THALES

Thales is a global technology leader with more than 81,000 employees on five continents. The Group is investing in digital and "deep tech" innovations – Big Data, artificial intelligence, connectivity, cybersecurity and quantum technology – to build a future we can all trust. Trust is essential for societies to flourish, with humans playing a central role in every critical decision.

Thales's high-tech solutions, services and products help companies, organisations and governments to achieve their goals and ambitions. And in each of our five vertical markets — digital identity and security, defence and security, aerospace, space, and transport — our customers play a vital role in society.

2021

81,000 employees

€bn 16.2 SALES

68 countries

1,027 €m R&D expenses

https://www.thalesgroup.com/en/global/group
https://www.thalesgroup.com/en/investors
https://onboard.thalesgroup.com/thaless-aerospace-expertise-comes-together/
https://www.thalesgroup.com/sites/default/files/database/document/2022-03/Thales%20-

AIRBUS

Airbus is a leader in **designing, manufacturing and delivering aerospace products, services and solutions** to customers on a worldwide scale.

With **around 130,000 employees** and as the **largest aeronautics and space company** in Europe and a worldwide leader, Airbus is at the forefront of the aviation industry. We build the most innovative commercial aircraft and consistently capture about half of all commercial airliner orders. Thanks to our deep understanding of changing market needs, customer focus and technological innovation, we offer products that connect people and places via air and space.

Airbus – Full-Year (FY) 2021 Results

Revenues, in millions	52,149	**Research & Development expenses**, in millions	2,746
thereof defence, in millions	9,175		

(Amounts in Euro)

https://www.airbus.com/en/who-we-are
https://www.airbus.com/sites/g/files/jlcbta136/files/2022-02/EN-Press-Release-Airbus-FY2021-Results_0.pdf

DASSAULT AVIATION

Dassault Aviation is a French aerospace company with proven dual expertise as a manufacturer of both military aircraft and business jets. Creator of more than 100 prototypes in the last century, with over 10,000 aircraft delivered to 90 countries.

12,371 employees,
of which 78% in France

2021	Adjusted net sales (billions of euros)	12.1

Self-financed R&D expenditures:
€551 millions

https://www.dassault-aviation.com/en/
https://www.dassault-aviation.com/en/group/finance/consolidated-financial-operating-highlights/
https://photos.dassault-aviation.com/galerie/search.do?page=3

LEONARDO

Leonardo is an **industrial and technological** leader in the Aerospace, Defence & Security sector, with a **balanced** and geographically distributed **order backlog** and a significant industrial footprint in Italy, the United Kingdom, Poland and the USA

Leonardo operates in **150 countries** in the world offering **customised solutions** and innovative, value-added **after-sales support services** in order to be a trusted partner for its customers. It competes in the most important international markets by leveraging technology and product leadership in its business areas (Helicopters, Aircraft, Aerostructures, Electronics, Cyber Security and Space).

ANNUAL REPORT **2021**

REVENUES	EMPLOYEES	R&D
€ 14.1 BN	50,413	€1.8 BN

https://www.leonardo.com/documents/15646808/16736384/Integrated+annual+report+2021.pdf?t=1649761893131

indra

Indra is one of the leading global technology and consulting companies and the technological partner for core business operations of its customers world-wide. It is a world-leader in providing proprietary solutions in specific segments in Transport and Defence markets, and the leading firm in Digital Transformation Consultancy and Information Technologies in Spain and Latin America through its affiliate Minsait. Its business model is based on a comprehensive range of proprietary products, with a high-value focus and with a high innovation component.

(2021 Data)

€3.39Bn	+52.000	+140	€293m
In revenues	Profesionals	Countries	R&D

https://www.indracompany.com/en/indra

SAAB

When Saab was founded in 1937, our primary aim was to provide military aircraft for Sweden. Today, we serve the global market with world-leading products, services and solutions from military defence to civil security. With operations on every continent, Saab continuously develops, adapts and improves new technology to meet customers' changing needs.

NUMBER OF EMPLOYEES IN THE WORLD

18,153

2021

SALES IN 2021

39,154

MSEK

5%

Saab's own R&D spending as % of sales in 2021

https://www.saab.com/about/company-in-brief
https://www.saab.com/globalassets/corporate/sustainability/reports/saab-annual-and-sustainability-report-2021.pdf

EDF EPIIC Project

WP7&8 – Crew monitoring system

Mental resilience (i.e. stress resilience, cognitive resilience and fatigue resilience)
as a research interest of University of Zagreb Faculty of Electrical Engineering and Computing, participating in WP8

