Australian Cobotics Centre

Demystifying cobots: Human Decision and Robot Tasks

PROGRAM 3 WORKSHOP@ACC SYMPOSIUM 2025

Industrial transformation Training Centre in Collaborative Robotics
funded by the Australian government through the Australian Research Council

Australian Government
Australian Research Council

Acknowledgement of Traditional Owners

QUT acknowledges the Turrbal and Yugara, as the First Nations owners of the lands where QUT now stands. We pay respect to their Elders, lores, customs and creation spirits. We recognise that these lands have always been places of teaching, research and learning.

QUT acknowledges the important role Aboriginal and Torres Strait Islander people play within the QUT community.

ACC Program 3 Team

Matthias Victor Muge Bochao Glenda Jasper Al Yuan

Cobot→CoApp?

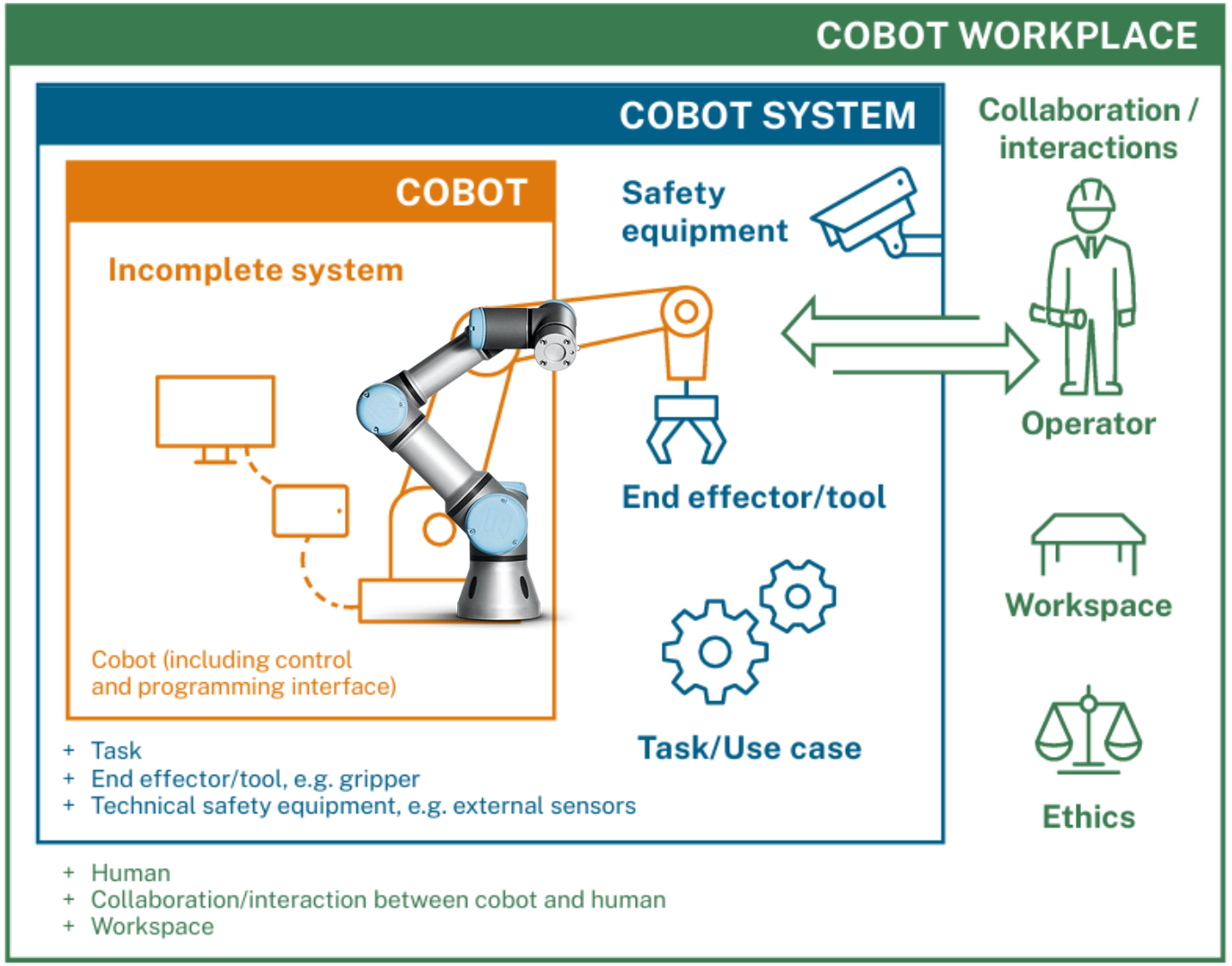
ISO/TS15066 → ISO 10218-1:2025

"… human-robot collaboration relates to the application and not to the robot alone … Safety functions that enable a collaborative task can be part of the robot or can be provided by a protective device, or a combination."

SafeWork NSW

- Workplace ⊂ System ⊂ Robot

Collaborative Application vs Automation



Cobot ≈ Collaborative application with a robot

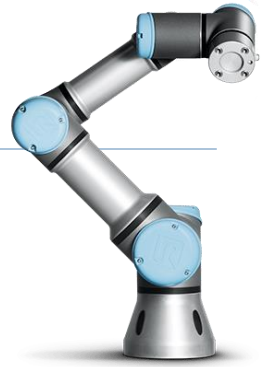
Cobot ≈ Collaborative application with a robot

We have a cobot.

We are about to implement a cobot.

We are assessing cobot.

Typical Technology Adoption Phases



We are assessing cobot.

We are about to implement a cobot.

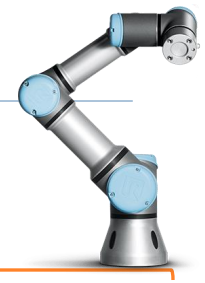
We have a cobot.

Regular activities → Dedicated adoption effort

Less money → More money

Bochao xu

Typical Technology Adoption Activities



Regular activities

Dedicated adoption effort

We are about to implement a cobot.

We have a cobot.

Activity 1: Video Analysis of Work Tasks

We are assessing cobot.

