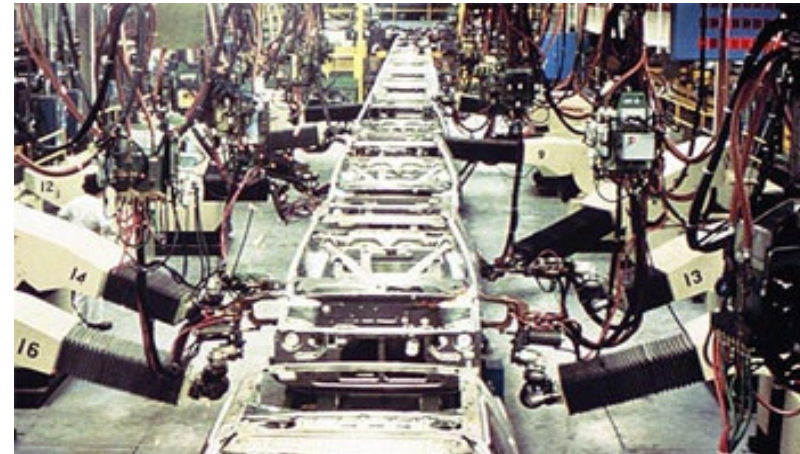
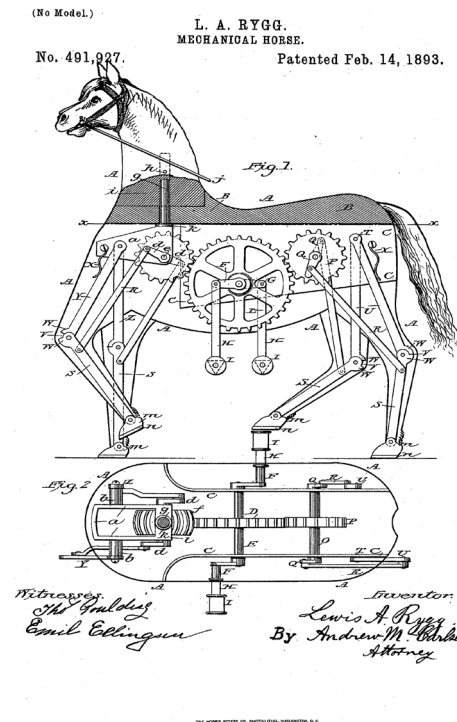
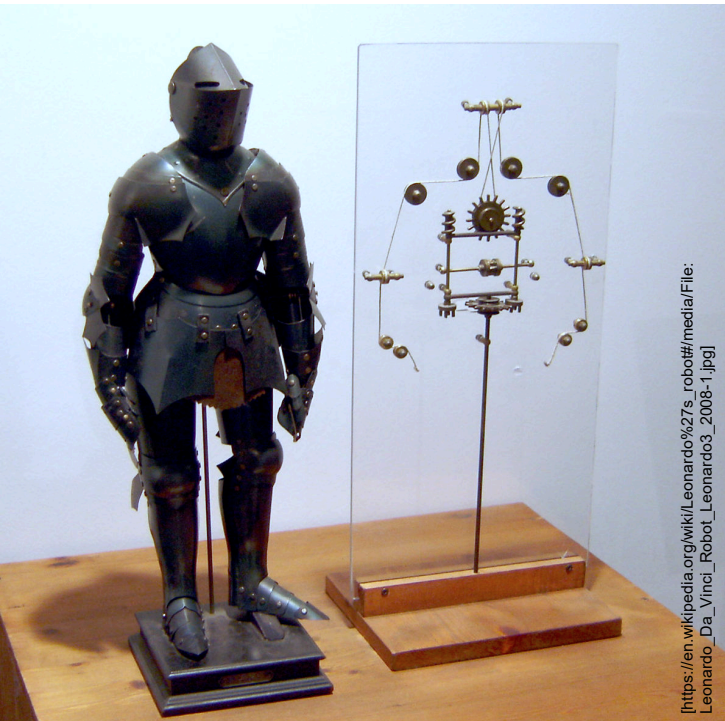


Cobotit tuotannossa

Teollisuus X.0 - Teollisuuden digitaalinen tulevaisuus 16.11.2021

Jere Siivonen

Robotiikka: Tehokkaammin, helpommin, turvallisemmin, laadukkaammin..



