Correct-by-construction synthesis for smart manufacturing

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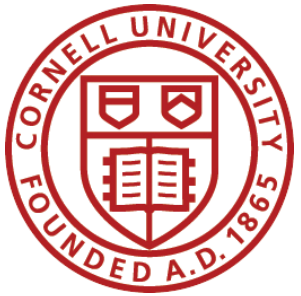
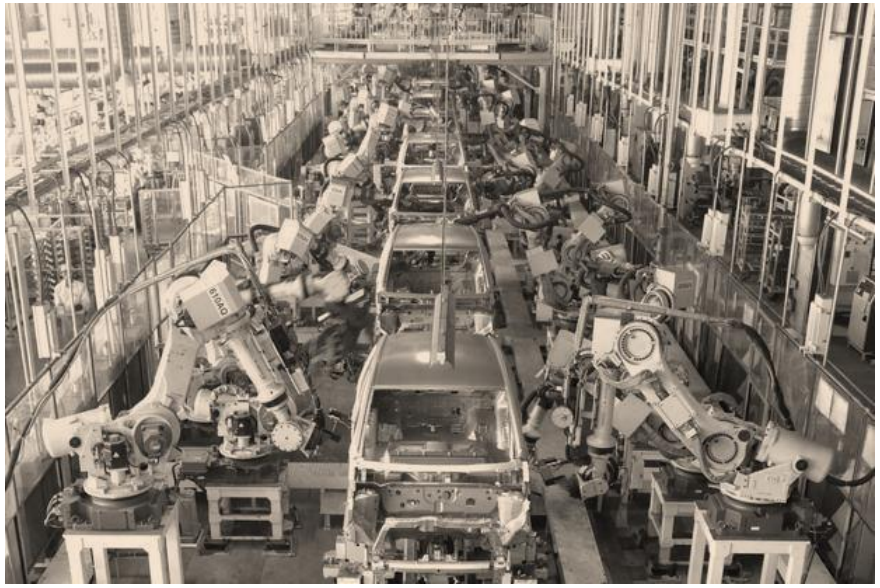
http://verifiablerobotics.com/



https://iptmajor.weebly.com/automated-assembly-line-robotic-arms.html

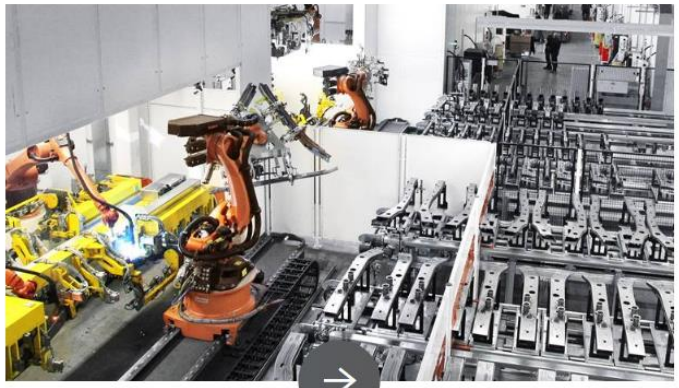


Standardized manufacturing cells

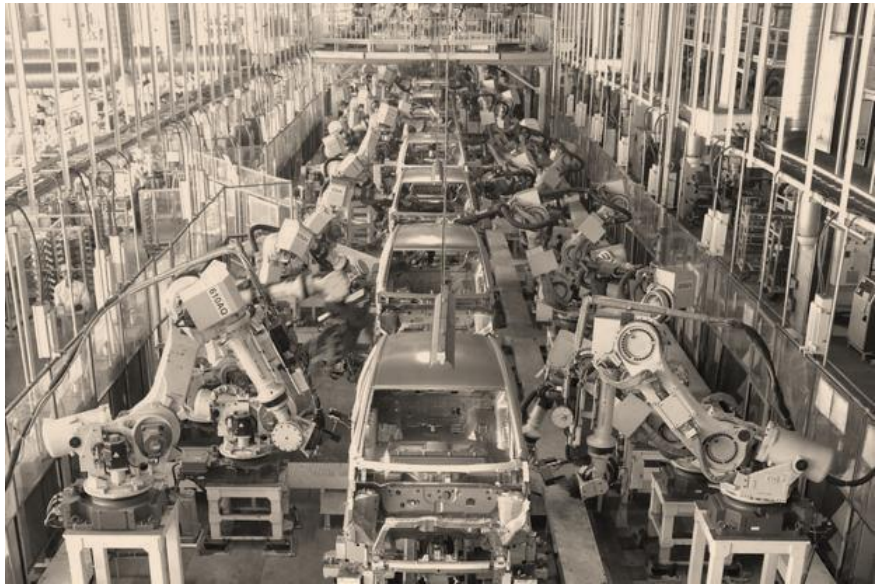
We supply future-oriented and highly automated manufacturing cells based on standardized and flexible cell concepts.