Activity 2: Socio-technical System Analysis

1 Develop and Maintain Strategy
Problem Space

1.1 Plan to innovate
1.2 Identify improvement needs
1.3 Develop strategy and goals
1.4 Learn strategy and management

Parallel Adoption Initiation
Strategy
People
Technology
1.6 Intend to Adopt

2.1 Scan and scout technology
2.2 Learn and evaluate technology

2 Solution Space
Scan and Evaluate Technology

3 Investigate Solutions
Adoption Decision

3.1 Gather solutions
3.2 State and prioritise requirements
3.3 Research external support
Plan and business case

3.5 Authorise

4 Implement Solution
Adoption Project

4.1 Acquire and allocate resources
4.2 Acquire /develop technology
4.3 Test and commission
4.4 Upskill workforce
4.5 Roll-out and transition
4.6 Reflect and evaluate

Successful Technology Adoption

Contact: bochao.xu@student.uts.edu.au

Activity 1: Analysis of Workplace

Questions to ask

[1.2] What problem(s) are we facing? Where in our organisation needs improvement?

[2.2] What is a cobot?

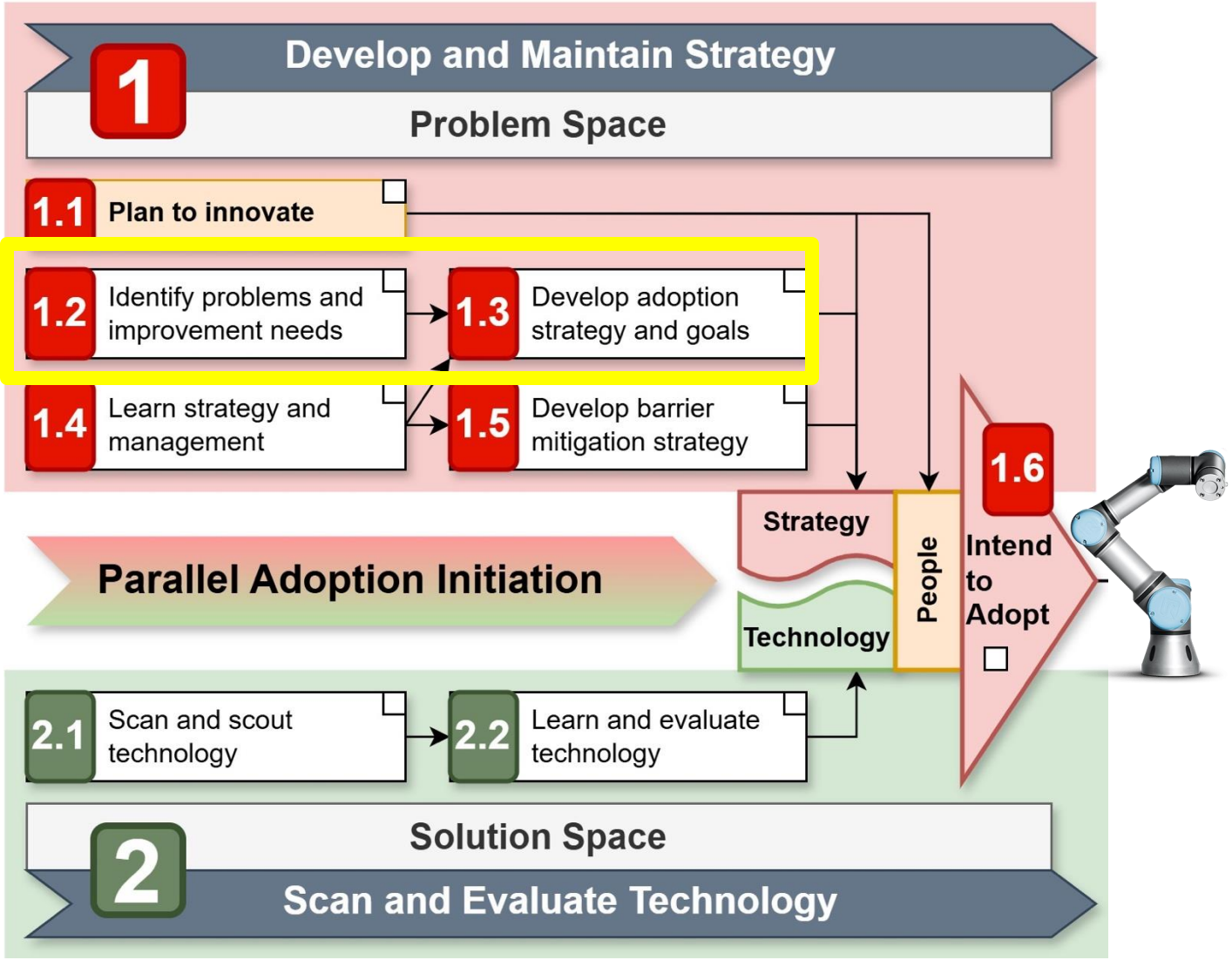
[1.3] Where does a cobot fit in our workplace?

[1.3] Where does a cobot sit in our roadmap?

[1.3] What KPIs are affected by adopting a cobot?

[1.5] What barriers might impact our adoption?

[1.6] Should we adopt a cobot?



Activity 2: Socio-technical System Analysis

Questions to ask

[3.1] What robot models are available?

[3.1] What kind of robot fits our use case?

[3.2] What are the technical requirements of our cobot?

[3.2] Is the robot compatible with our system?

[3.2] Do operators have sufficient skills?