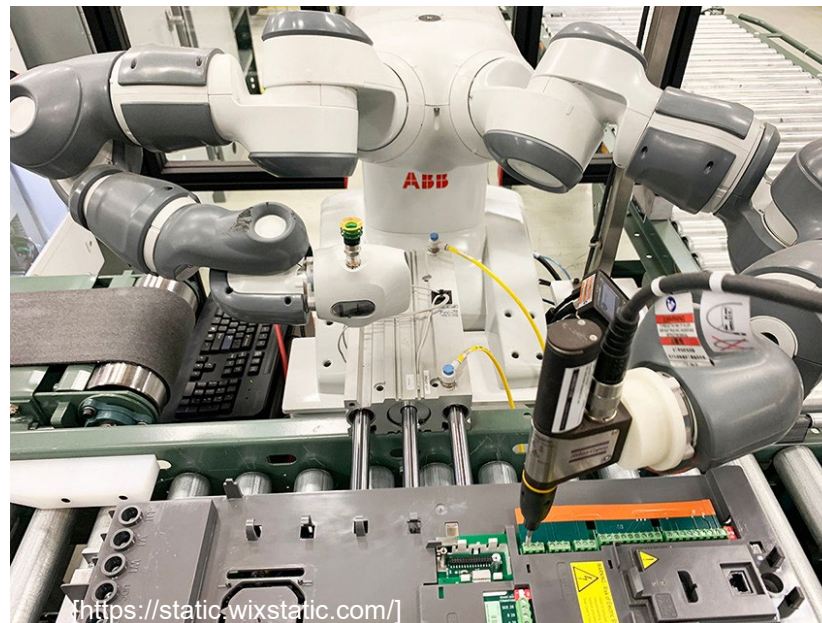
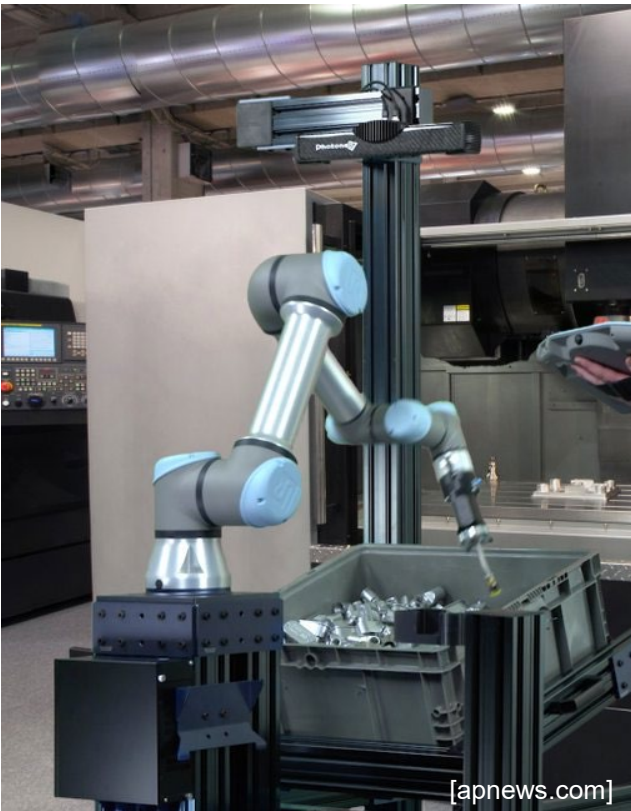
Yhteistoimintarobotit eli cobotit



"Ihmisen kanssa suoraan vuorovaikutukseen suunniteltu robotti."



Cobottisovelluksia



Collaborative Robots Market's Numbers Speak For Themselves

61

Cobot Manufacturers

194

Cobot Models

600M

USD Market Size

25%

Market Growth Rate

Cobotit ovat:

- Edullisempia kuin perinteiset teollisuusrobotit
- Helpompia ohjelmoida
- Siirreltävissä (monikäyttöisiä)
- Vievät vähemmän tilaa
- Nopeampia ottaa käyttöön
- Turvallisempia (varauksin)
- ...