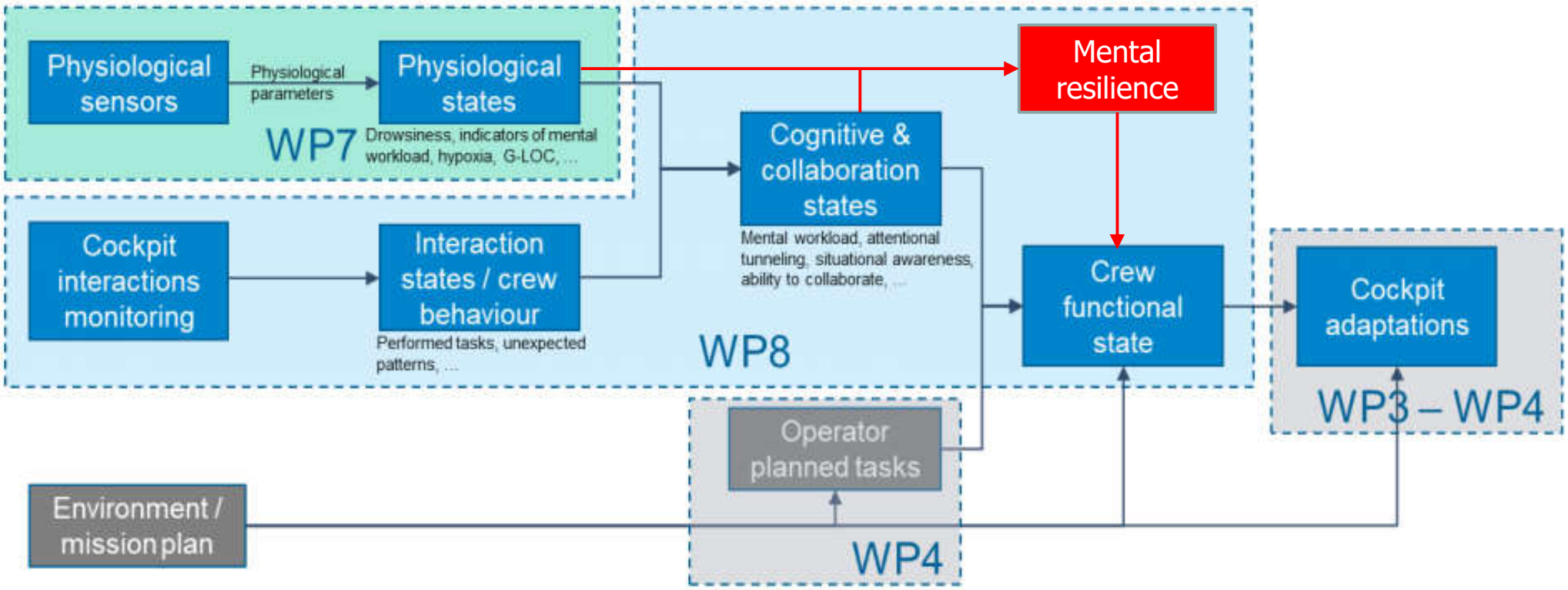
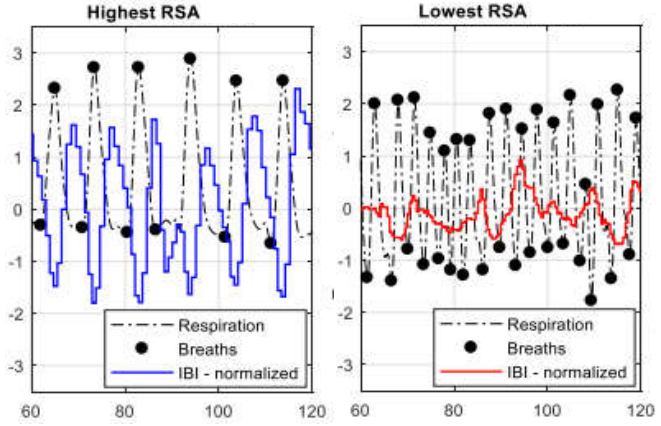


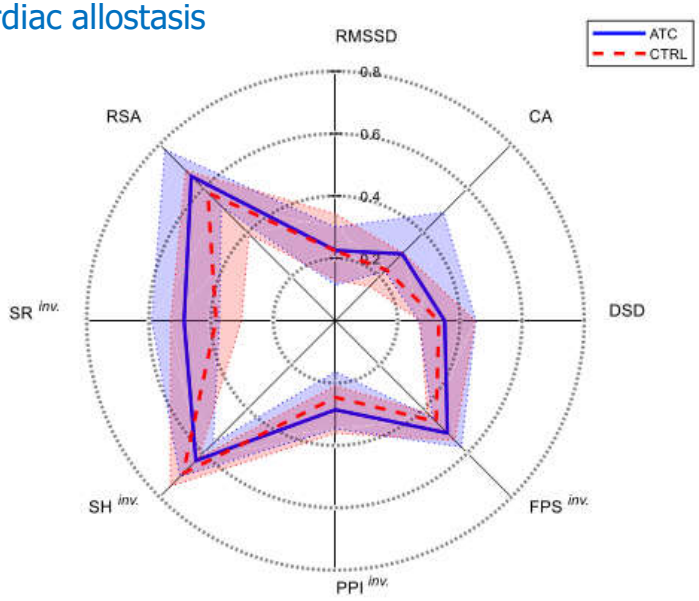
Figure 11 - Overall architecture of the CMS