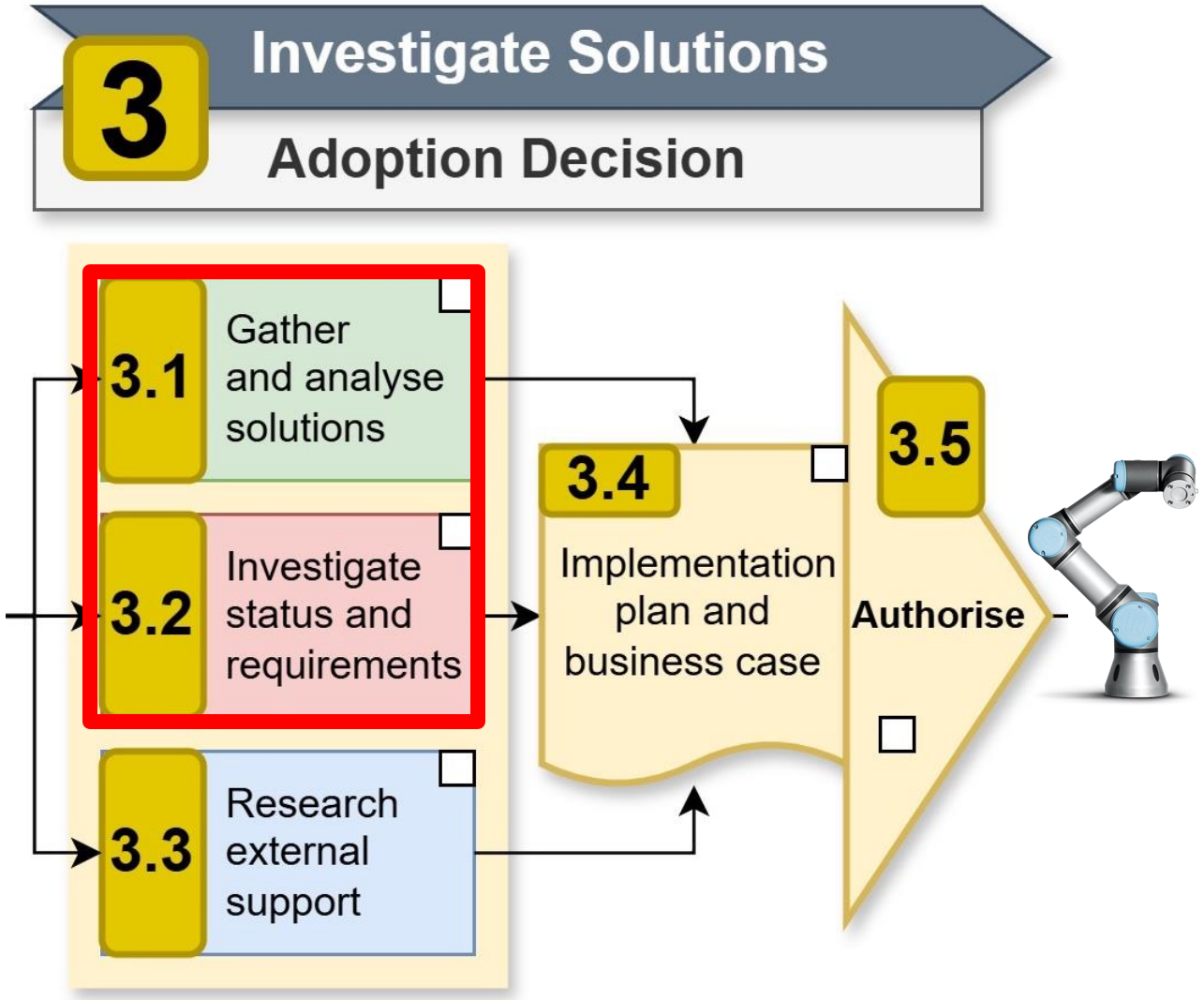
[3.2] Are our members happy to work with a robot?

[3.3] What external support can we acquire?

[3.4] What is the return on investment?

[3.4] How are we carrying out the cobot project?

[3.5] Will the business case and plan be approved?