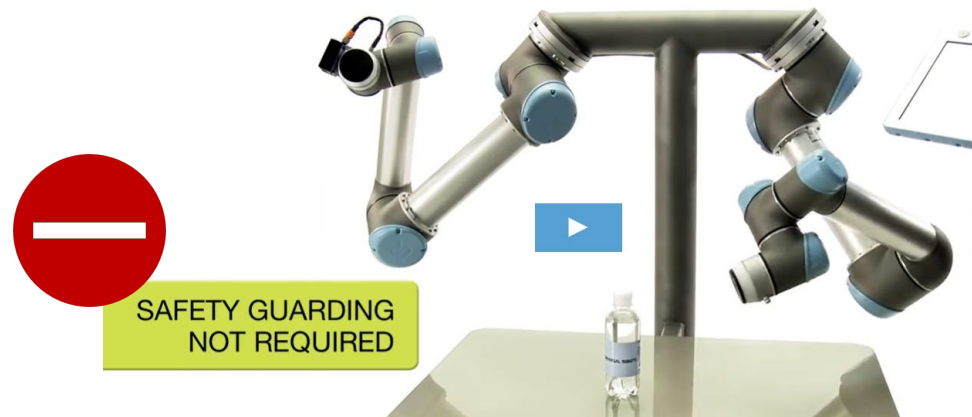
“..collaborative applications are virtually non-existent in production facilities at the present time.”

[Lightweight robots in manual assembly – best to start simply! Fraunhofer IAO.2016
Wilhelm Bauer (Editor) | Manfred Bender | Martin Braun | Peter Rally | Oliver Scholtz]



Mikä hankaloittaa cobottien käyttöönottoa?

- 1) Uuden teknologian hyödyntämisen yleiset ”kitkat”
- 2) Epäselvät turvallisuusvaatimukset ja ristiriita markkinoinnin tuottamaan mielikuvaan.



Cobottien turvallisuusvaatimuksista

Cobotti on robotti

Cobotti on osittain valmis kone, ei tarkoitettua käyttöä.

Riskinarviointi edellytetään. AINA

Arvioidaan kokonaisuutta: prosessi, cobotti, tuote, ympäristö, työkalut, ...

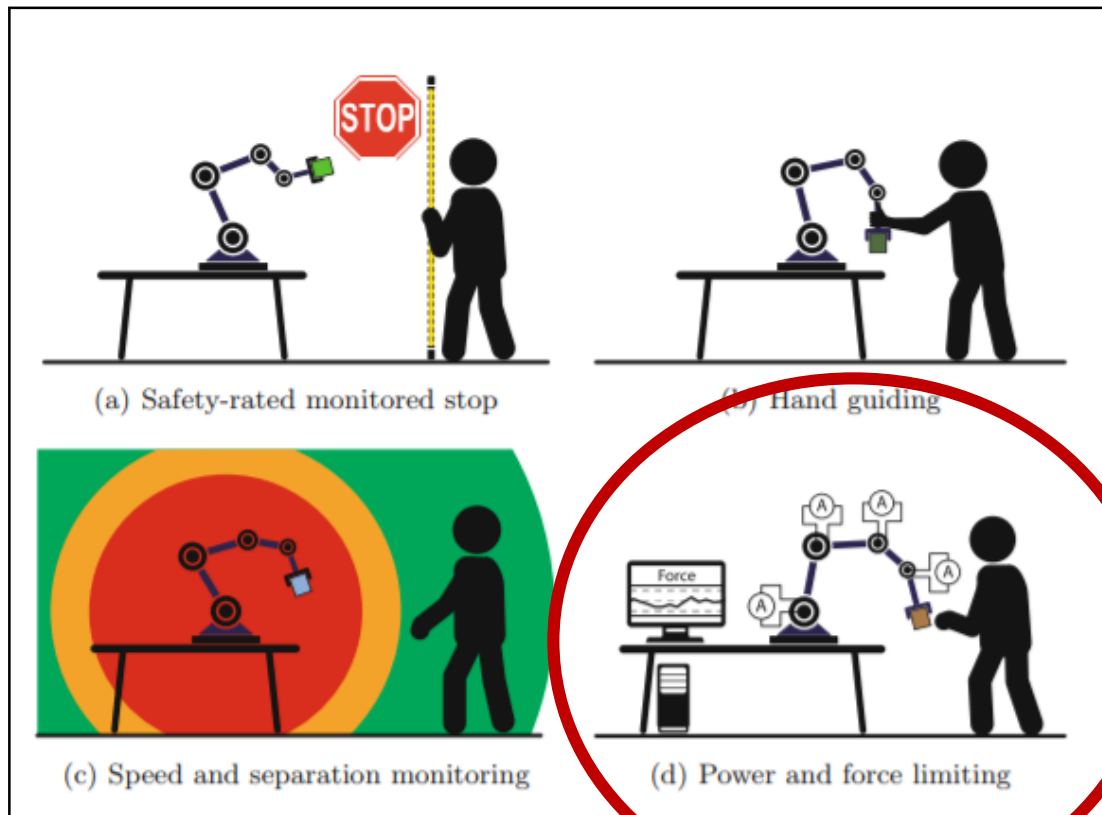
Riskianalyysiprosessiin liittyvä validointi tulee suorittaa