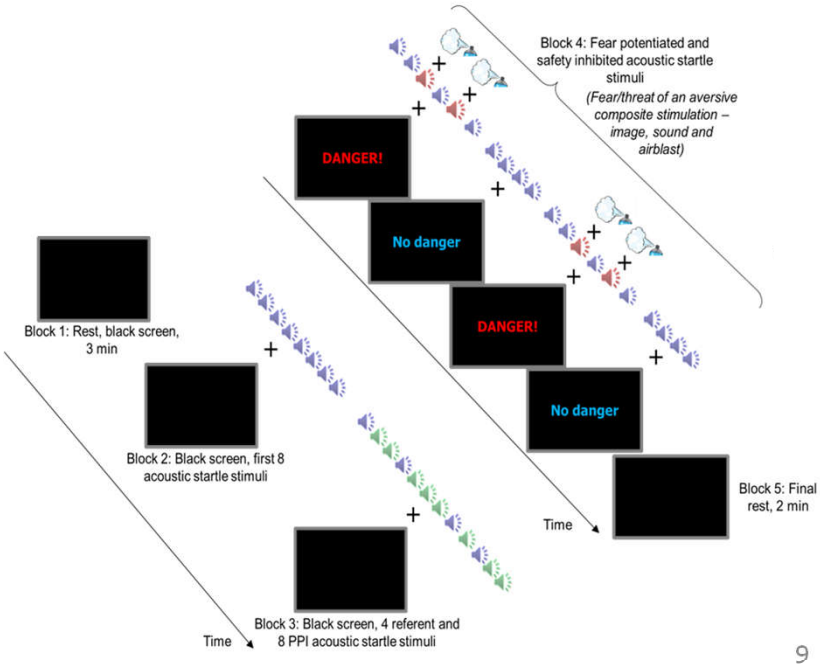
Selected research on stress and cognitive resilience by the University of Zagreb Faculty of Electrical Engineering and Computing (FER)

Stress resilience assessment based on physiological features in selection of air traffic controllers (pročitati članak jer se nalazi u materijalima za ispit)

- A system for input/output multimodal stress resilience assessment based on physiological features has been developed and applied in the ATC selection process on 40 ATC candidates, as well as on 40 age/sex-matched control subjects
- Variability of each physiological feature is assessed using a specifically designed 15-min paradigm for stress resilience assessment, and illustrated in 8-D physiological resilience space
- ATC candidates in comparison to control subjects had:
  - significantly higher resting respiratory sinus arrhythmia
  - significantly lower startle reactivity
  - significantly more pronounced cardiac allostasis







Ćosić, K., Šarlija, M., Ivkovic, V., Zhang, Q., Strangman, G., & Popović, S. (2019). Stress resilience assessment based on physiological features in selection of air traffic controllers. IEEE access, 7, 41989-42005.

Classification of cognitive load based on neurophysiological features from functional near-infrared spectroscopy and electrocardiography signals on n-back task (pročitati članak jer se nalazi u materijalima za ispit)

- Cognitive load can be estimated using individuals' task performance, their subjective measures, and neurophysiological measures
- In this paper the focus was on specific neurophysiological measures computed from fNIRS and ECG signals
- fNIRS and ECG signals were collected from 32 participants during three levels of n-back task (n = 1, 2, 3)
- Specific fNIRS and ECG features were computed and applied in classification of the three levels of cognitive load (1-back, 2-back, 3-back) using several machine learning methods:
  - Support vector machine (SVM)
  - K-nearest neighbours (KNN)
  - Linear discriminant analysis (LDA)
- Combination of fNIRS and ECG feature sets obtained higher 3-level classification accuracy than each of these sets separately

		1-back vs. 2-back vs. 3-back		
		Accuracy		
	Feature set	Mean	SD	AUC
SVM	fNIRS	58.85	20.73	0.7607
	ECG	61.98	20.41	0.7669
	fNIRS+ECG	63.54	21.77	0.8259
KNN	fNIRS	52.08	16.80	0.6367
	ECG	55.73	19.68	0.7511
	fNIRS+ECG	61.46	19.14	0.7586
LDA	fNIRS	53.65	17.83	0.7307
	ECG	62.50	20.30	0.7821
	fNIRS+ECG	67.71	21.56	0.8266

Kesedžić, I., Šarlija, M., Božek, J., Popović, S., & Ćosić, K. (2020). Classification of cognitive load based on neurophysiological features from functional near-infrared spectroscopy and electrocardiography signals on n-back task. IEEE Sensors Journal, 21(13), 14131-14140.