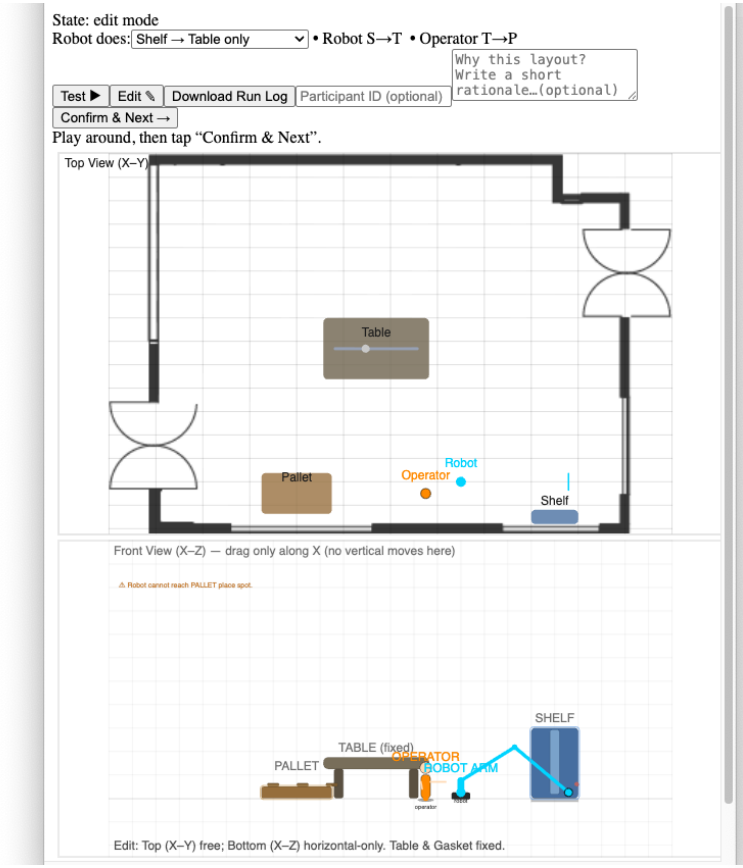


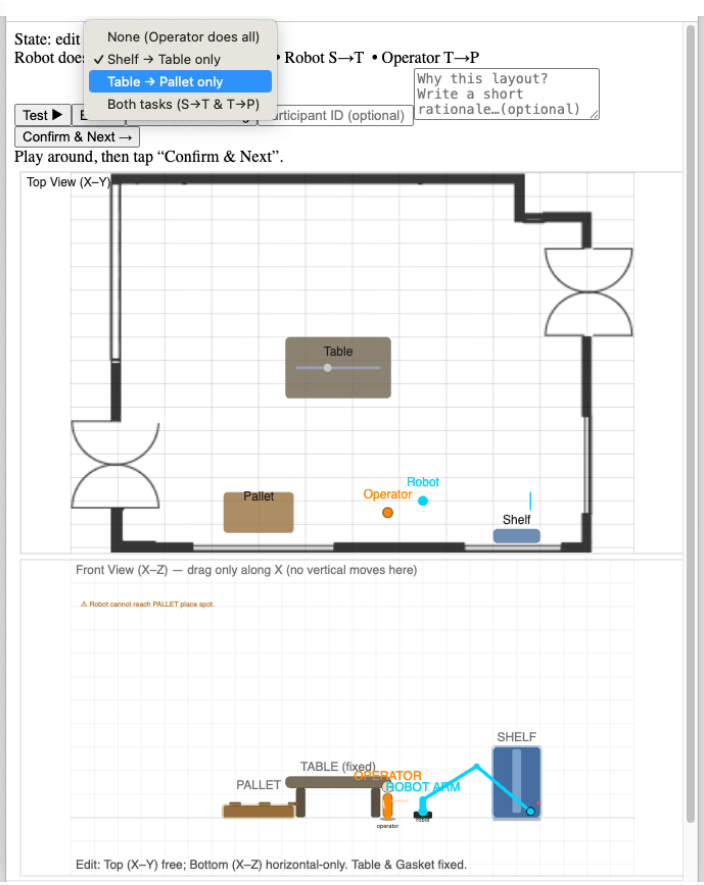
Agenda

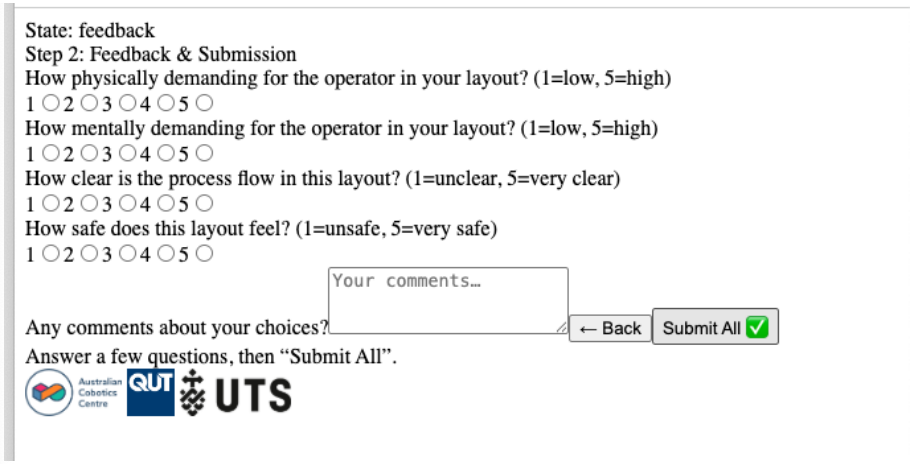
- Cobot workplace game (10 mins)
- Activity 1: Video analysis of the workplace (20 mins)
- Discussion for Activity 1 (10 mins)
- Activity 2: Sociotechnical System Analysis (20 mins)
- Discussion for Activity 2 (20mins)

Yuan Liu

Workplace HRC Layout Game







Yuan Liu

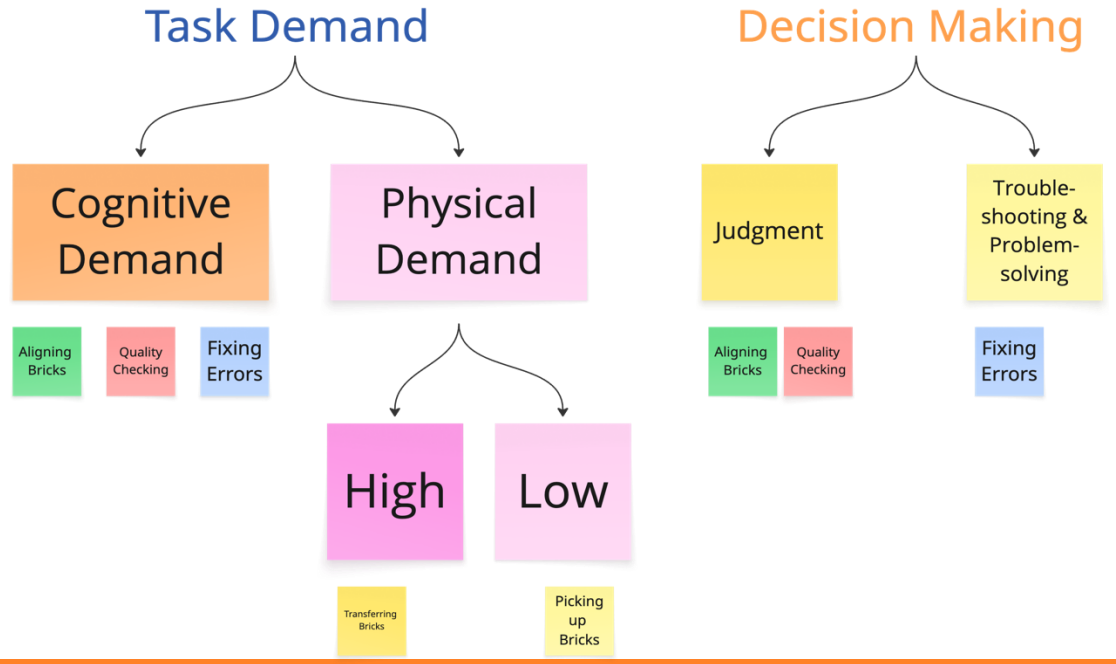
Video Analysis

Step1 Workflow and Activities

Example:

Step2 Task Demand and Decision Making

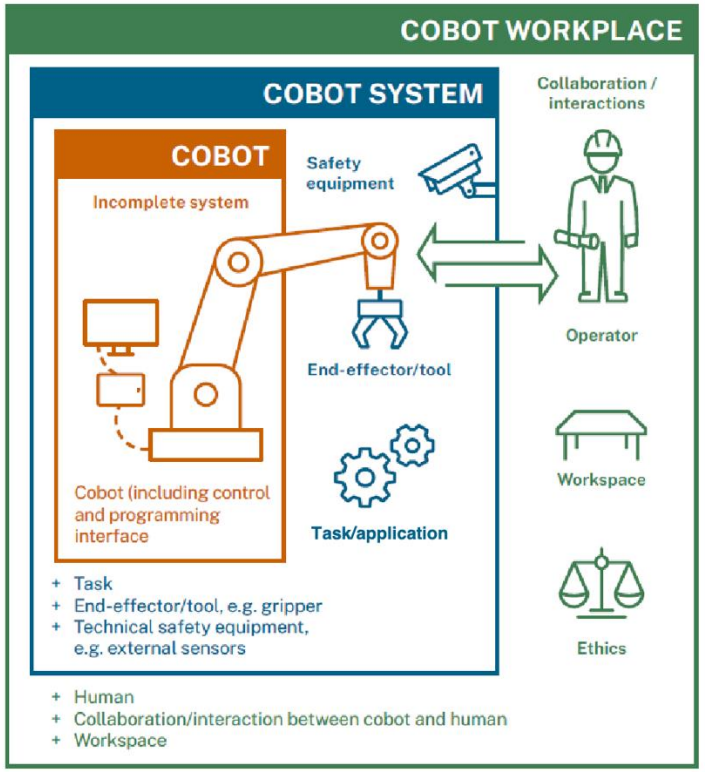
Example:



Making cobot design decisions more systematic

Collaborative robot projects are socio-technical

- Product, People, robot and workplace are all coupled
- Very hard to see all factors at once

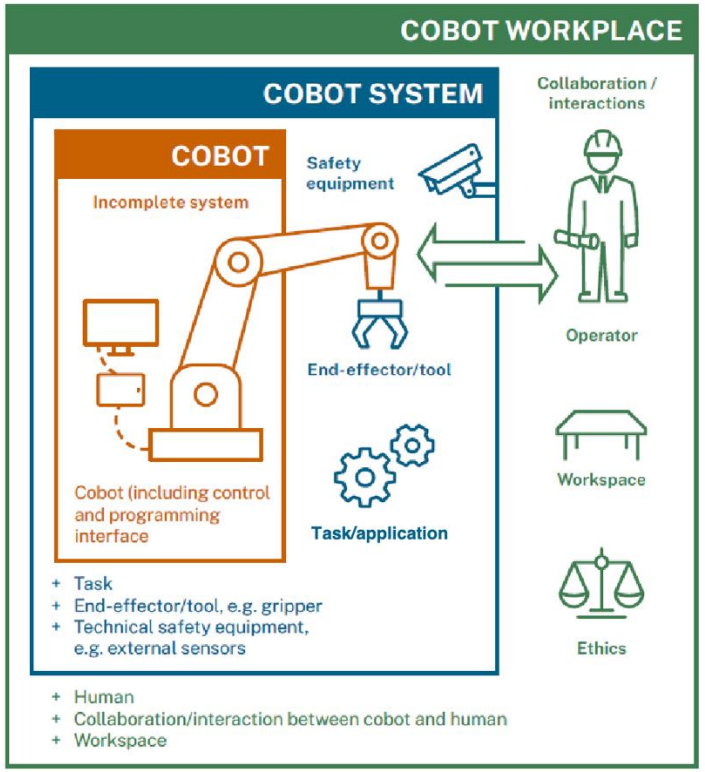


(Guertler et al. 2024)

Making cobot design decisions more systematic

We will use a matrix tool to

1. Capture context of a use-case
2. Translate that into critical cobot attributes
3. Use this as a structured basis for discussion.



(Guertler et al. 2024)

Using the matrix tool

1) Fill in use-case for your task

- *Don't overthink every box, approximate values are fine*

2) Automated analysis

- Tool analyses use case and generates your critical cobot attributes and underlying matrices
- You will see
  - A ranked list of cobot attributes
  - How each attribute's importance compares to your implied priority

3) Discussion and compare

- Where do priorities align and where do they differ?
- Reflect on what that means for:
  - Cobot selection e.g. payload, safety, UI.
  - Training, ergonomics, process redesign

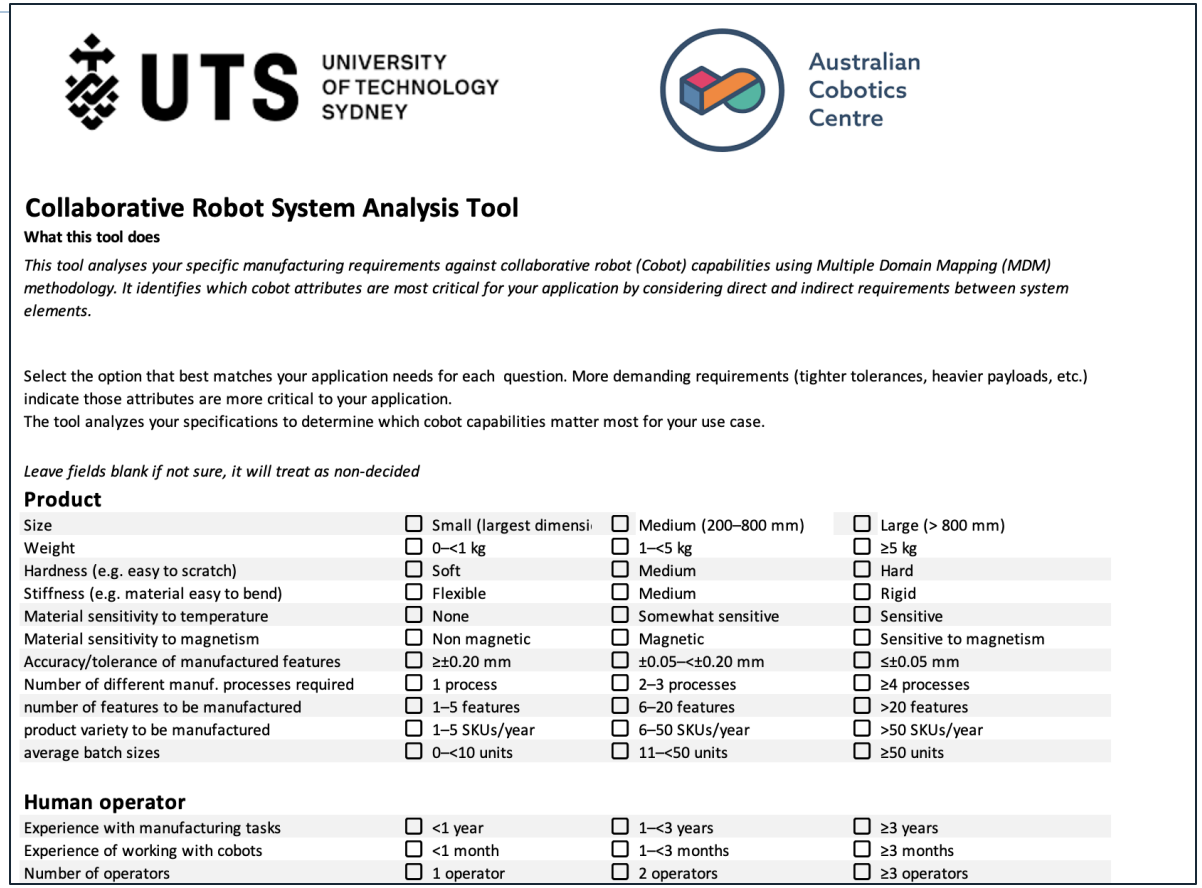
Fill in use-case from video

Open link from QR code or TinyURL

Fill in values for your video scenario:

- **Product**: size, variety, tolerances etc.
- **Human operator**: experience, effort, attention demand etc.
- **Workplace**: Scope of cobot task, number of steps, general automation level etc.

