# Changing roles and responsibilities in human-automation teams

Jelle van Dijk & Rosa van Tuijn

SASG meeting 2025

TNO innovation for life

# Overview

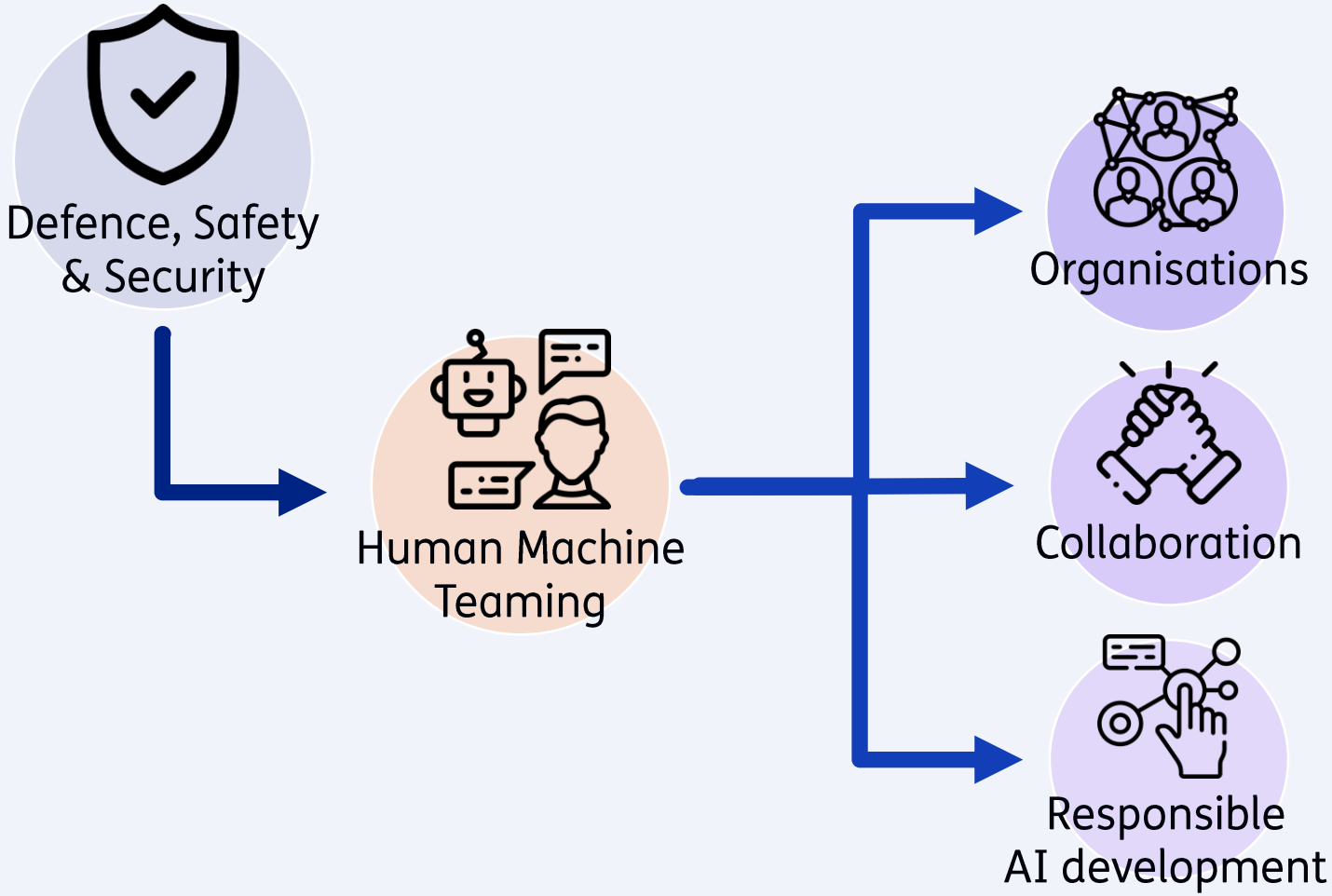
1. Introduction
2. Human Machine Teaming
3. Designing for Human Machine Teams
4. Human Machine Teams for uncrewed systems
5. Summary