Classification of cognitive load based on oculometric features
(pročitati članak jer se nalazi u materijalima za ispit)

- Cognitive load can be estimated using individuals' task performance, their subjective measures, and neurophysiological measures
- In this paper the focus was on specific neurophysiological measures computed from oculometric signals related to the dynamics of the oculomotor system, pupil dilation, and eye blinking
- Oculometric signals were collected from 38 students during four levels of n-back task (n = 0, 1, 2, 3)
- Computed oculometric feature sets were related to: pupil dilation (PD) features, gaze fixation features, and blink features
- These features were used to classify four levels of cognitive load on n-back task (0-back, 1-back, 2-back, 3-back) using support vector machine (SVM)
- Combination of all three feature sets obtained higher 4-level classification accuracy than each of these sets separately

TABLE I. MEAN CLASSIFICATION ACCURACIES (IN %) OF TRAINED SVM MODELS FOR 4-LEVEL CLASSIFICATION

Feature set	*Mean accuracy ± SD*
PD	33.33 ± 21.96
Blink	30.90 ± 12.50
Fixation	30.21 ± 15.92
PD + blink + fixation	36.11 ± 25.14

Gambiraža, M., Kesedžić, I., Šarlija, M., Popović, S., & Ćosić, K. (2021). Classification of Cognitive Load based on Oculometric Features. In 2021 44th International Convention on Information, Communication and Electronic Technology (MIPRO) (pp. 377-382). IEEE.

Extension of FER research scope from generic tasks, like n-back, toward multitasking MATB assessments and simulator use-cases which are closer to the actual tasks of pilots in the cockpit

Extension of FER research scope

- Hierarchical composition of mental resilience features enables pilot's real-time cognitive/functional state assessment and real-time task performance prediction in **increasingly relevant and aviation-specific contexts**

highly generic → **highly specific**

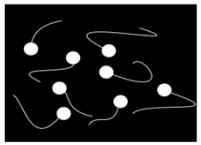
GENERIC TASKS

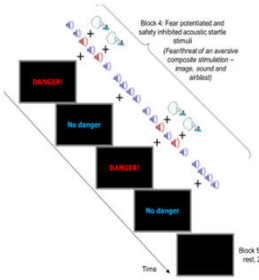
Emotional, cognitive and visuo-motor tasks

Performance [N-back, Arith, MOT, …]

Subjective [CD-RISC, AO, NASA-TLX…]

Features [RSA, SR, CA, F0, E, pupil, …]





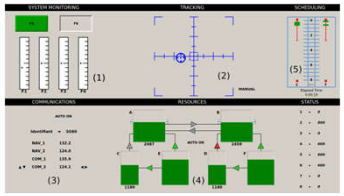
MULTITASKING TASKS

Cognitive and visuo-motor multitasking tasks

Performance [Dual task, MATB, …]

Subjective [NASA-TLX, ISA…]

Features [RSA, SR, CA, F0, E, pupil, …]



SIMULATOR TASKS

Low- to high-fidelity simulators

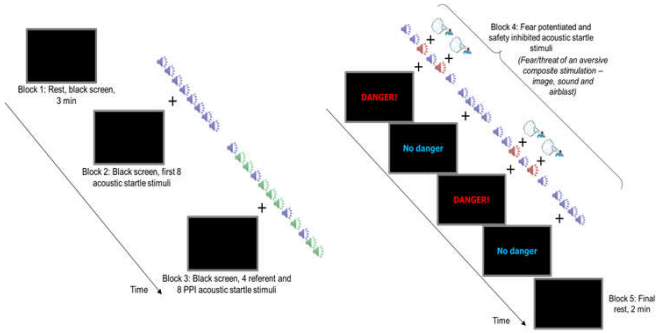
[Real-time and post-hoc task performance]

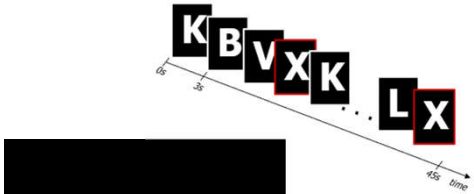
Subjective [NASA-TLX, ISA, SAGAT, …]

Features [RSA, SR, CA, F0, E, pupil, …]

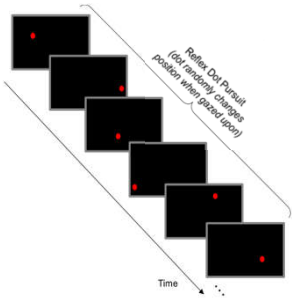
FIGHTER COCKPIT TRAINING & REAL MISSION TASKS