If unsure, just leave blank



UTS UNIVERSITY OF TECHNOLOGY SYDNEY

Australian Cobotics Centre

Collaborative Robot System Analysis Tool

What this tool does

This tool analyses your specific manufacturing requirements against collaborative robot (Cobot) capabilities using Multiple Domain Mapping (MDM) methodology. It identifies which cobot attributes are most critical for your application by considering direct and indirect requirements between system elements.

Select the option that best matches your application needs for each question. More demanding requirements (tighter tolerances, heavier payloads, etc.) indicate those attributes are more critical to your application.
The tool analyzes your specifications to determine which cobot capabilities matter most for your use case.

Leave fields blank if not sure, it will treat as non-decided

Product

Size	☐ Small (largest dimensi	☐ Medium (200–800 mm)	☐ Large (> 800 mm)
Weight	☐ 0–<1 kg	☐ 1–<5 kg	☐ ≥5 kg
Hardness (e.g. easy to scratch)	☐ Soft	☐ Medium	☐ Hard
Stiffness (e.g. material easy to bend)	☐ Flexible	☐ Medium	☐ Rigid
Material sensitivity to temperature	☐ None	☐ Somewhat sensitive	☐ Sensitive
Material sensitivity to magnetism	☐ Non magnetic	☐ Magnetic	☐ Sensitive to magnetism
Accuracy/tolerance of manufactured features	☐ ≥±0.20 mm	☐ ±0.05–<±0.20 mm	☐ ≤±0.05 mm
Number of different manuf. processes required	☐ 1 process	☐ 2–3 processes	☐ ≥4 processes
number of features to be manufactured	☐ 1–5 features	☐ 6–20 features	☐ >20 features
product variety to be manufactured	☐ 1–5 SKUs/year	☐ 6–50 SKUs/year	☐ >50 SKUs/year
average batch sizes	☐ 0–<10 units	☐ 11–<50 units	☐ ≥50 units

Human operator

Experience with manufacturing tasks	☐ <1 year	☐ 1–<3 years	☐ ≥3 years
Experience of working with cobots	☐ <1 month	☐ 1–<3 months	☐ ≥3 months
Number of operators	☐ 1 operator	☐ 2 operators	☐ ≥3 operators

- empty: no link
- 1: weak link/dependency
- 3: strong link/dependency

			Cobot											
			Maximum portable load	Maximum range (reach)	Speed	Position accuracy	Degrees of freedom	Costs	User Interface/ease of program.	Number of diff. tools	Safety-rated monitored stop	Hand guiding	Speed and separation monitoring	Power and force limiting
			C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
Cobot	Maximum portable load (payload)	C1												
	Maximum range (reach)	C2												
	Speed	C3												
	Position accuracy	C4												
	Degrees of freedom - number of axes	C5												
	Costs	C6												
	User Interface/ease of programming	C7												
	Number of diff. tools	C8												
	Safety-rated monitored stop	C9												
	Hand guiding	C10												
	Speed and separation monitoring	C11												
	Power and force limiting	C12												
Product	Size	P1	1	1	1	1	1	1		1		1	1	1
	Weight	P2	3	3	3	3		3			1	1	1	3
	Hardness (sensitivit to pressure)	P3			1			1		1				3
	Stiffness (stiff vs. floppy parts)	P4			1	3	1	1		1		1		1
	Material sensitivity to temperature	P5				1				1				
	Material sensitivity to magnetism	P6				1				3				
	Accuracy / Tolerance of man. features	P7		1	3	3	3	1	3	1		1		
	Number of diff. manuf. processes required	P8	1	1	1	1	3	3	3	3		1		
	Number of Features to be manufactured	P9			1	1	3	1	3	3				
	Product variety to be manufactured	P10			3	3	3	1	3	3		3		
	Average batch sizes	P11	1		3	1	1	1	1	1				
Human Operator	Experience with manufacturing tasks	H1			1				3	1	1	1	1	1
	Experience of working with cobots	H2	1		3	1	1		3	1	3	3	3	3
	Number of operators	H3		1	3				3		3	1	3	3
	Height	H4		3	1	1	1					1		
	Strength	H5	3			1					1	3	1	1
	(Fine) Motoric skills	H6				1	1					3		
	Attention span	H7	1	1	3	1			3		3	3	3	3
Workplace	Scope of application (diff. processes)	W1		3	3	3	3	3	3	3	3	3	3	3
	Number of process steps	W2		1	1	1	1		1	1	1	1		
	Degree of automatization	W3	3	3	3	3	3	1	3	1	3	1	3	3
	Hazard risks of process operations/tools	W4	1	1	3	3	1		3	3	3	1	3	1
	Existing safety regulations	W5	3	3	3	1	3	1	3	1	3	3	3	3
	Access-controlled workplace	W6	1	3	3		1			3		3	1	1
	Room size	W7		3	1	1	3		1	3	3		3	3
	Variability of workplace	W8		1	1	1	1		3		3	3	3	3
	Brightness / Light condition of the room	W9			3	3			1		3		3	3
	Noise Level	W10			3								1	1
	Workplace Ergonomic for humans	W11	3	3	3	1	3		1	1		1		
	Connectivity (column sum)		22	32	55	40	37	18	44	33	37	36	38	40