# Who are we?

**Jelle van Dijk, PhD**
Cognitive psychologist
*Cognitive neuroscience*

**Rosa van Tuijn, MSc**
Interaction designer
*Industrial Design, TU/e*

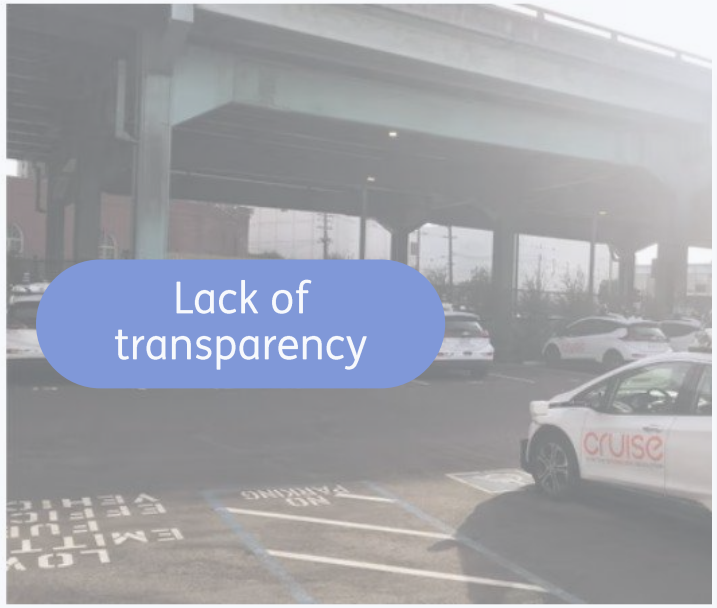
# Human Machine Teaming




# Why Human-Machine Teaming?

## Cruise recalls all self-driving cars after grisly accident and California ban

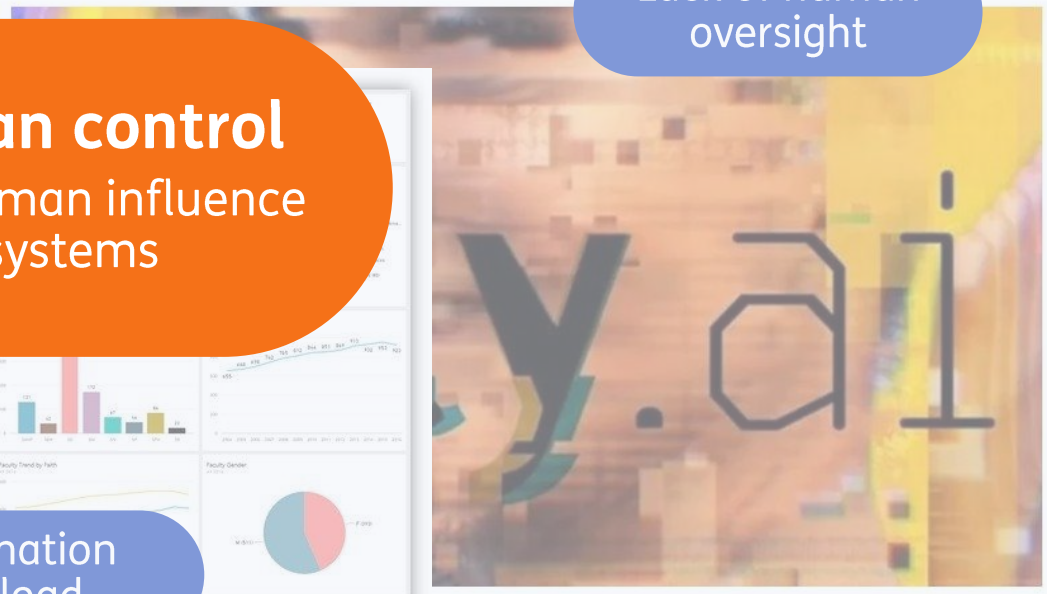
All 950 of the General Motors subsidiary's autonomous cars will be taken off roads for a software update



