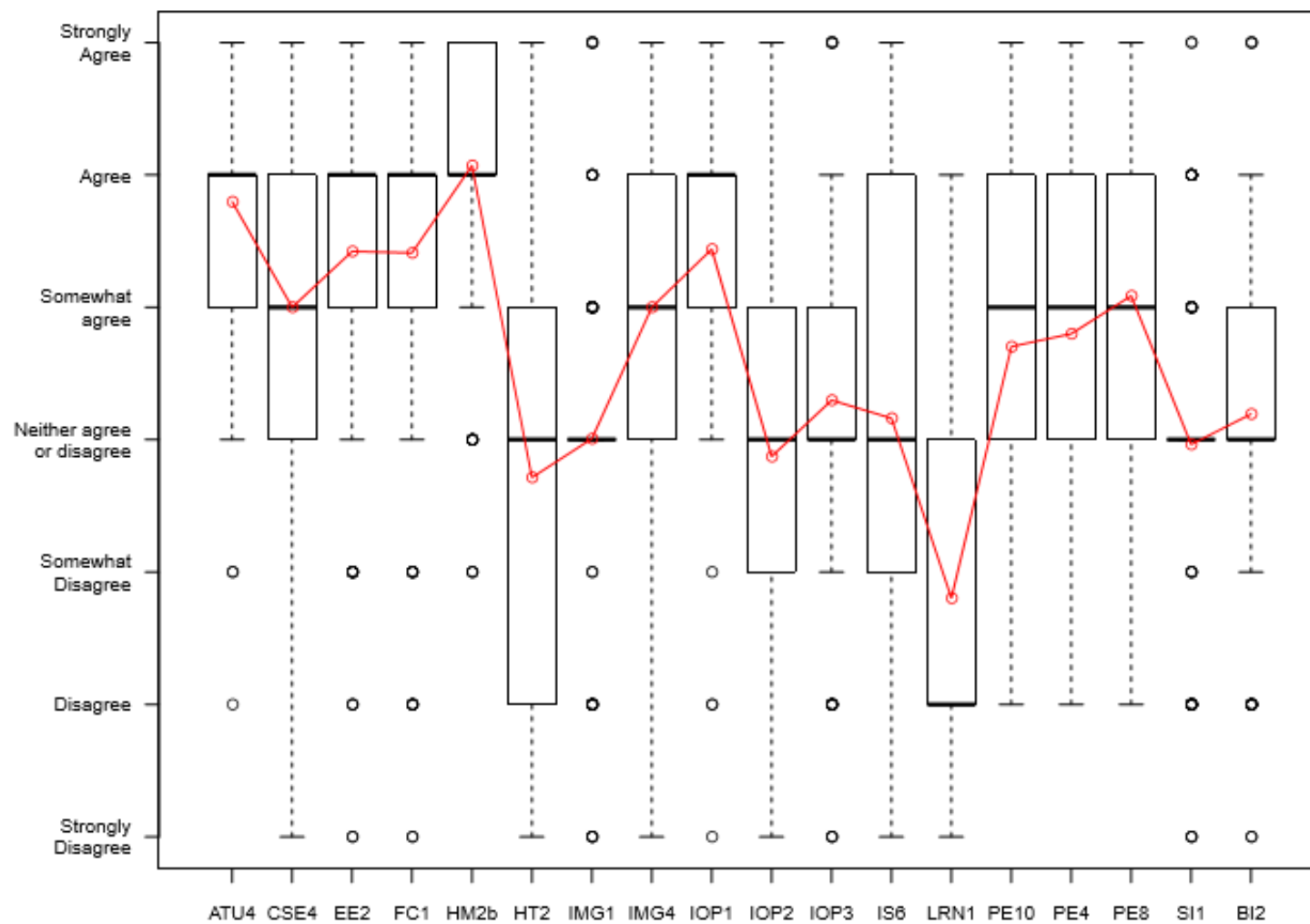
- Technology Acceptance and Use
- Simulator Sickness
- Usability of the Software
- User Satisfaction with the Hardware
- User Interaction Satisfaction
- Use of Transfer Mechanisms