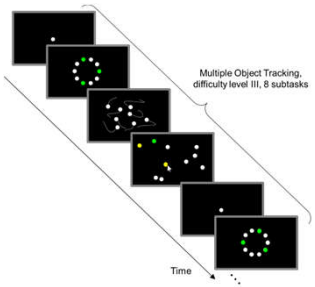
GENERIC PARADIGM





2 + 2 = 5





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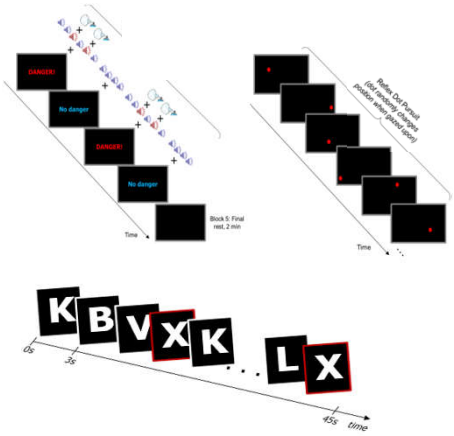
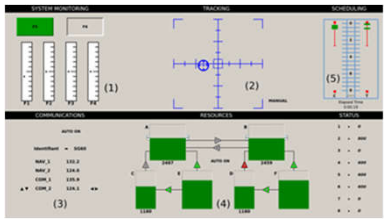
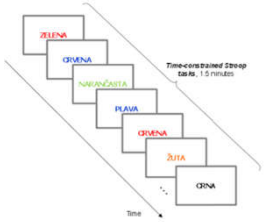
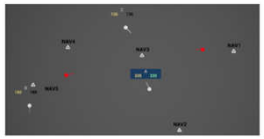
EXTENDED PARADIGM





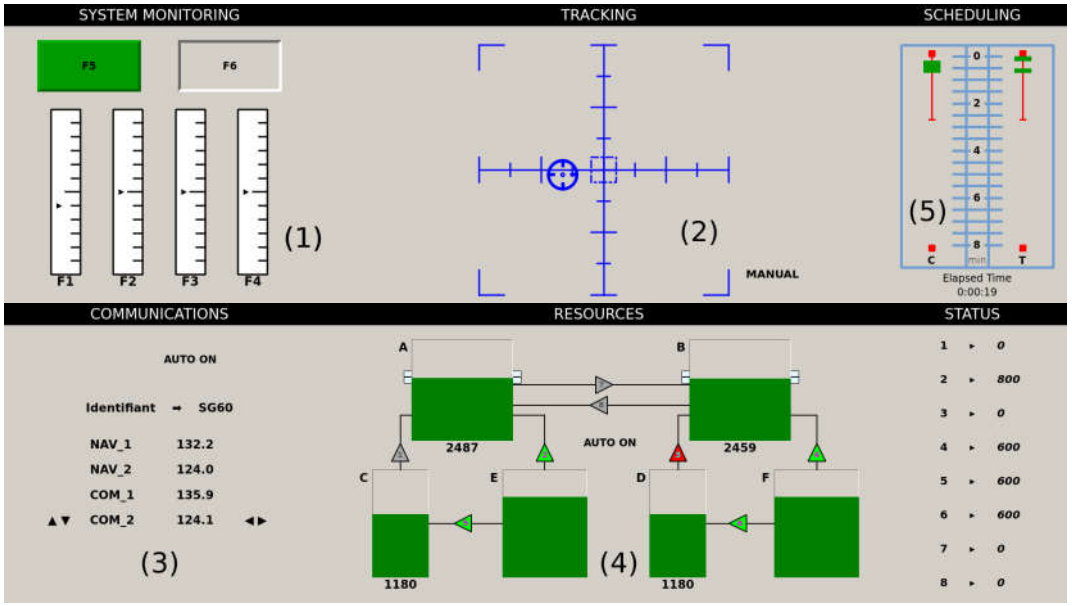




- trajanje paradigme cca 1h
- baza zadataka
- generični zadaci prije, a zatim kompleksniji
- prilagoditi simulatorski dio paradigme sukladno ispitanicima (**selekcija / check-up**)

OpenMATB – a standard multitasking assessment test

- Varijante MATB zadatka:
  1. MATB (original with source code) [1]
  2. MATB-II (no source code) [2]
  3. AF-MATB [3]
  4. TSU-MATB [4]
  5. **OpenMATB** (available) [5]
- MATB offers a robust way to study the effects of various parameters (e.g., automation, priorities, instructions, and so on) on the components of the participant's multitasking behavior, such as his/her decision-making, level of performance, ocular behavior, mental workload (https://link.springer.com/content/pdf/10.3758/s13428-020-01364-w.pdf)
- Tasks:
  - The system monitoring task
  - The tracking task
  - The communication task
  - The resource management task
  - The scheduling view