Customized manufacturing cells

As a competent partner we supply you with manufacturing cells configured for your special production requirements.



Kuka.com



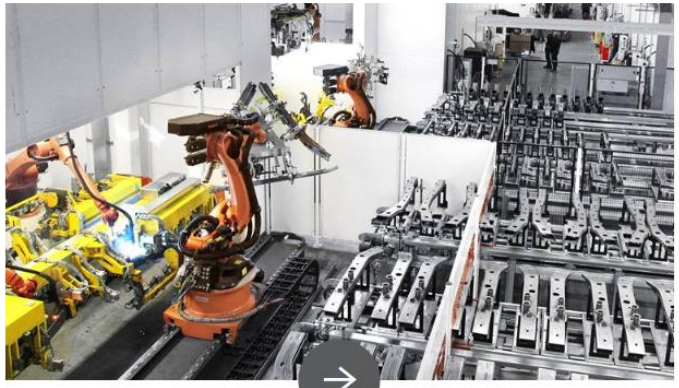
Rethink robotics

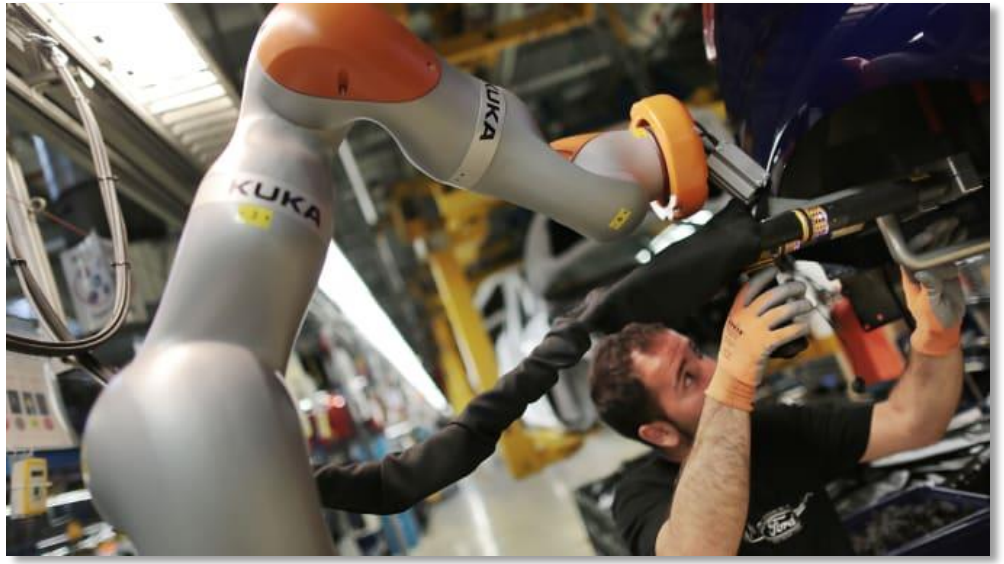
Standardized manufacturing cells

We supply future-oriented and highly automated manufacturing cells based on standardized and flexible cell concepts.

Customized manufacturing cells

As a competent partner we supply you with manufacturing cells configured for your special production requirements.