			Product										
			Size	Weight	Hardness	Stiffness	Material temperature sensitivity	Material magnetic sensitivity	Accuracy / Tolerance of features	Number of diff. manuf. processes	Number of Features	Product variety	Average batch sizes
			P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11
Cobot	Maximum portable load (payload)	C1		3						1			1
	Maximum range (reach)	C2	1	3					1	1			
	Speed	C3	1	3	1	1			3	1	1	3	3
	Position accuracy	C4	1	3		3	1	1	3	1	1	3	1
	Degrees of freedom - number of axes	C5	1			1			3	3	3	3	1
	Costs	C6	1	3	1	1			1	3	1	1	1
	User Interface/ease of programming	C7							3	3	3	3	1
	Number of diff. tools	C8	1		1	1	1	3	1	3	3	3	1
	Safety-rated monitored stop	C9		1									
	Hand guiding	C10	1	1		1			1	1		3	
	Speed and separation monitoring	C11	1	1									
	Power and force limiting	C12	1	3	3	1							
Product	Size	P1											
	Weight	P2											
	Hardness (sensitivit to pressure)	P3											
	Stiffness (stiff vs. floppy parts)	P4											
	Material sensitivity to temperature	P5											
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	Accuracy / Tolerance of man. features	P7											
	Number of diff. manuf. processes required	P8											
	Number of Features to be manufactured	P9											
	Product variety to be manufactured	P10											
	Average batch sizes	P11											
Human Operator	Experience with manufacturing tasks	H1	1	1	1	1	1	1	3	3	3	3	1
	Experience of working with cobots	H2							1	1	1	1	1
	Number of operators	H3	1	1					1	1	1	1	1
	Height	H4	1	1									
	Strength	H5	1	3	1				1	1			
	(Fine) Motoric skills	H6			3	1			3	1	1		
	Attention span	H7							3	1	1	1	
Workplace	Scope of application (diff. processes)	W1	3	1	3	3	3	1	3	3	3	3	1
	Number of process steps	W2	1	1		1	1		1	3	3	3	1
	Degree of automatization	W3	1	1	1	1	1	1	1	3	3	3	3
	Hazard risks of process operations/tools	W4	1	1					1	1	1		
	Existing safety regulations	W5		1			1	1		1			
	Access-controlled workplace	W6		1			1		3	1			
	Room size	W7	3							3	1	1	3
	Variability of workplace	W8	1							3	1	1	1
	Brightness / Light condition of the room	W9							1			1	
	Noise Level	W10							1				
	Workplace Ergonomic for humans	W11	3	3		1				1	1	1	1
	Connectivity (column sum)		27	36	15	17	10	8	39	44	32	38	22

			Human operator						
			Experience with manuf. tasks	Experience of work. with cobots	Number of operators	Height	Strength	(Fine) Motoric skills	Attention span
			H1	H2	H3	H4	H5	H6	H7
Cobot	Maximum portable load (payload)	C1		1			3		1
	Maximum range (reach)	C2			1	3			1
	Speed	C3	1	3	3	1			3
	Position accuracy	C4		1		1	1	1	1
	Degrees of freedom - number of axes	C5		1		1		1	
	Costs	C6							
	User Interface/ease of programming	C7	3	3	3				3
	Number of diff. tools	C8	1	1					
	Safety-rated monitored stop	C9	1	3	3		1		3
	Hand guiding	C10	1	3	1	1	3	3	3
	Speed and separation monitoring	C11	1	3	3		1		3
	Power and force limiting	C12	1	3	3		1		3
Product	Size	P1	1		1	1	1		
	Weight	P2	1		1	1	3		
	Hardness (sensitivit to pressure)	P3	1				1	3	
	Stiffness (stiff vs. floppy parts)	P4	1					1	
	Material sensitivity to temperature	P5	1						
	Material sensitivity to magnetism	P6	1						
	Accuracy / Tolerance of man. features	P7	3	1	1		1	3	3
	Number of diff. manuf. processes required	P8	3	1	1		1	1	1
	Number of Features to be manufactured	P9	3	1	1			1	1
	Product variety to be manufactured	P10	3	1	1				1
	Average batch sizes	P11	1	1	1				
Human Operator	Experience with manufacturing tasks	H1							
	Experience of working with cobots	H2							
	Number of operators	H3							
	Height	H4							
	Strength	H5							
	(Fine) Motoric skills	H6							
	Attention span	H7							
Workplace	Scope of application (diff. processes)	W1	3	3	1			1	1
	Number of process steps	W2	3		1				1
	Degree of automatization	W3	3	3	3			3	1
	Hazard risks of process operations/tools	W4	1	1	1			1	3
	Existing safety regulations	W5	3	1					3
	Access-controlled workplace	W6	1	3	1				
	Room size	W7			1				
	Variability of workplace	W8		1	1				1
	Brightness / Light condition of the room	W9			1			1	3
	Noise Level	W10			1				3
	Workplace Ergonomic for humans	W11	1	1	1	1	1	1	
	Connectivity (column sum)		43	40	36	10	18	21	43