CE-merkintä edellytetään ennen markkinoille saattamista, vaatimustenmukaisuusvakuutus + allekirjoitus

ISO 10218-1
ISO 10218-2
ISO/TS 15066



Yhteistoimintarobotiikan toteutustavat



Safety Monitored Stop

Safety monitored stop pauses a robot's motion while an operator is in the collaborative workspace. The robot maintains power but cannot move. This workspace is the shared space where a human and a robot perform tasks. While the workspace is clear of operators, the cobot works at high speeds. This results in a faster cycle time. Robots can also start back up automatically once the workspace is clear again.

Hand Guiding

Hand guiding allows a cobot to move through direct input from an operator. The cobot stays in a safety monitored stop until an operator actuates the hand guiding device through an enabling switch. These devices are often used on robots as an intelligent lift device. Such assists are easier to maneuver than traditional designs. Hand-guided cobots can also work autonomously when operators aren't around.

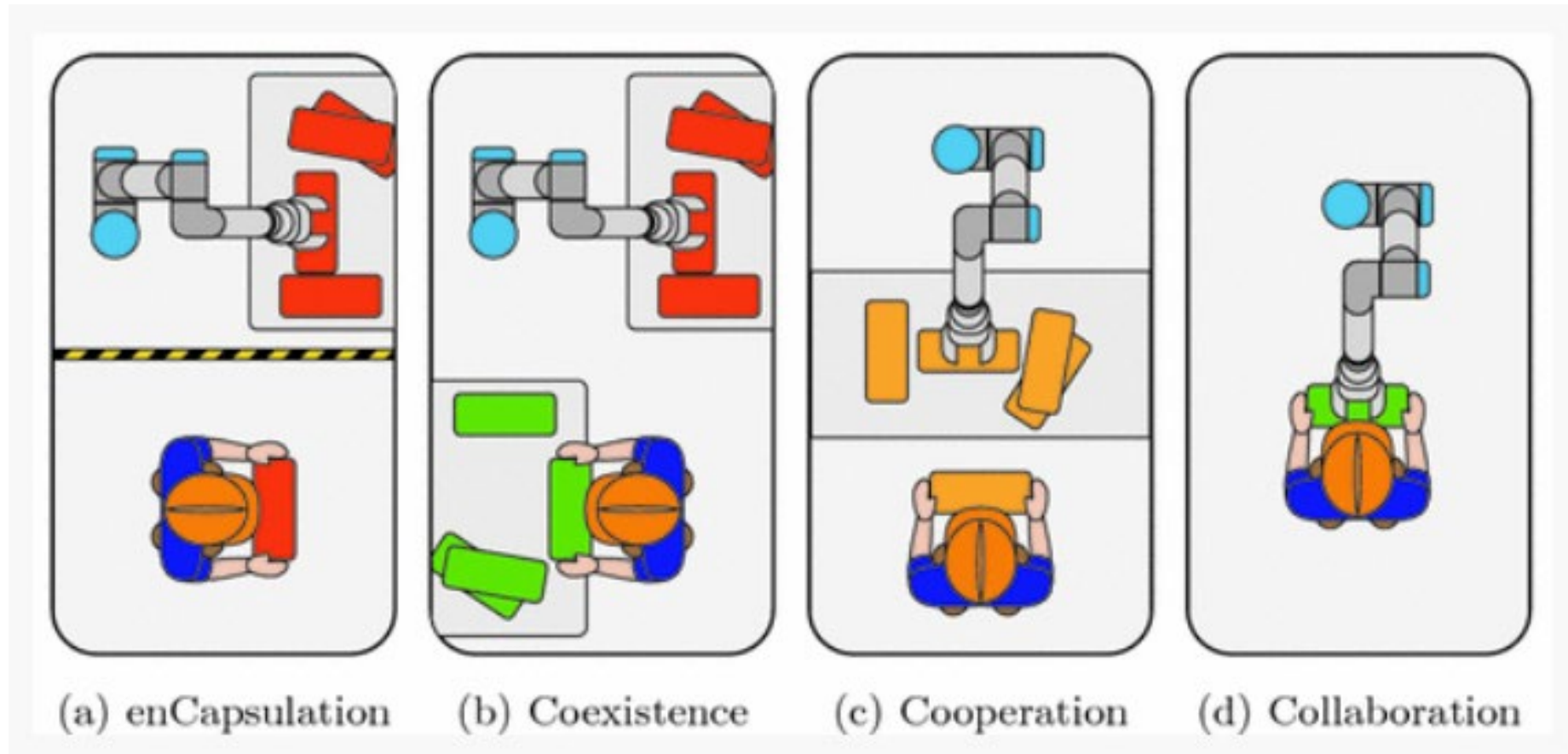
Speed and Separation Monitoring

Speed and separation monitoring is often referred to as a fenceless robot system. The collaborative robot is able to move concurrently with the operator as long as they maintain a pre-determined distance apart. Often a safety-rated laser area scanner monitors this cobot application. The distance often varies based on how fast the cobot is moving.