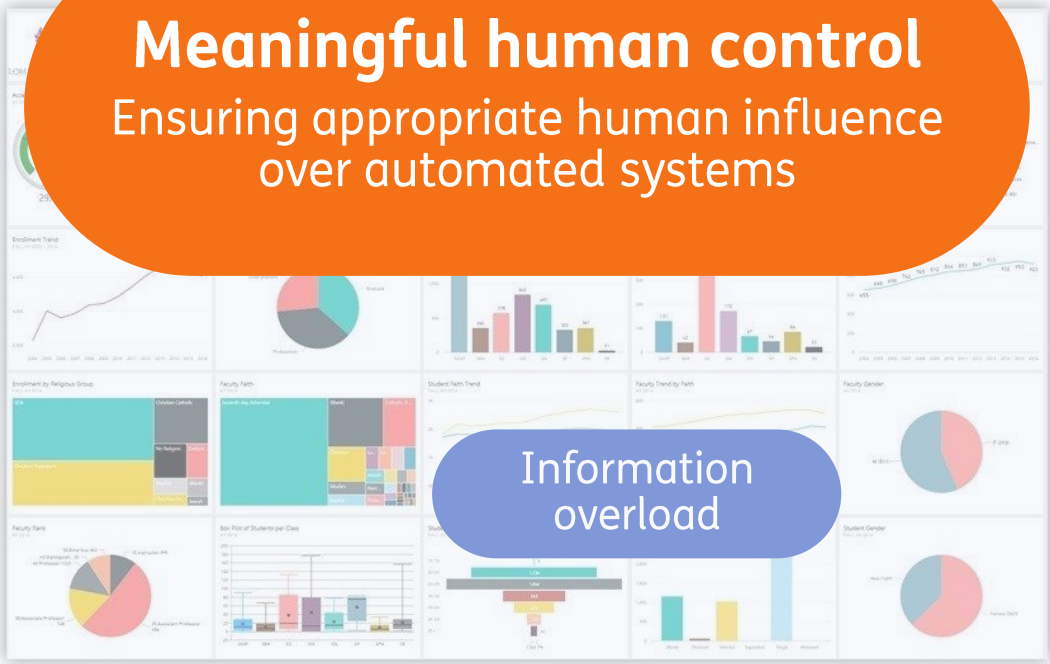

Lack of transparency

## Tay: Microsoft issues apology over racist chatbot fiasco

25 March 2016 · 385 Comments



Lack of human oversight



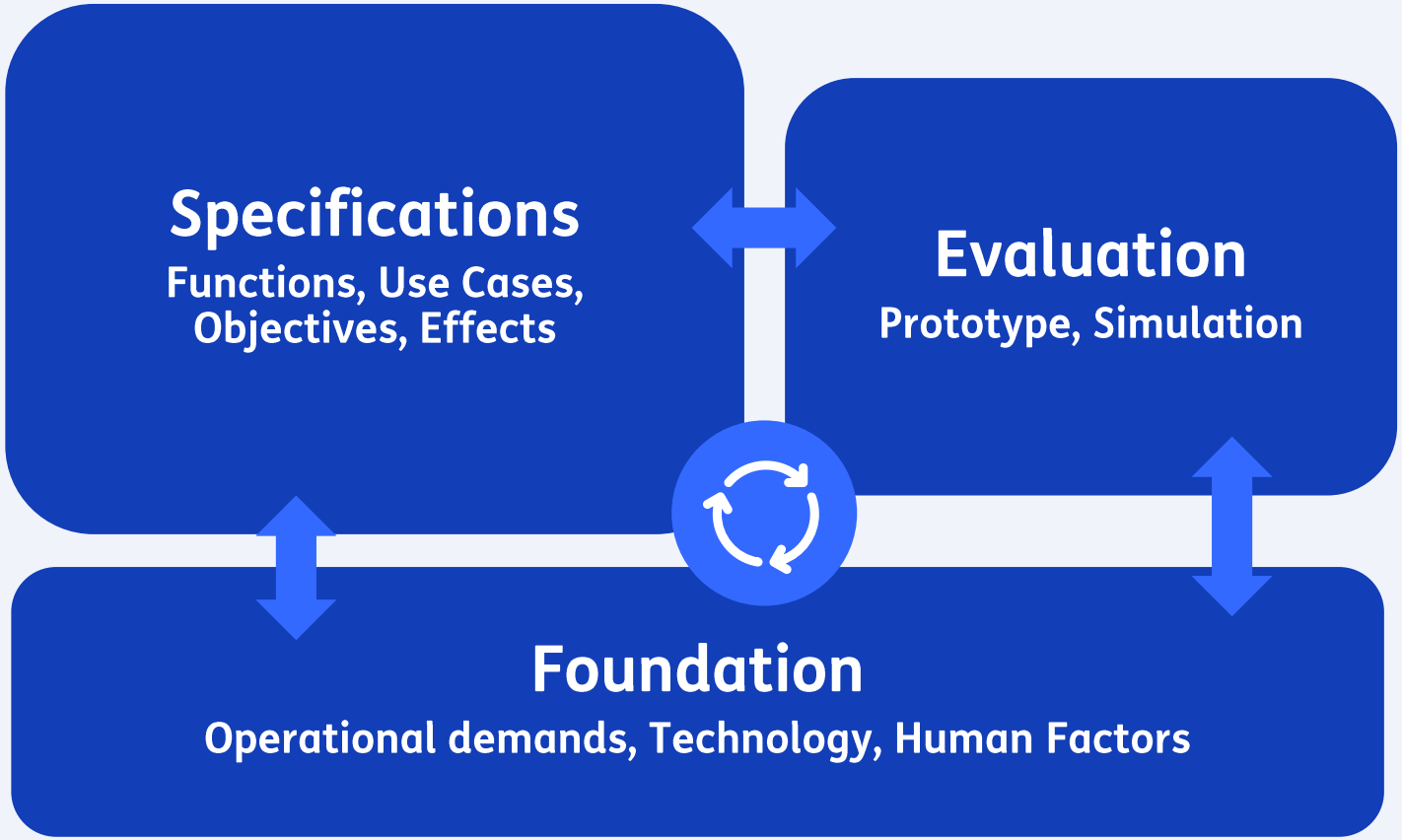
Information overload

**Meaningful human control**

Ensuring appropriate human influence over automated systems

# How to design Human-Machine Teams?

- Socio-Coginitive Engineering (SCE) Method



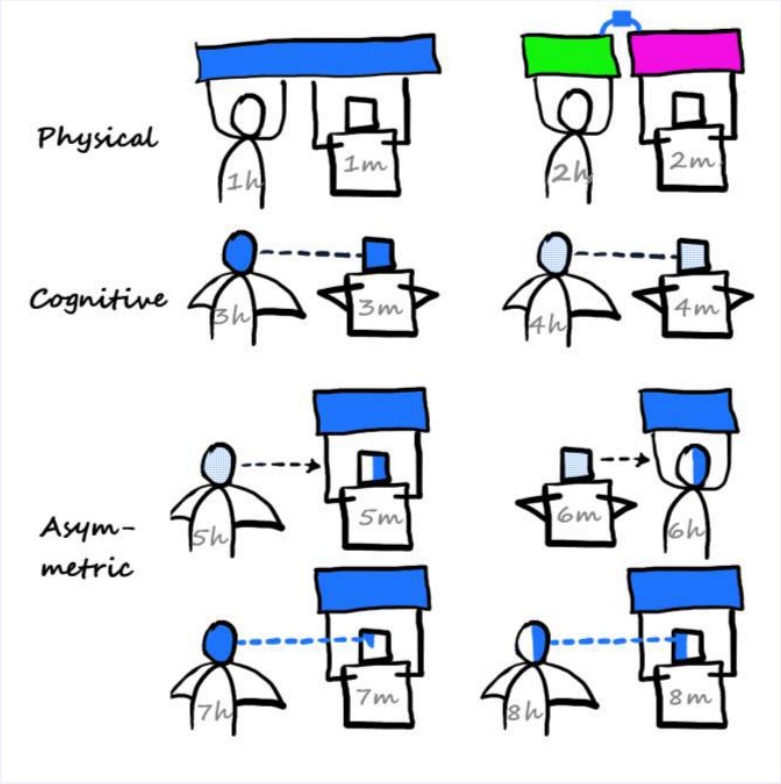
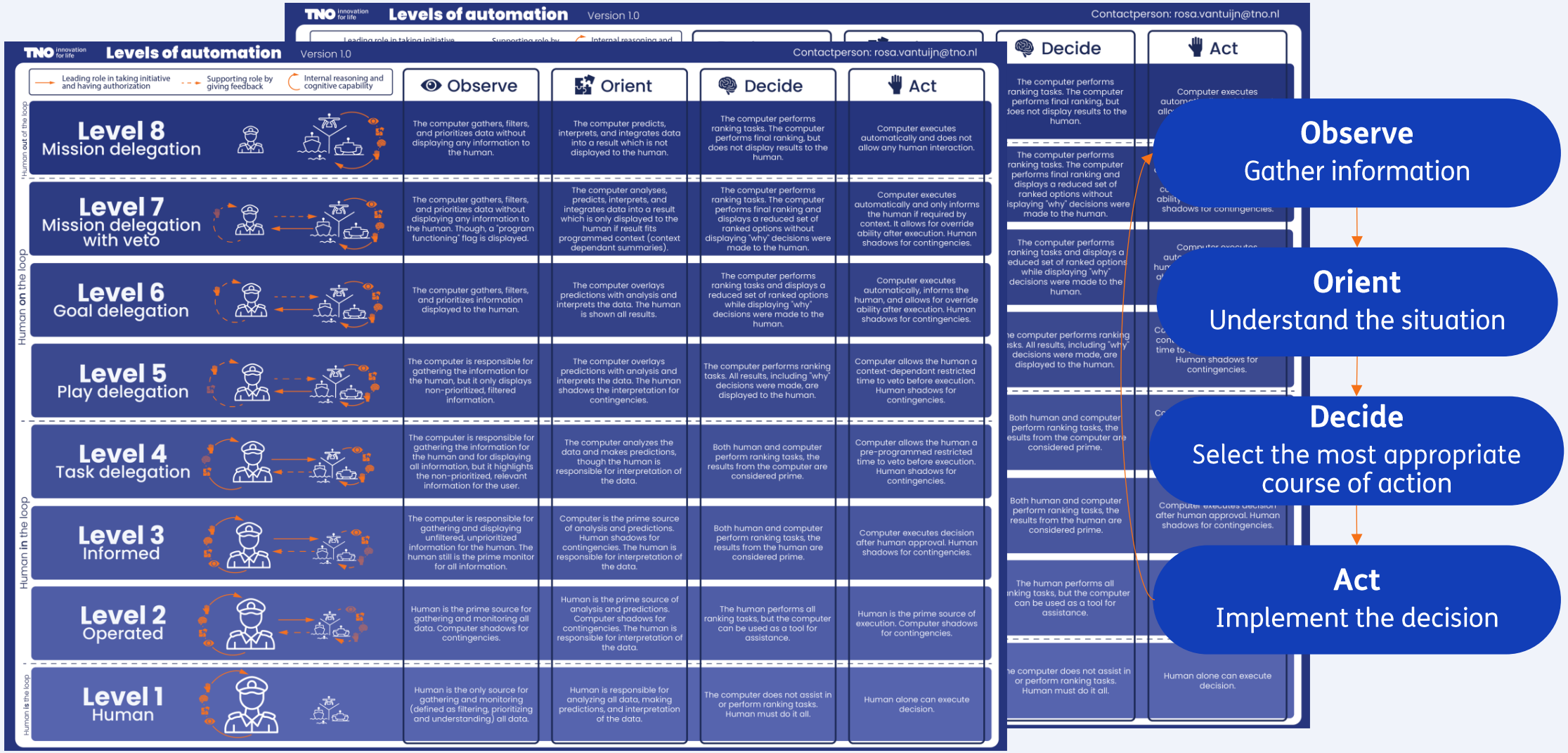