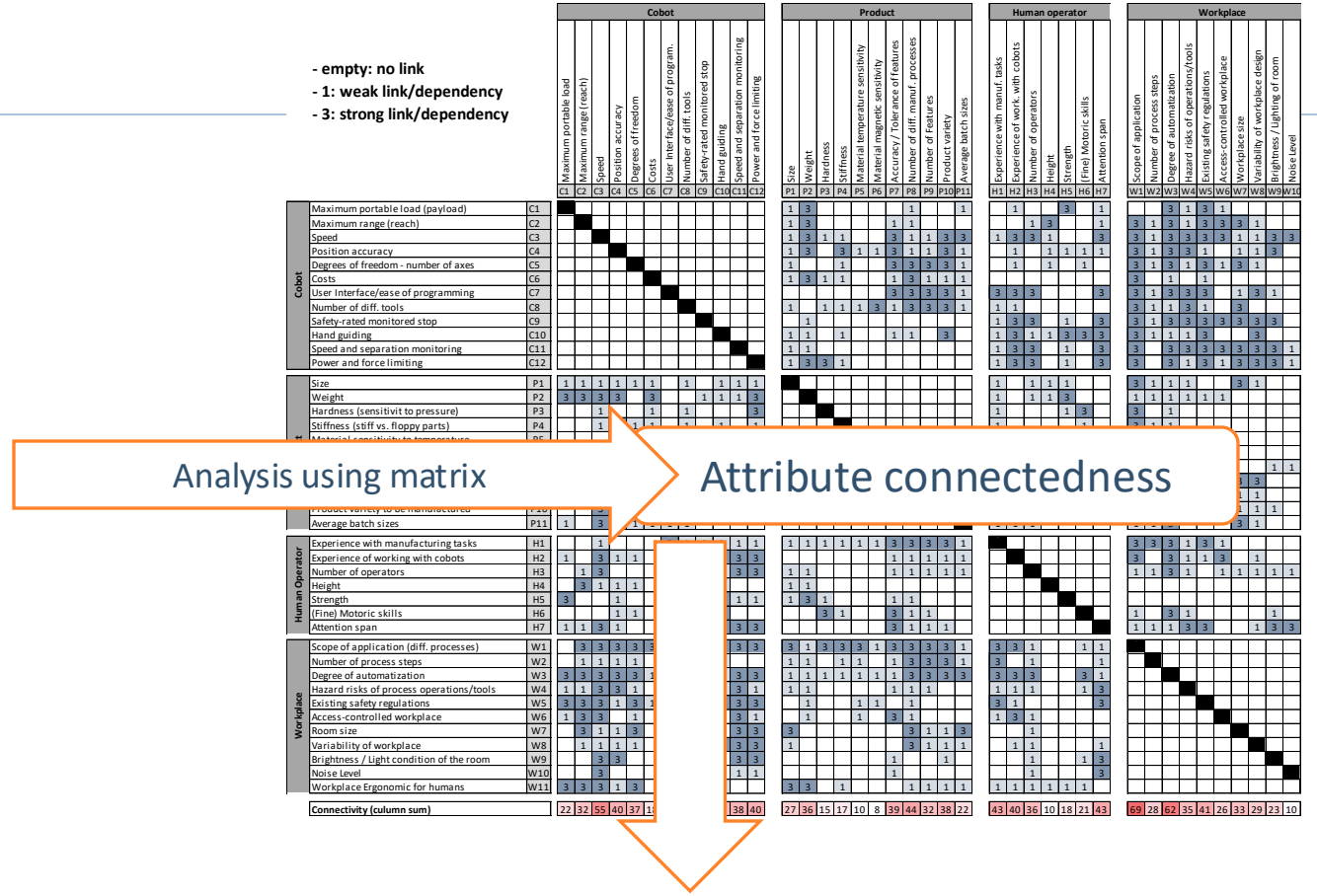
			Workplace									
			Scope of application	Number of process steps	Degree of automatization	Hazard risks of operations/tools	Existing safety regulations	Access-controlled workplace	Workplace size	Variability of workplace design	Brightness / lighting of room	Noise Level
			W1	W2	W3	W4	W5	W6	W7	W8	W9	W10
Cobot	Maximum portable load (payload)	C1			3	1	3	1				
	Maximum range (reach)	C2	3	1	3	1	3	3	3	1		
	Speed	C3	3	1	3	3	3	3	1	1	3	3
	Position accuracy	C4	3	1	3	3	1		1	1	3	
	Degrees of freedom - number of axes	C5	3	1	3	1	3	1	3	1		
	Costs	C6	3		1		3					
	User Interface/ease of programming	C7	3	1	3	3	3		1	3	1	
	Number of diff. tools	C8	3	1	1	3	1		3			
	Safety-rated monitored stop	C9	3	1	3	3	3	3	3	3	3	
	Hand guiding	C10	3	1	1	1	3			3		
	Speed and separation monitoring	C11	3		3	3	3	3	3	3	3	1
	Power and force limiting	C12	3		3	1	3	1	3	3	3	1
Product	Size	P1	3	1	1	1			3	1		
	Weight	P2	1	1	1	1	1	1				
	Hardness (sensitivit to pressure)	P3	3		1							
	Stiffness (stiff vs. floppy parts)	P4	3	1	1							
	Material sensitivity to temperature	P5	3	1	1		1	1				
	Material sensitivity to magnetism	P6	1		1		1					
	Accuracy / Tolerance of man. features	P7	3	1	1	1		3			1	1
	Number of diff. manuf. processes required	P8	3	3	3	1	1	1	3	3		
	Number of Features to be manufactured	P9	3	3	3	1			1	1		
	Product variety to be manufactured	P10	3	3	3				1	1	1	
	Average batch sizes	P11	1	1	3				3	1		
Human Operator	Experience with manufacturing tasks	H1	3	3	3	1	3	1				
	Experience of working with cobots	H2	3		3	1	1	3		1		
	Number of operators	H3	1	1	3	1		1	1	1	1	1
	Height	H4										
	Strength	H5										
	(Fine) Motoric skills	H6	1		3	1					1	
	Attention span	H7	1	1	1	3	3			1	3	3
Workplace	Scope of application (diff. processes)	W1										
	Number of process steps	W2										
	Degree of automatization	W3										
	Hazard risks of process operations/tools	W4										
	Existing safety regulations	W5										
	Access-controlled workplace	W6										
	Room size	W7										
	Variability of workplace	W8										
	Brightness / Light condition of the room	W9										
	Noise Level	W10										
	Workplace Ergonomic for humans	W11										
	Connectivity (column sum)		69	28	62	35	41	26	33	29	23	10

(Guertler et al. 2023)

Tool analyses use-case

Product	Size
	Weight
	Hardness (sensitivit to pressure)
	Stiffness (stiff vs. floppy parts)
	Material sensitivity to temperature
	Material sensitivity to magnetism
	Accuracy / Tolerance of man. features
	Number of diff. manuf. processes required
	Number of Features to be manufactured
	Product variety to be manufactured
	Average batch sizes
Human Operator	Experience with manufacturing tasks
	Experience of working with cobots
	Number of operators
	Height
	Strength
	(Fine) Motoric skills
	Attention span
Workplace	Scope of application (diff. processes)
	Number of process steps
	Degree of automatization
	Hazard risks of process operations/tools
	Existing safety regulations
	Access-controlled workplace
	Room size
	Variability of workplace
	Brightness / Light condition of the room
	Noise Level
	Workplace Ergonomic for humans

- empty: no link
- 1: weak link/dependency
- 3: strong link/dependency



weighted cobot attributes (i.e. relevance for given workplace and product)

➢ e.g. speed and hand-guidance are particularly relevant

Discussion

Which attributes jump out as most critical for this scenario, and why?

Given these attributes, what should we look at first when choosing or configuring a cobot?

(Payload, reach, speed, safety functions, UI, etc.)

What changes might be needed around the cobot?

(Training for operators, adjustments to layout and ergonomics, or tweaks to the overall process.)

Thank you!

Contact ACC Program 3:

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