# SYSTEM USABILITY

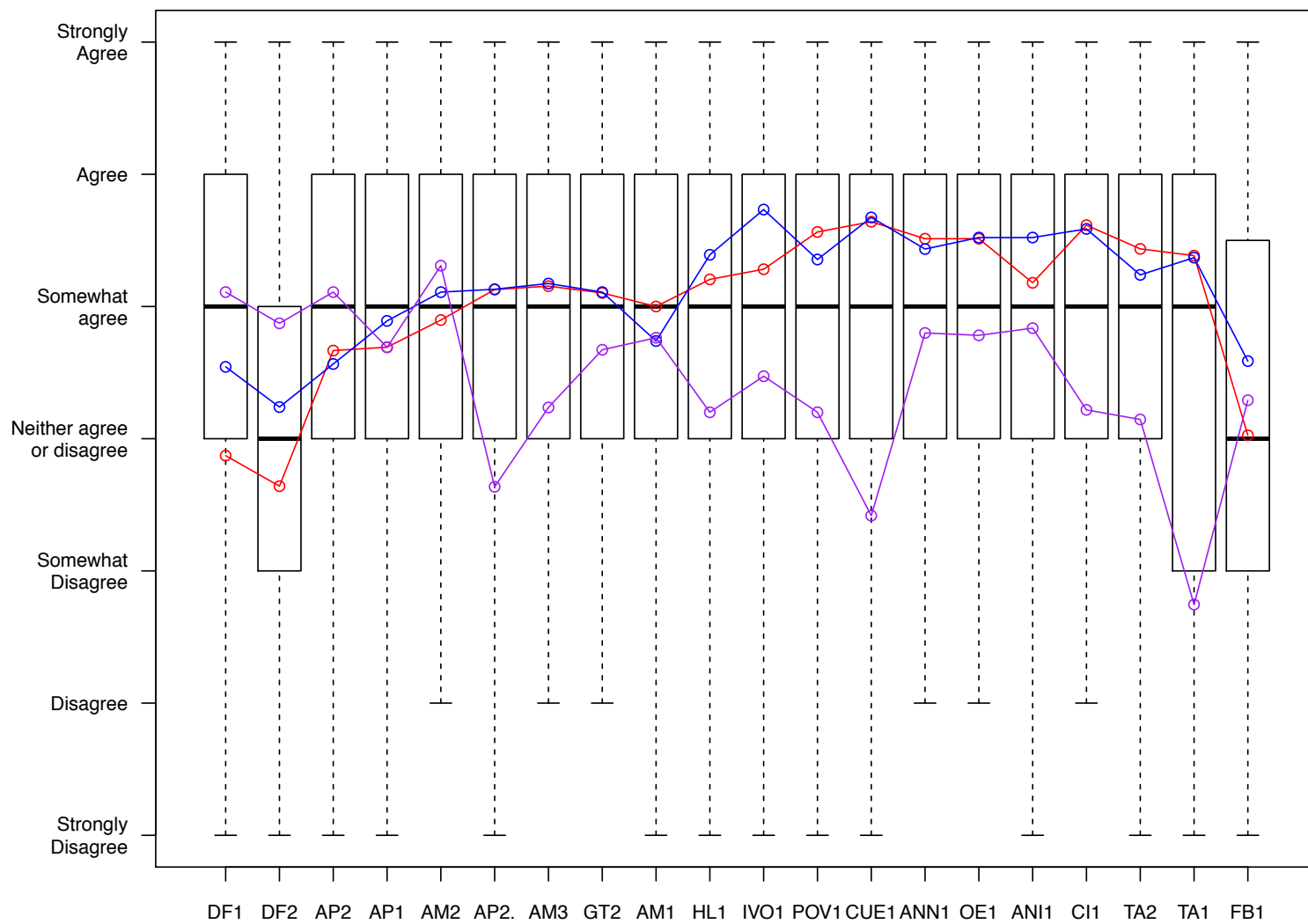
(Brooke, 2013)