*Image credits: Jurriaan van Diggelen, TNO*

*Neerincx MA, van Vught W, Blanson Henkemans O, Oleari E, Broekens J, Peters R, Kaptein F, Demiris Y, Kiefer B, Fumagalli D and Bierman B (2019) Socio-Cognitive Engineering of a Robotic Partner for Child's Diabetes Self-Management. Front. Robot. AI 6:118. doi: 10.3389/frobt.2019.00118*

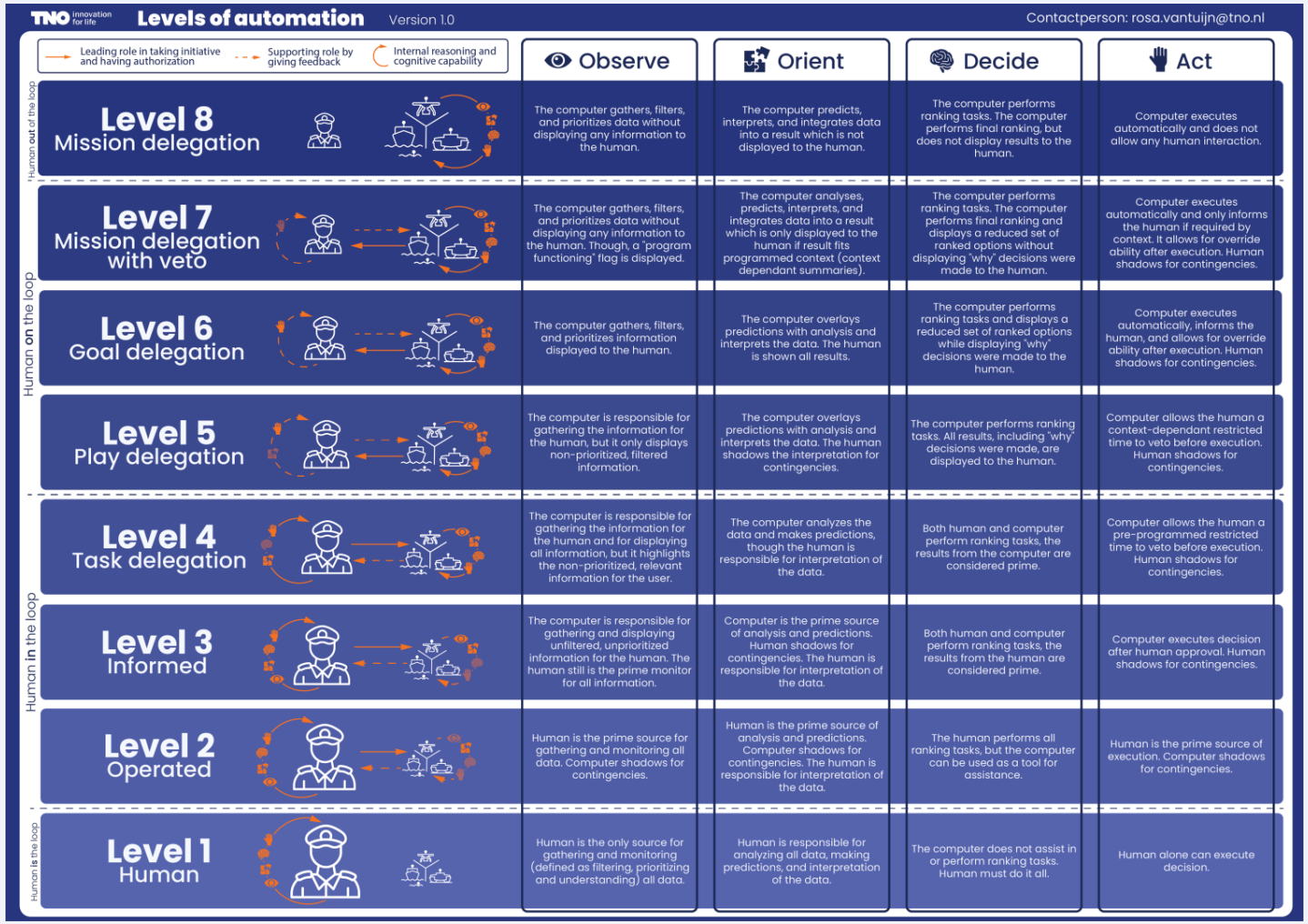
# Levels of Automation

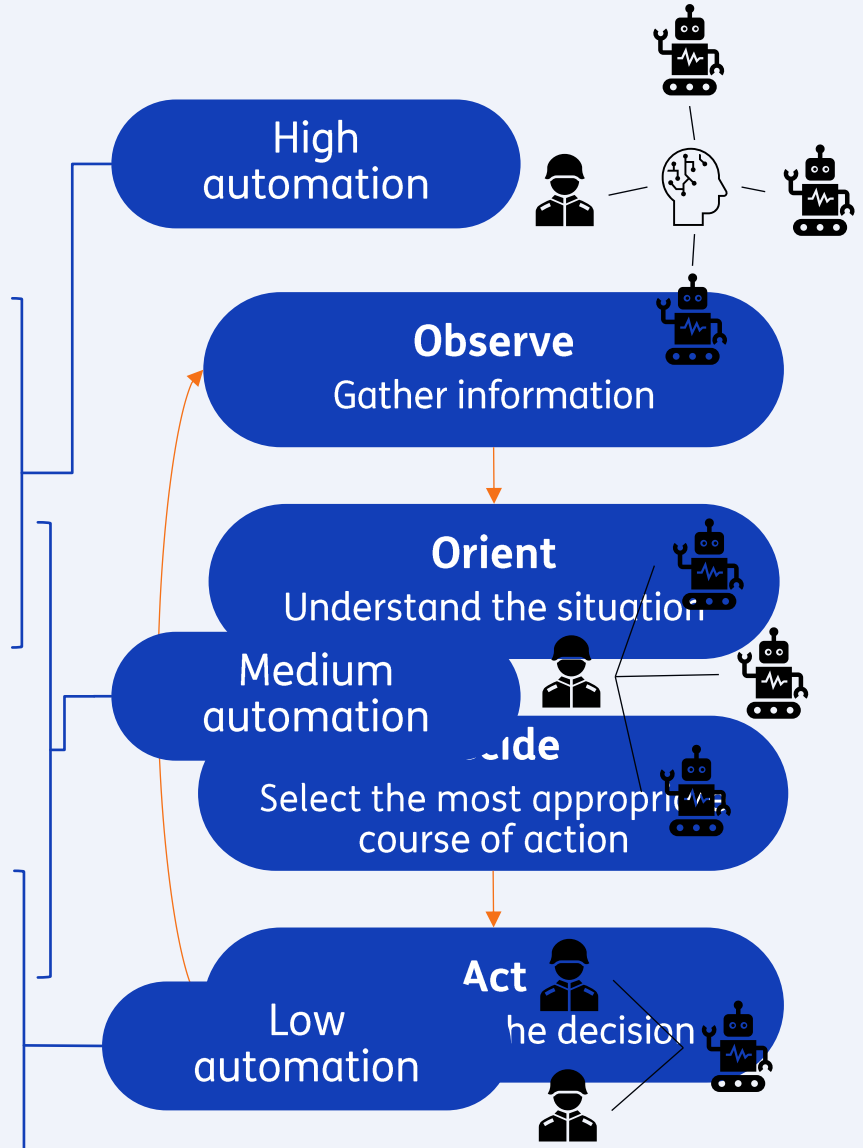



***Young, L. A., Yetter, J. A., & Guynn, M. D.*** *(2005, September). System analysis applied to autonomy: Application to high-altitude long-endurance remotely operated aircraft. American Institute of Aeronautics and Astronautics. https://doi.org/10.2514/6.2005-7103*

***European Defence Agency.