Power and Force Limiting by Inherent Design or Control

Limitations on power and force require a special robot that has power or force feedback built in. This system lets the cobot detect contact with a person. This is the most popular type of cobot. It requires an extensive risk assessment because the operator can remain within reach of the cobot.

Ihminen-robotti yhteistyön tasot



Cobotin ja ihmisen törmäys?

Body region	Specific body area		Quasi-static contact		Transient contact	
			Maximum permissible pressure ^a p_s N/cm ²	Maximum permissible force ^b N	Maximum permissible pressure multiplier ^c P_T	Maximum permissible force multiplier ^c F_T
Skull and forehead ^d	1	Middle of forehead	130	130	not applicable	not applicable
	2	Temple	110		not applicable	
Face ^d	3	Masticatory muscle	110	65	not applicable	not applicable
Neck	4	Neck muscle	140	150	2	2
	5	Seventh neck muscle	210		2	
Back and shoulders	6	Shoulder joint	160	210	2	2
	7	Fifth lumbar vertebra	210		2	2
Chest	8	Sternum	120	140	2	2
	9	Pectoral muscle	170		2	
Abdomen	10	Abdominal muscle	140	110	2	2
Pelvis	11	Pelvic bone	210	180	2	2
Upper arms and elbow joints	12	Deltoid muscle	190	150	2	2
	13	Humerus	220		2	
Lower arms and wrist joints	14	Radial bone	190	160	2	2
	15	Forearm muscle	180		2	
	16	Arm nerve	180		2	

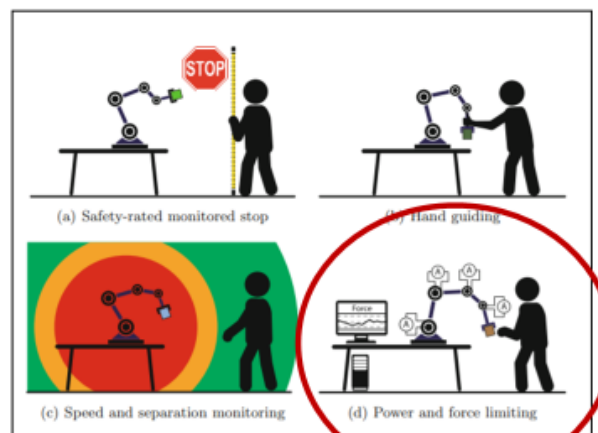
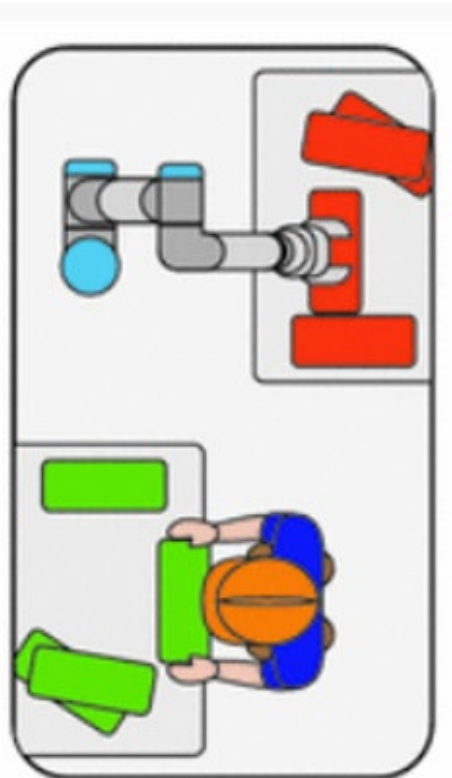
[ISO/TS 15066]

Cobotit on suunniteltu vuorovaikutukseen ihmisen kanssa → kontakteja saa syntyä.