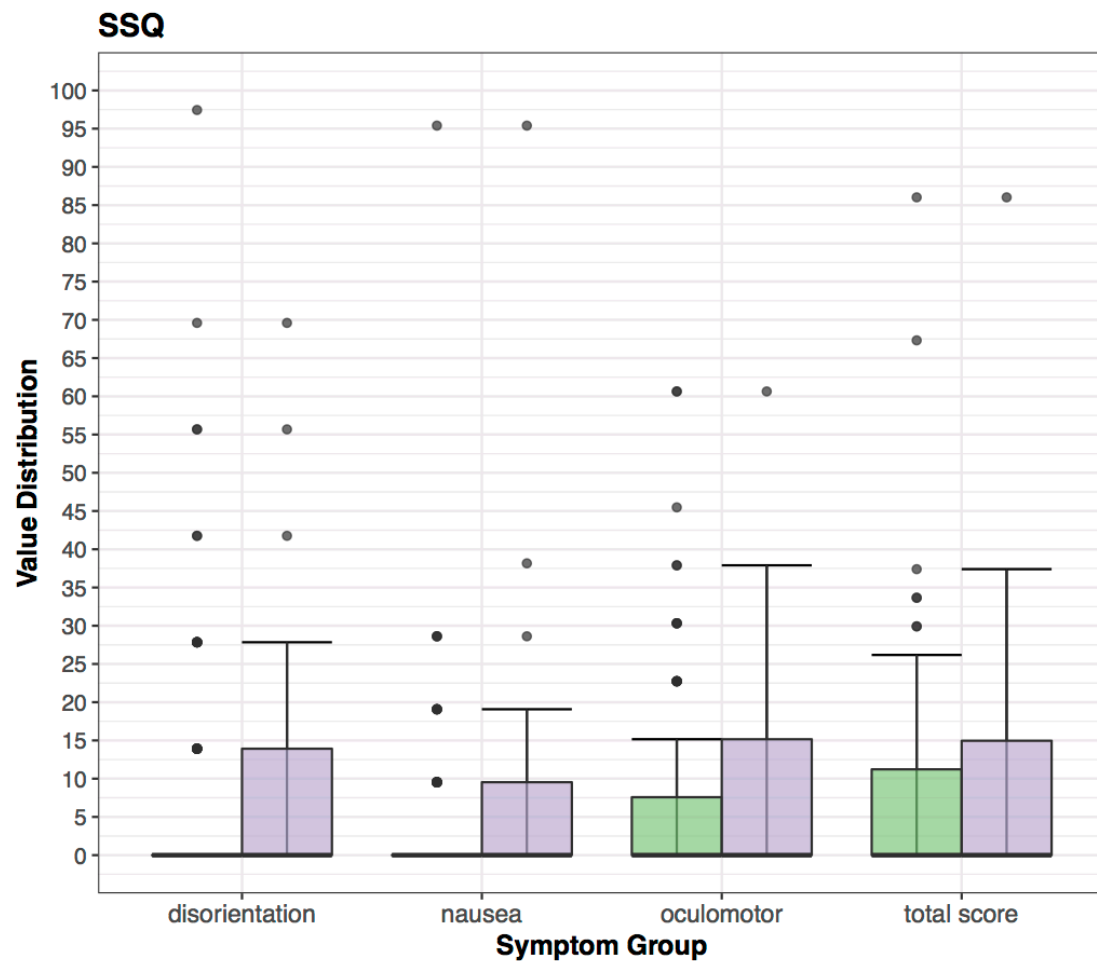


Technology Acceptance and Use (All)