*** *(2022). Best Practice Guide for Unmanned Maritime Systems Handling, Operations, Design and Regulations (SARUMS BPG 2022) (Public Version). European Defence Agency. https://www.eda.europa.eu/*

# Types of Human-Machine Teams




*van Diggelen, J., Boshuijzen-van Burken, C., & Abbass, H. (2024, October). Team Design Patterns for Meaningful Human Control in Responsible Military Artificial Intelligence. In International Conference on Bridging the Gap between AI and Reality (pp. 40-54). Cham: Springer Nature Switzerland.*

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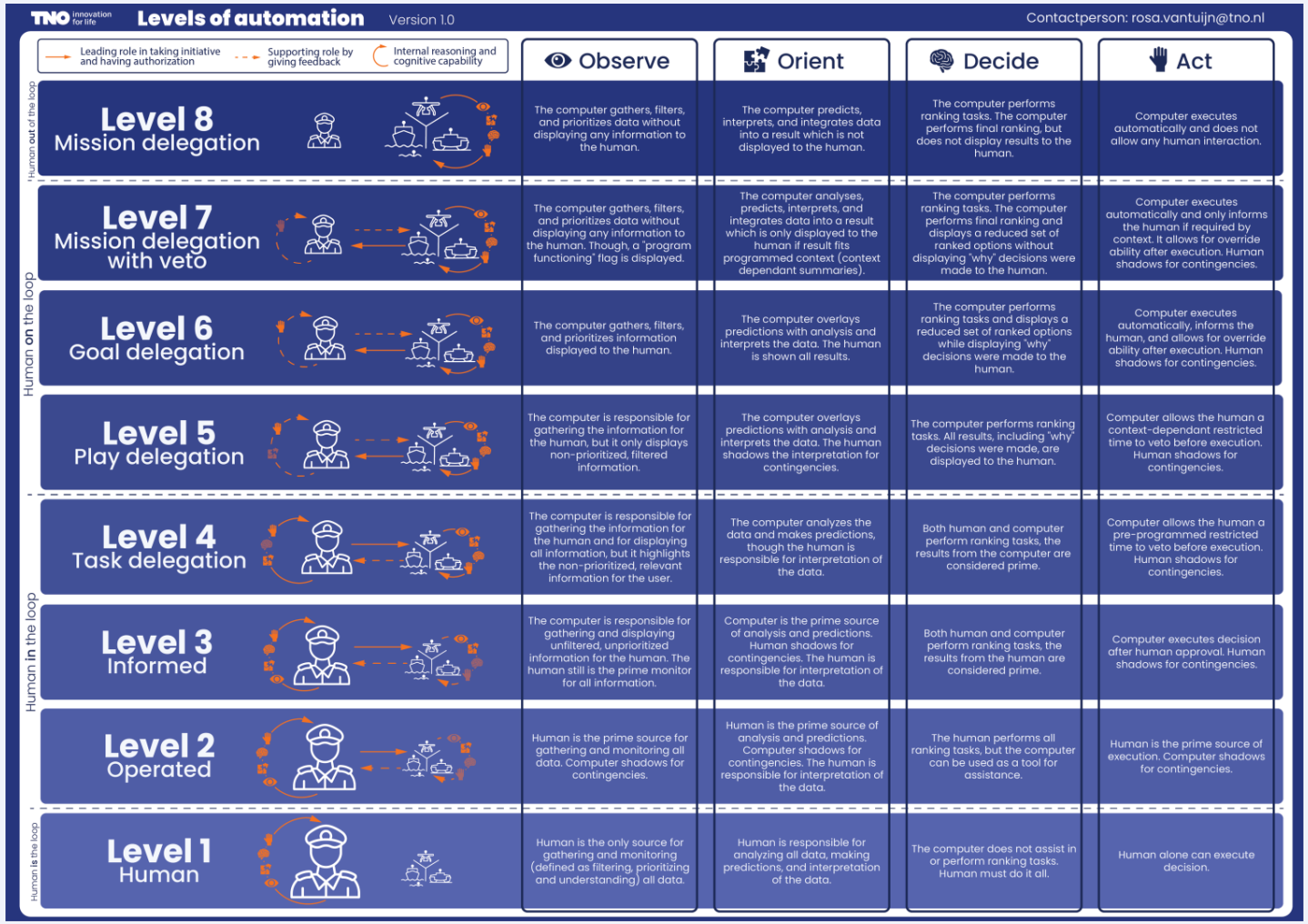