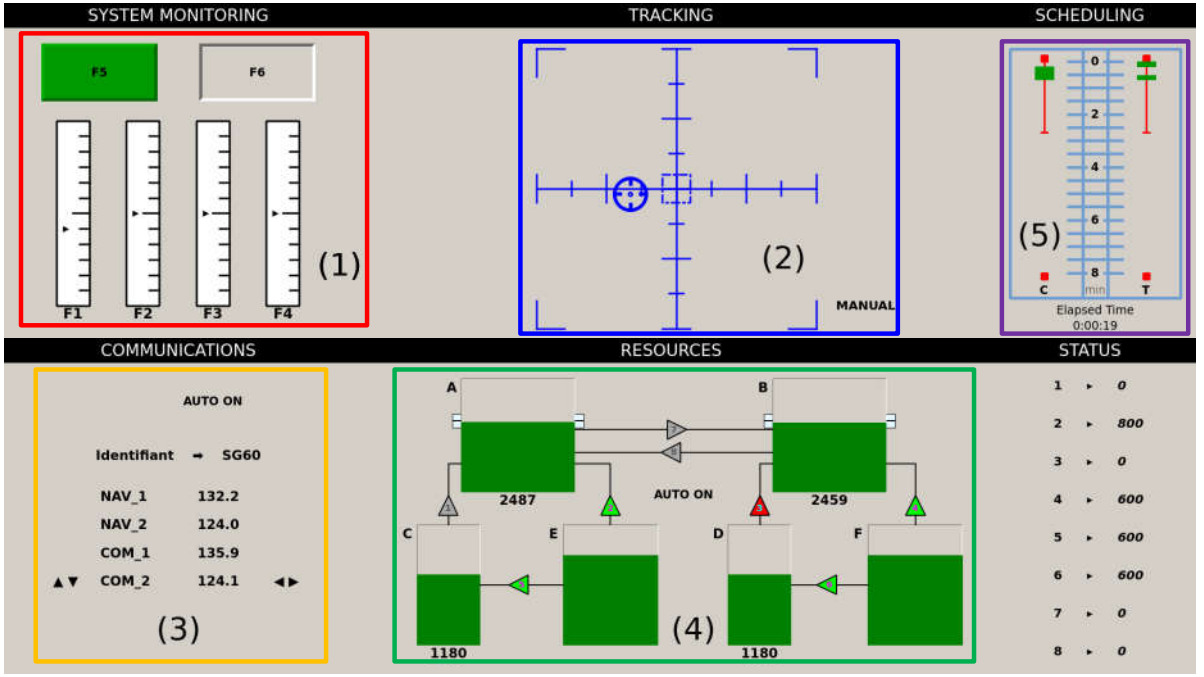


[1] Comstock, J. R., & Arnegard, R. J. (1992). The Multi-Attribute Task Battery for human operator workload and strategic behavior research (NASA TM-104174). Hampton, VA: NASA Langley Research Center.
[2] Santiago-Espada, Y., Myer, R. R., Latorella, K. A., & Comstock Jr, J. R. (2011). The multi-attribute task battery ii (matb-ii) software for human performance and workload research: A user's guide (No. L-20031).
[3] Miller Jr, W. D. (2010). The US air force-developed adaptation of the multi-attribute task battery for the assessment of human operator workload and strategic behavior. CONSORTIUM RESEARCH AND FELLOWS PROGRAM ARLINGTON VA.
[4] Thanoon, M. I., Zein-Sabatto, M. S., & McCurry, C. D. (2017, July). Multi-Attribute Task Battery for Human-Machine Teaming. In International Conference on Advances on Applied Cognitive Computing, Las Vegas, USA.
[5] Cegarra, J., Valéry, B., Avril, E., Calmettes, C., & Navarro, J. (2020). OpenMATB: A Multi-Attribute Task Battery promoting task customization, software extensibility and experiment replicability. *Behavior research methods*, *52*(5), 1980-1990.

OpenMATB – a standard multitasking assessment test

System Monitoring (1)

- 6 vizualnih indikatora i popravljanje abnormalnih pojava
- F5 i F6 stisnuti ovisno o boji
- F1-F4 stisnuti kada se pointer pomakne sa sredine
- Nakon što se stisne F1-F4 2 vizualna feedback-a su osigurana: pointer je namješten na sredinu i pojavi se žuti pravokutnik na dnu odgovarajuće skale



Communications (3)

- Interakcija pilota sa ATCO
- Ispitaniku je prikazan vlastiti kod (SG60)
- 4 polja na kojima treba mijenjati frekvenciju
- Audio instrukcije nisu uvijek za ispitanika, već ih treba ignorirati kada se ne prozove njegov kod
- Upravljanje ▲▼ ◄ ►

The resource management task (4)