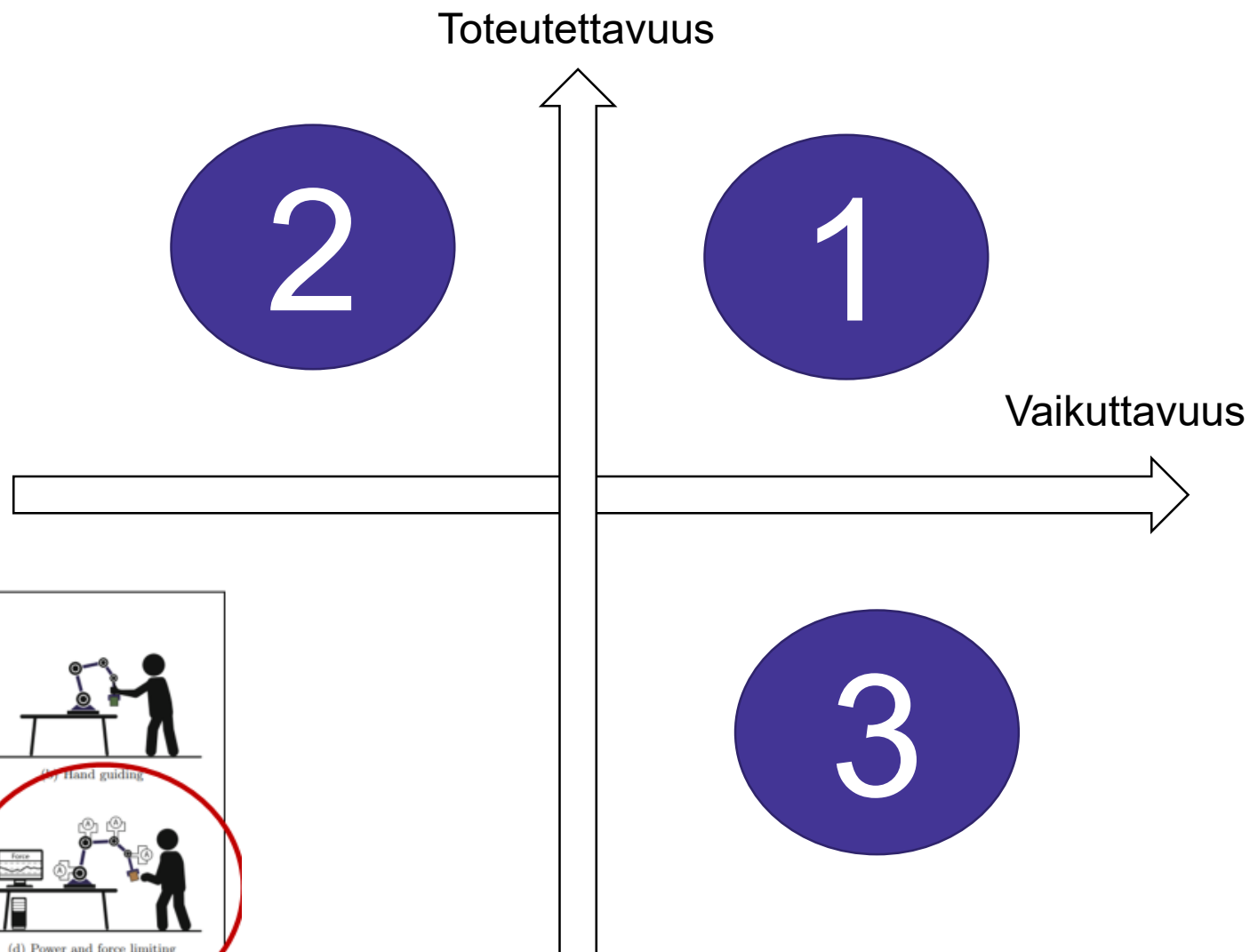
Eri kehonosiin sallitaan erilaiset voimat ja paineet.

Näiden suunnittelu ja verifiointi voi olla haastavaa..

Miten päästä liikkeelle?



[Kaiser et al., Safety-Related Risks and Opportunities of Key Design Aspects for Industrial Human-Robot Collaboration, Springer 2018, https://link.springer.com/content/pdf/10.1007%2F978-3-319-99502-3_11.pdf]



Yhteenveto

Coboteissa on potentiaalia!

Test-before-invest!

Start simple!

Varaudu (kustannus) yllätyksiin!

Aloita jo tänään!

*Everything should be made as
simple as possible, but not
simpler.*

-Albert E.



Kiitoksia mielenkiinnosta!