(On site) Goal delegation


(Remote) Delegation

Teleoperating

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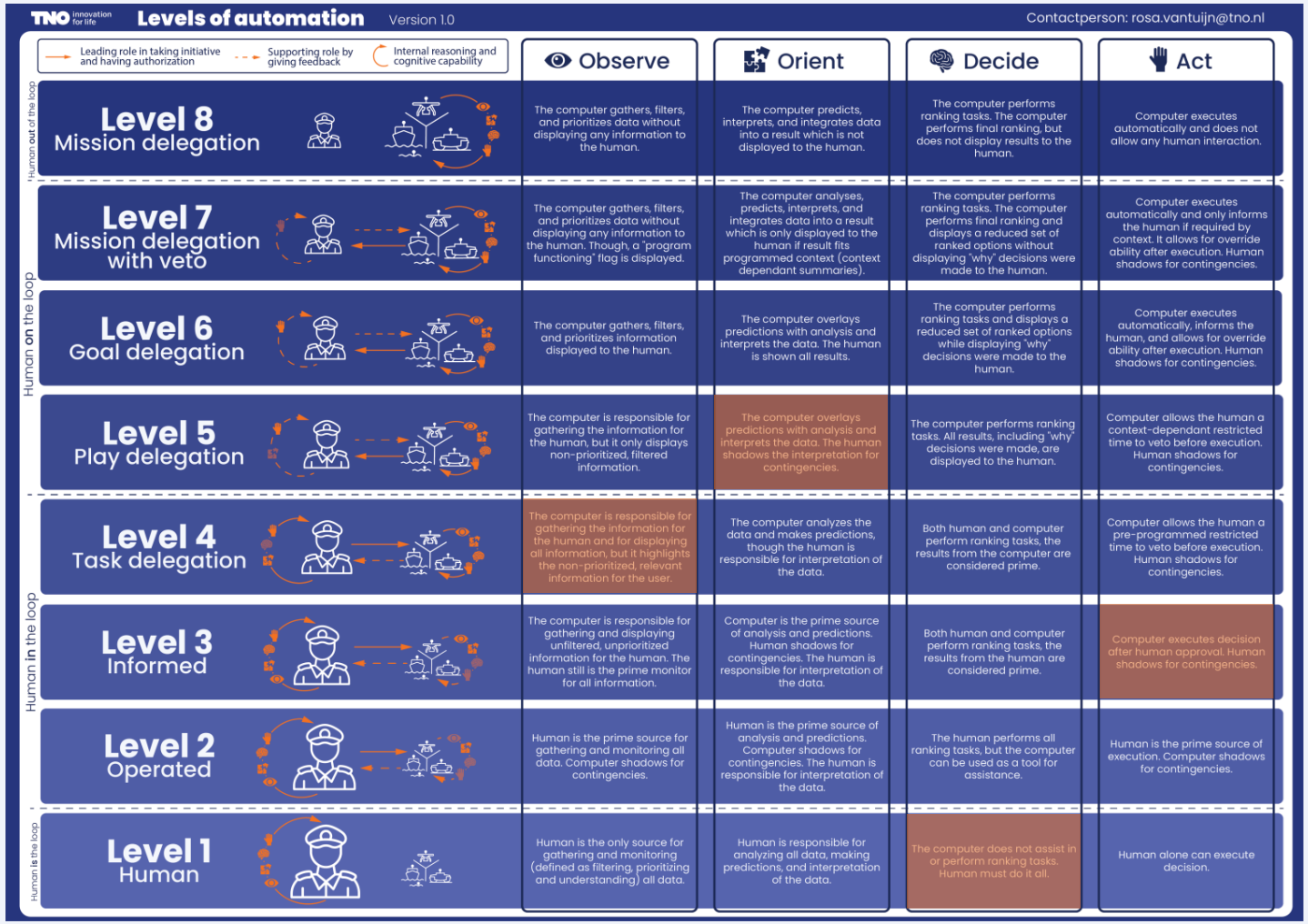


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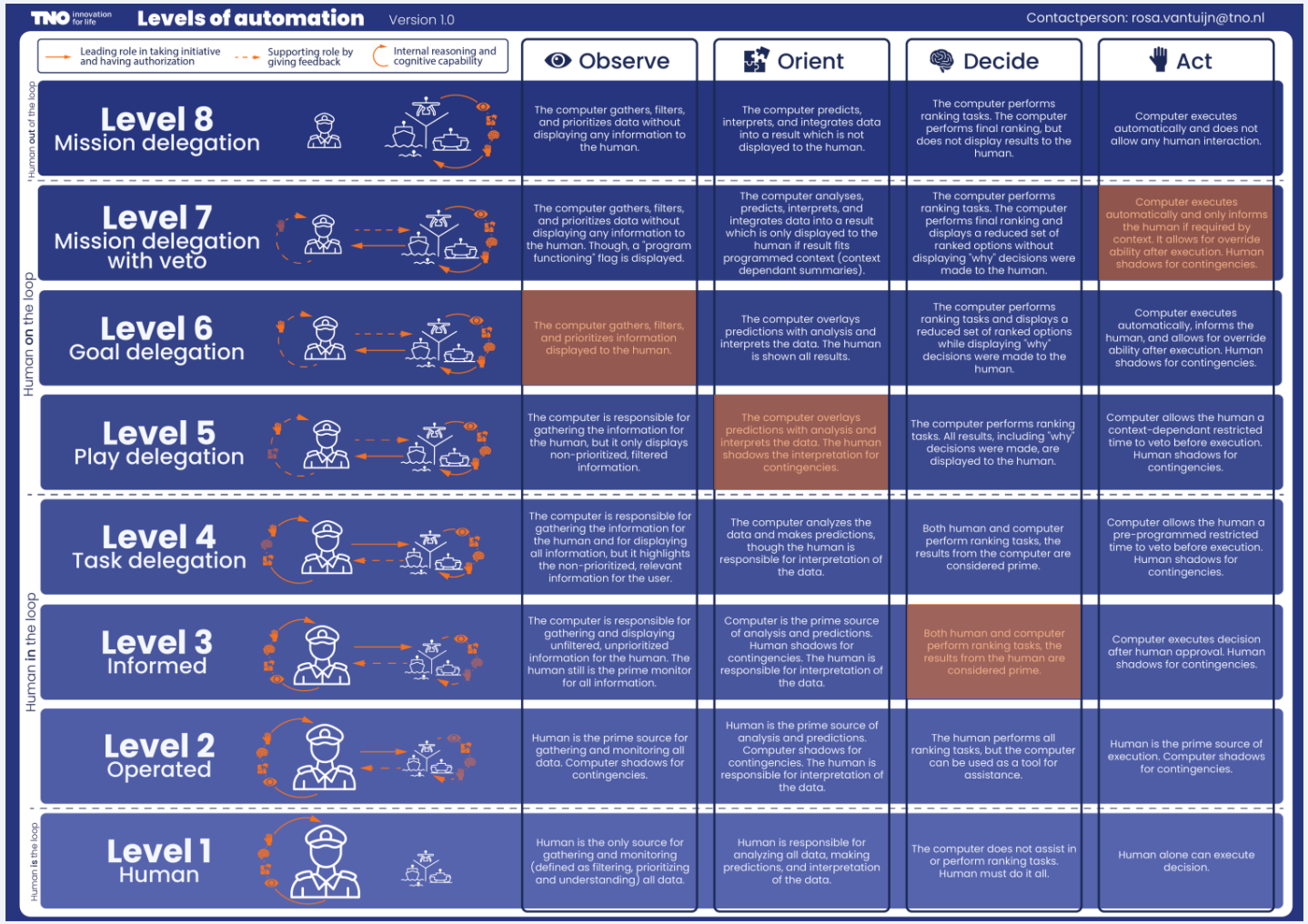