### Transfer Mechanisms (All)

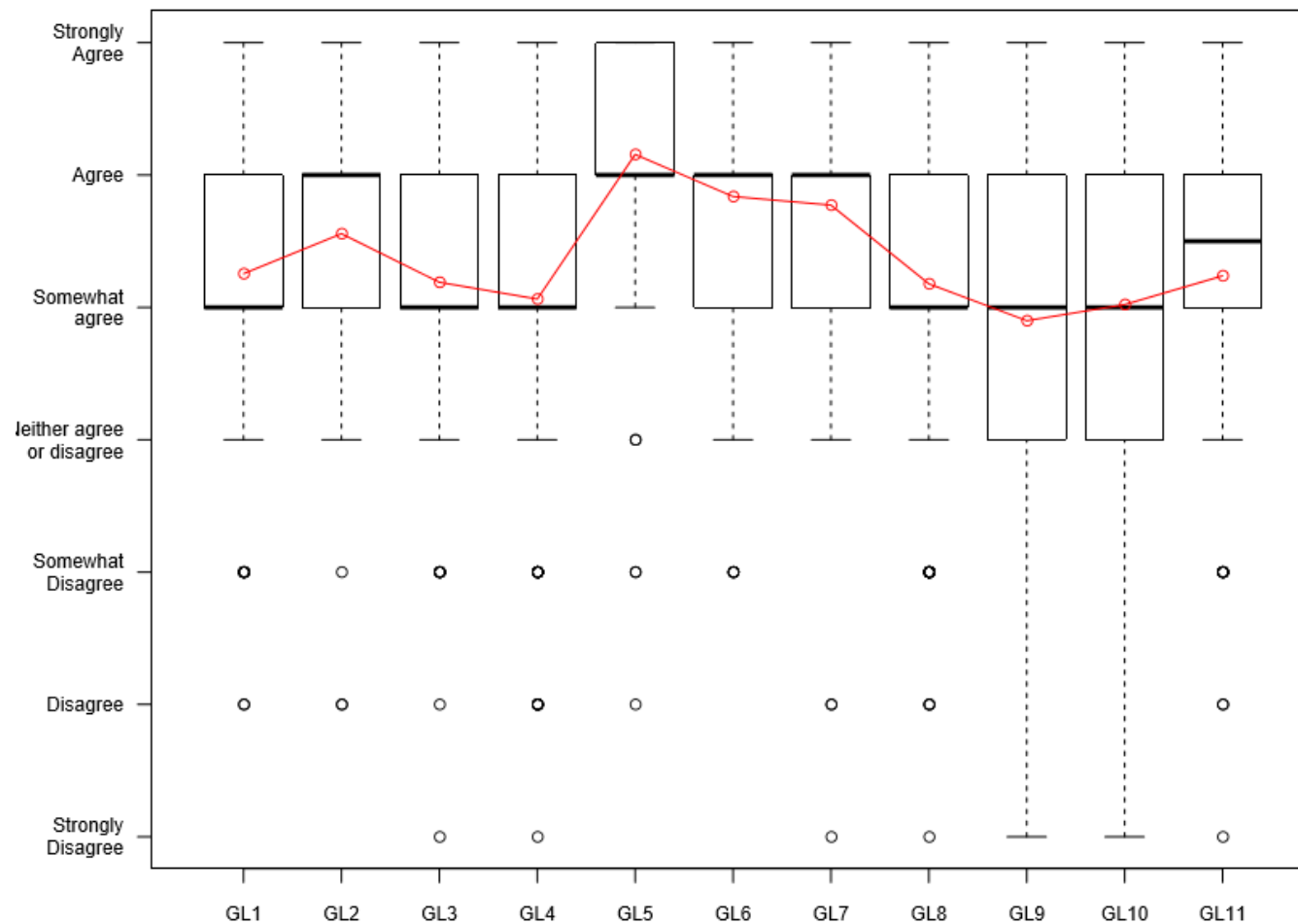




Application  
■ player  
■ recorder

	Nausea (N)		Oculomotor (O)		Disorientation (D)		Total Score	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
<i>Medical</i>	2.75	6.3	7.58	10.8	5.8	14.07	6.39	9.62
<i>Space</i>	4.33	8.29	9.8	12.92	13.07	19.97	10.08	13.33
<i>Aviation</i>	5.58	15.24	7.43	13.74	4.7	13.63	7.12	15.23
<i>Player</i>	3.7	11.04	7.51	12.42	6.96	15.97	7.03	12.96
<i>Recorder</i>	6.8	16.56	9.69	14.63	7.44	15.59	9.48	16.35

Smart Glasses User Satisfaction (All)



## OUTLOOK on CYCLE 2

- **Effectiveness:**  
Higher rate of skill transferability
- **Efficiency:**  
Increased efficiency in assembly task
- **Memorability:**  
Better percentage of long term memory recall
- **Cognitive Load:**  
Simulations of phenomena overlaid  
reduce cognitive load

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<http://pal.cct.brookes.ac.uk>



**THE END.**