- Reprezentacija sustava dobave goriva zrakoplova
- 6 spremnika goriva, 2 se crpe konstantnom brzinom (800 jedinica u minuti)
- Ispitanikov je zadatak održavati ta 2 spremnika na 2500 upravljajući pumpama koje su označene brojevima od 1 do 8
- Pritiskom odgovarajućeg broja, odabrana se pumpa pali ili gasi
- 2 spremnika imaju kapacitet od 2000 (C i D), a 2 spremnika nemaju limit (E i F)

Tracking (2)

- Oponaša upravljanje letjelicom
- Potrebno je metu održavati unutar pravokutnika
- Kada meta izađe iz područja, oboja se crveno
- 2 načina rada: manualni i automatski, koja alterniraju
- Upravljanje joystick-om

The scheduling view (5)

- Pokazuje ispitaniku što može očekivati u komunikaciji i tracking-u u sljedećih 8 minuta
- Crvena linija je indikator perioda kada će zadatak biti neaktivan (komunikacija) ili automatski upravljan (tracking)
- Zelena linija predstavlja periode kada se može očekivati najmanje jedan zadatak
- C i T su indikatori zadatka

OpenMATB – a standard multitasking assessment test

Scenario file build

- **Primjer scenarija**

```
0:00:10;sysmon;start
0:00:20;sysmon;scale-1-failure;up
0:00:40;sysmon;light-2-failure;True
0:00:50;sysmon;stop
```

  - Početak system monitoring zadatka u 10. sekundi
  - Problem sa prvom skalom u 20. sekundi
  - Problem sa drugim svjetlom u 40. sekundi
  - Zaustavljanje zadatka u 50. sekundi

- **Vrijeme**
  - Format oblika H:mm:ss koji odgovara trenutku kada naredba mora biti pokrenuta, ovisno o početku eksperimenta (pokretanje OpenMATB-a)

- **Objekt**
  - Definira se jedan od plugin-a o kojem se radi
  - Od zadataka se sastoji OpenMATB, te svaki od njih ima svoj alias; *sysmon*, *track*, *scheduling*, *communications*, *resman*, *pumpstatus*
  - Postoje i ekstenzije koje su periferalne i koje se mogu koristiti za dodavanje značajki: *participantinfo*, *eyetracker* (samo Windows), *genericscales*

- **Naredbe**
  - Mogu biti ili akcija (npr. start) ili parametar (npr. scale-1-failure;up)

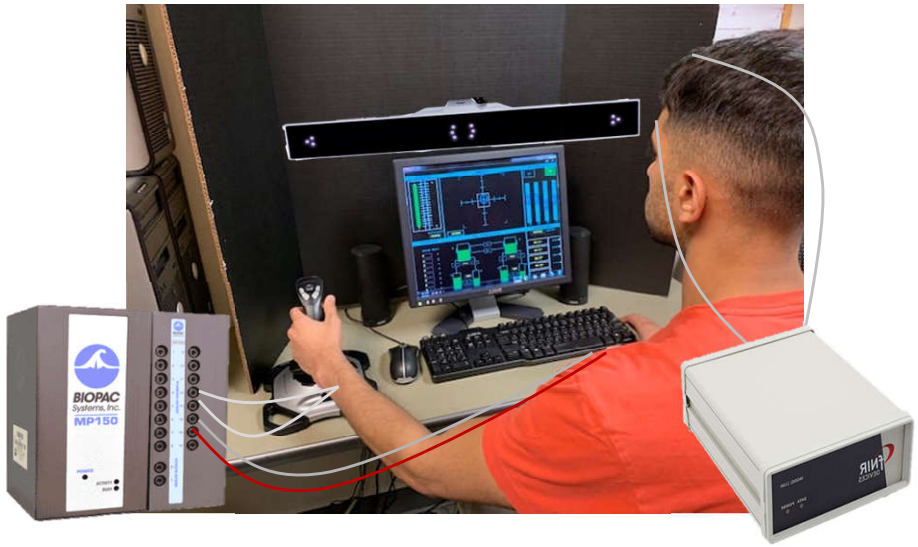
- **Kraj eksperimenta**
  - `H:mm:ss;end` – zaustavljanje svih zadataka prije početka novog