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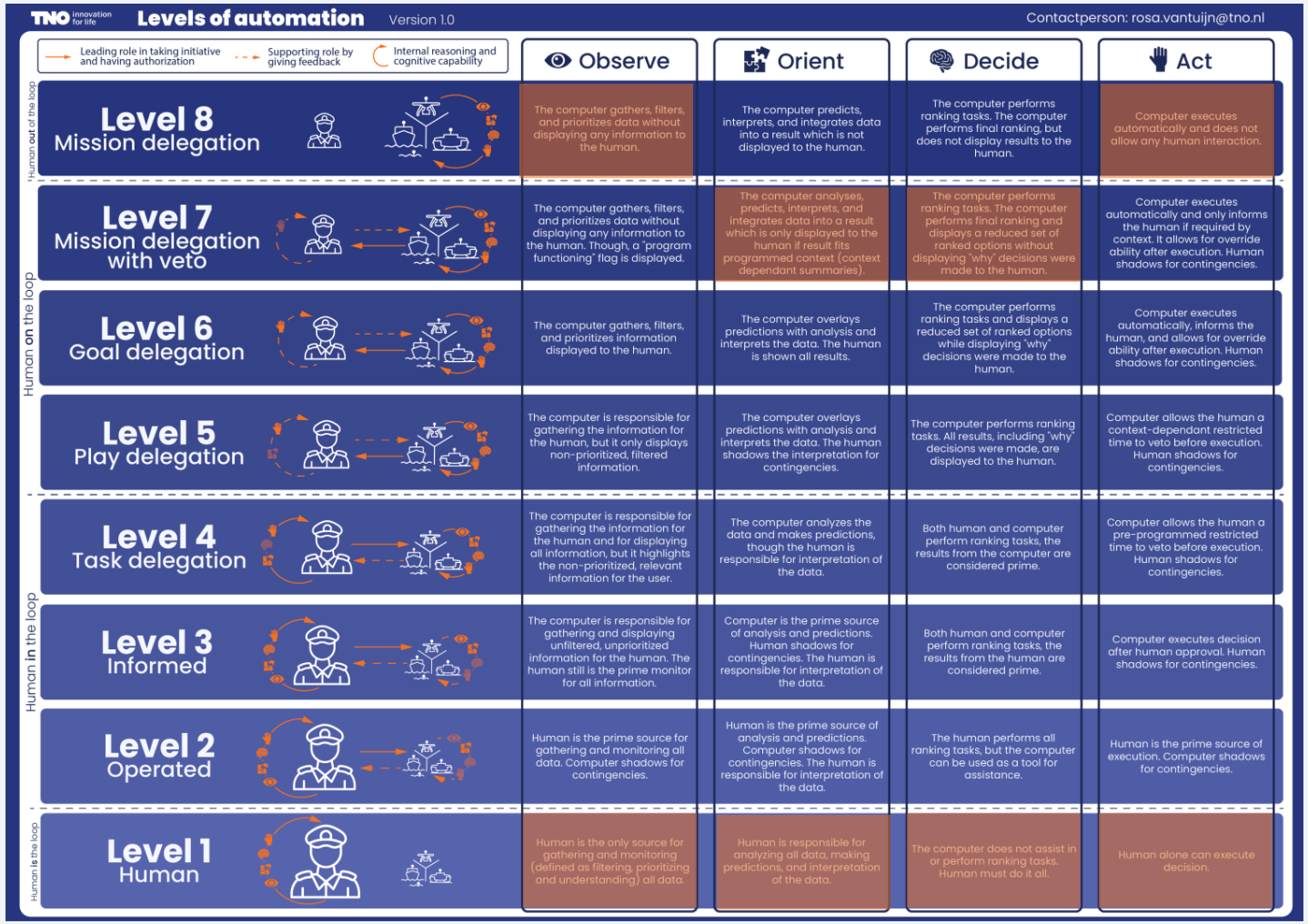


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# Uncrewed systems (UxVs)





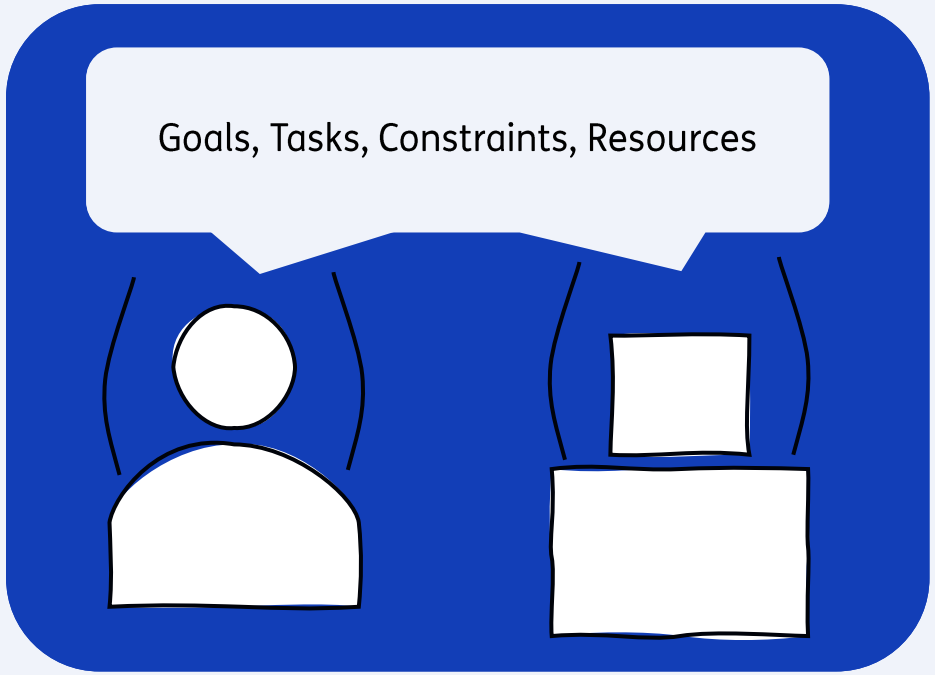
Inspector 90 - Unmanned Surface Vehicle | Exail
Autonomous Underwater Vehicles For Defense Applications | Exail
Ukraine's Drone Army Was Born In a Crucible of Conflict
THeMIS - Milrem