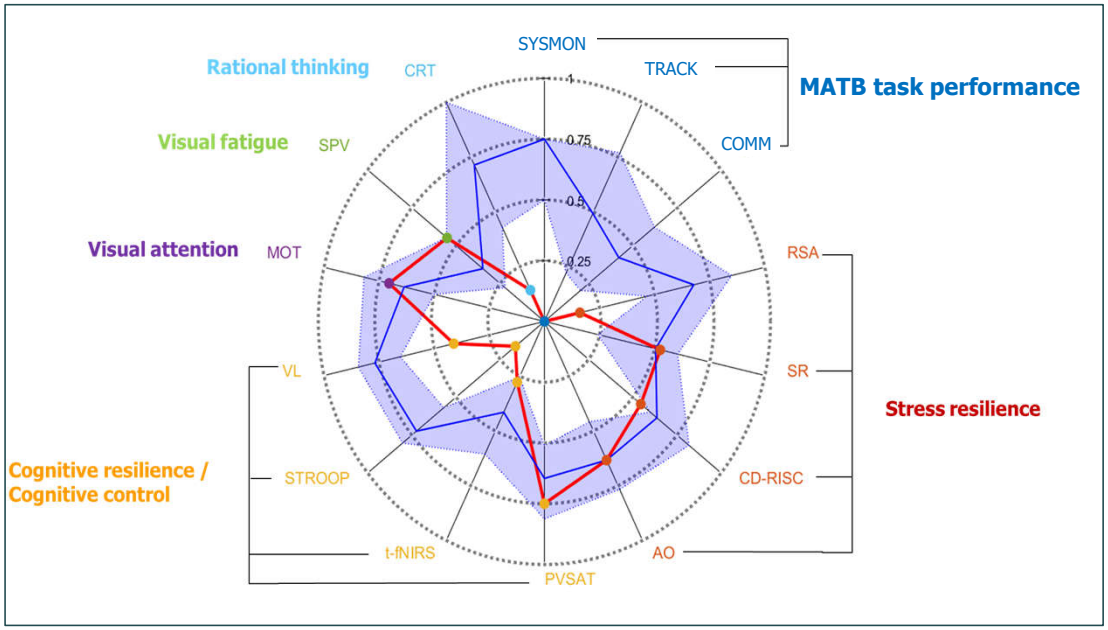
Preporučena struktura scenarija

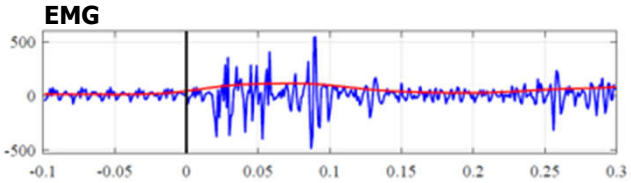
```
# Scenario title
# Comments

# 1. Set tasks parameters
# 1.a. System monitoring parameters
# 1.b.i. Resources management parameters
# 1.b.ii. Pumps status parameters
# 1.c. Tracking parameters
# 1.d. Communications parameters

# 2. Start appropriate tasks

# 3. Set scenario events

# 3.a. System monitoring events
# 3.b. Resources management events
# 3.c. Tracking events
# 3.d. Communications events

# 4. End tasks
```

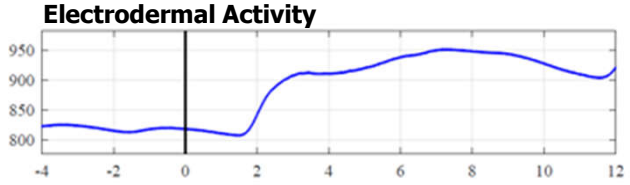
FER research interests and challenges

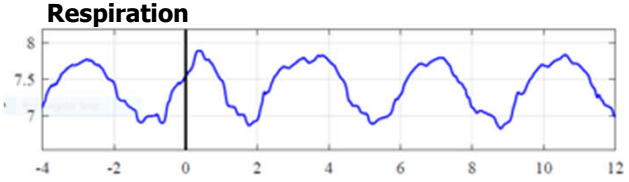
Integration of multimodal neuropsychophysiological measurements with multitasking assessments (OpenMATB)

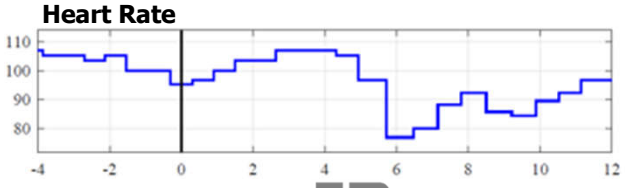


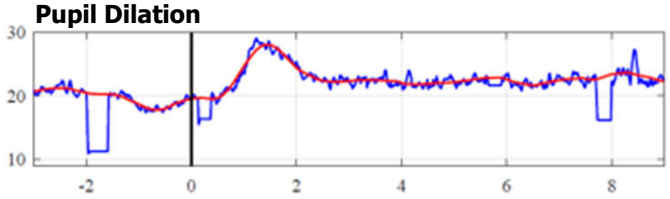


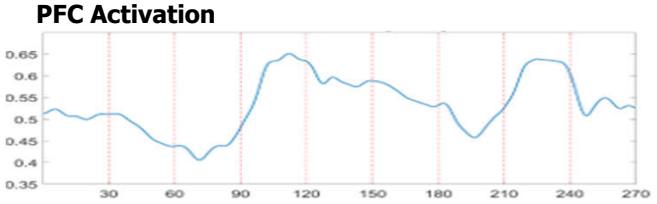












FER research interests and challenges

Integration of multimodal neuropsychophysiological measurements with research flight simulators