# Why UxVs?

| Opportunities | | Challenges | |
|---|---|---|---|
| Reduced risk to personnel | UxVs can perform dull, dirty, and dangerous tasks | Complex environments | UxV capabilities are reduced in complex environments, e.g. bad weather, hilly terrain |
| Do more | UxVs reduce the workload for personnel | Scalability | Operating 1 UAV: 3+ people<br>Operating 2 UAVs: 5+ people |
| Cost efficiency | A cheap UAV can have similar capabilities as a much more expensive helicopter | Reduced meaningful human control | A diminished overview of what the system is doing and what is happening, may lead to impaired decision making |

# Team Design Patterns

- Team Design Patterns are reusable solutions that describe how humans and intelligent agents can collaborate within teams. Each pattern includes:
  - **Design problem**: What are we trying to solve?
  - **Design rationale**: Why would this pattern work in this context?
  - **Design solution**: How do we try to solve it?
  - **Example**: A concrete illustration of the pattern in use
- TDP: Play-based delegation

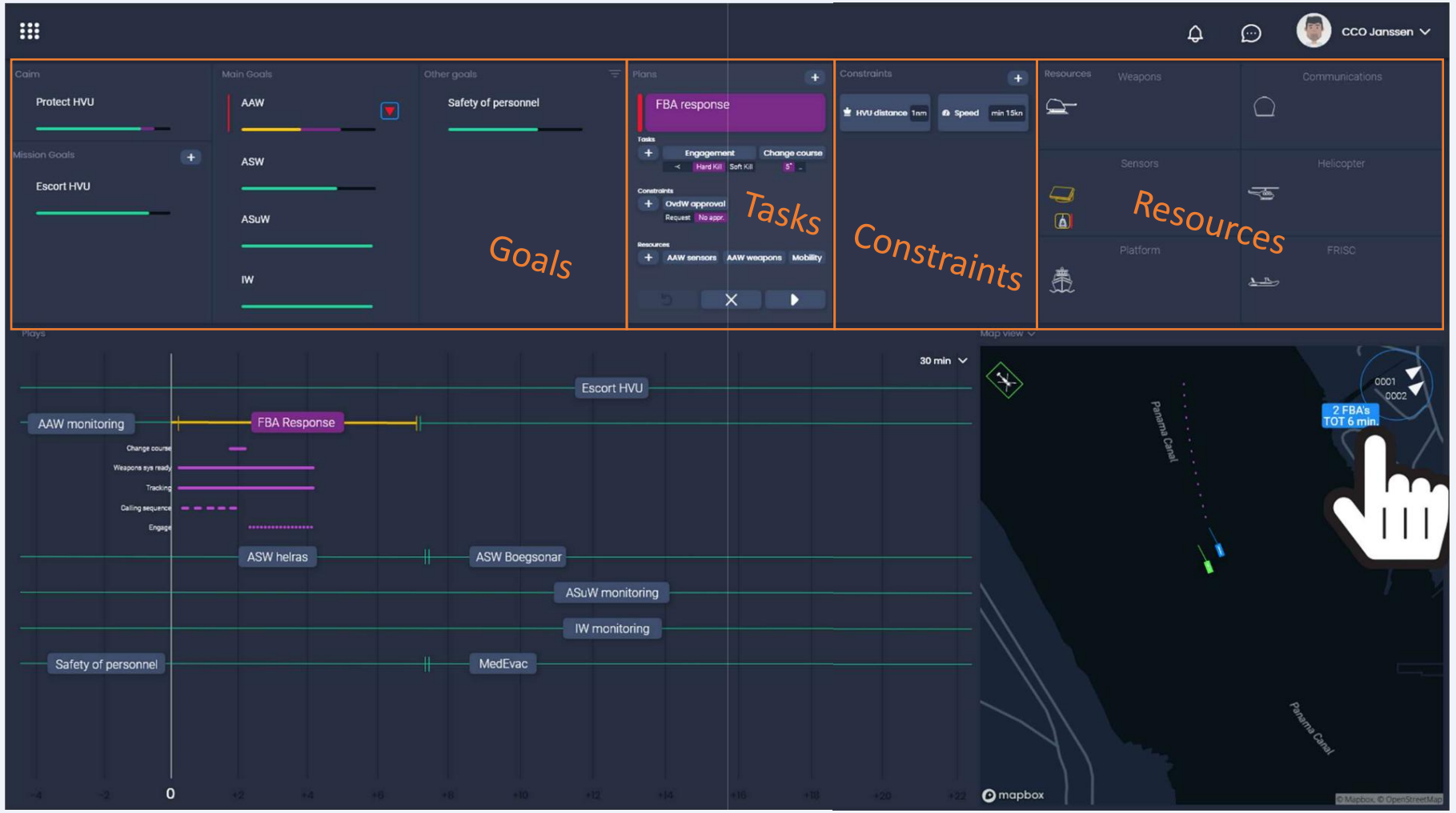



*(Diggelen et al, 2021)*

*Calhoun, G., Bartik, J., Ruff, H., Behymer, K., & Frost, E. (2021). Enabling human-autonomy teaming with multi-unmanned vehicle control interfaces. Human-Intelligent Systems Integration, 3(2), 155-174.*

# Team Design Pattern: Play-based delegation

- **Design problem:**
  - How can users quickly and effectively communicate complex instructions?
  - How can systems be given varying levels of autonomy depending on the situation?
- **Design rationale:**
  - Plays are templates with **goals**, **tasks**, **resources**, and **constraints**.
  - They can be customized and simulated before execution.
- **Design solution:**
  - Play-based delegation
- **Example:**





*Barnhoorn, J. S., Rakhorst-Oudendijk, M., Veltman, K., Holleman, B., Haije, T., Wolbers, J., & Janssen, J. (2022, October 10). IMMENS: Integrated Multi-Manager Environment for Naval Ships. In Conference Proceedings of the International Ship Control Systems Symposium (iSCSS). https://doi.org/10.24868/10732*

# Summary

We discussed

- What Human-Machine Teaming is
- Human-Machine Teaming at TNO
- Why Human-Machine Teaming is important
- How to design for Human-Machine teams
- Design solution: play-based delegation

# Thank you for Your attention

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