Oliver Berg | picture-alliance | dpa | AP Images

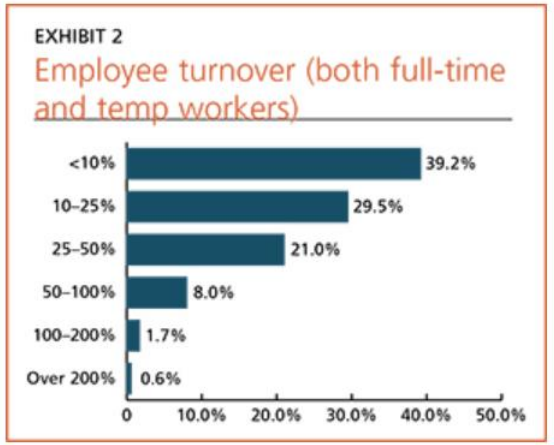
Kuka.com

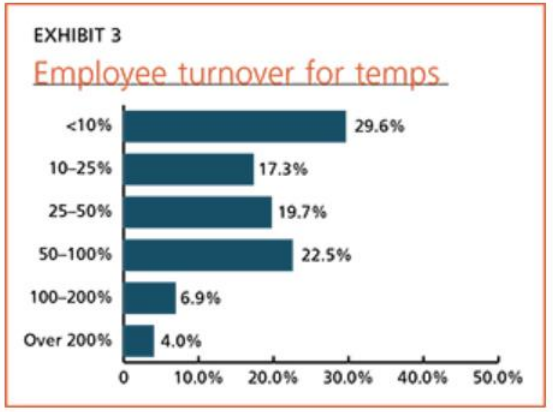
Flexible
Customizable
Programmable
Safe

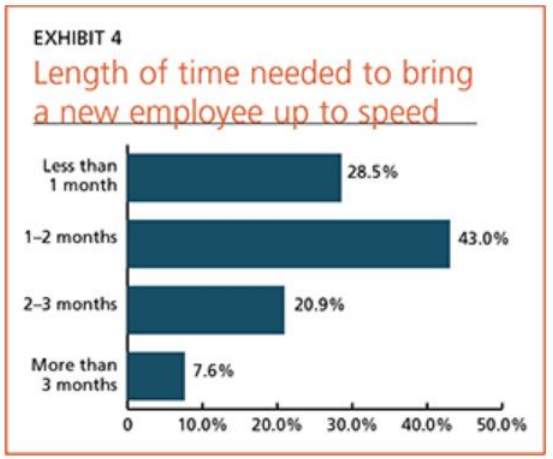
https://www.pengate.com/lift-trucks/used-forklifts

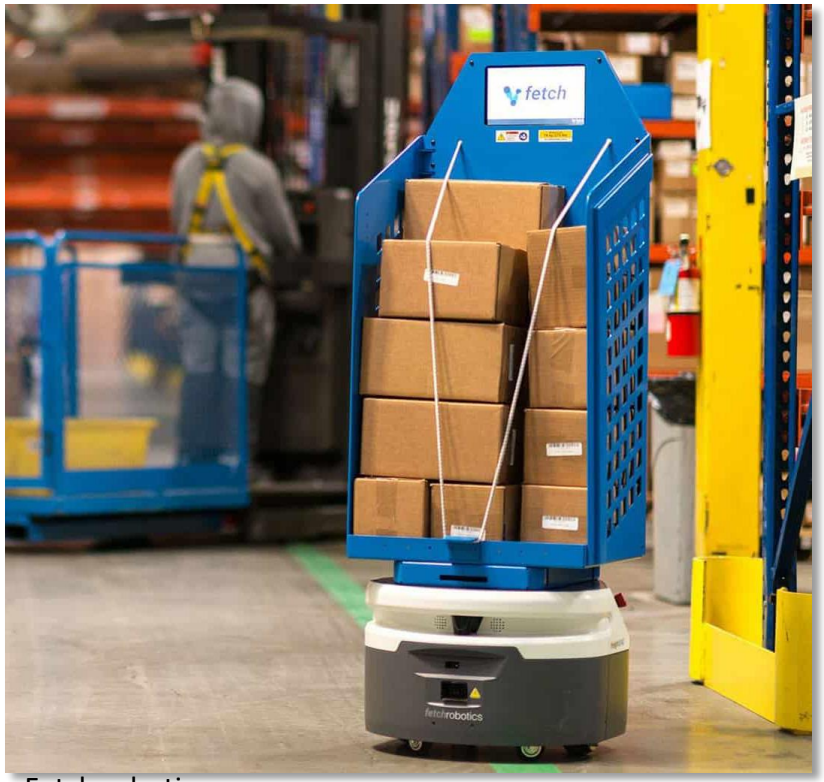
https://www.pengate.com/lift-trucks/used-forklifts

https://www.dcvelocity.com/articles/20170718-nine-ways-to-boost-warehouse-performance-and-cut-turnover/

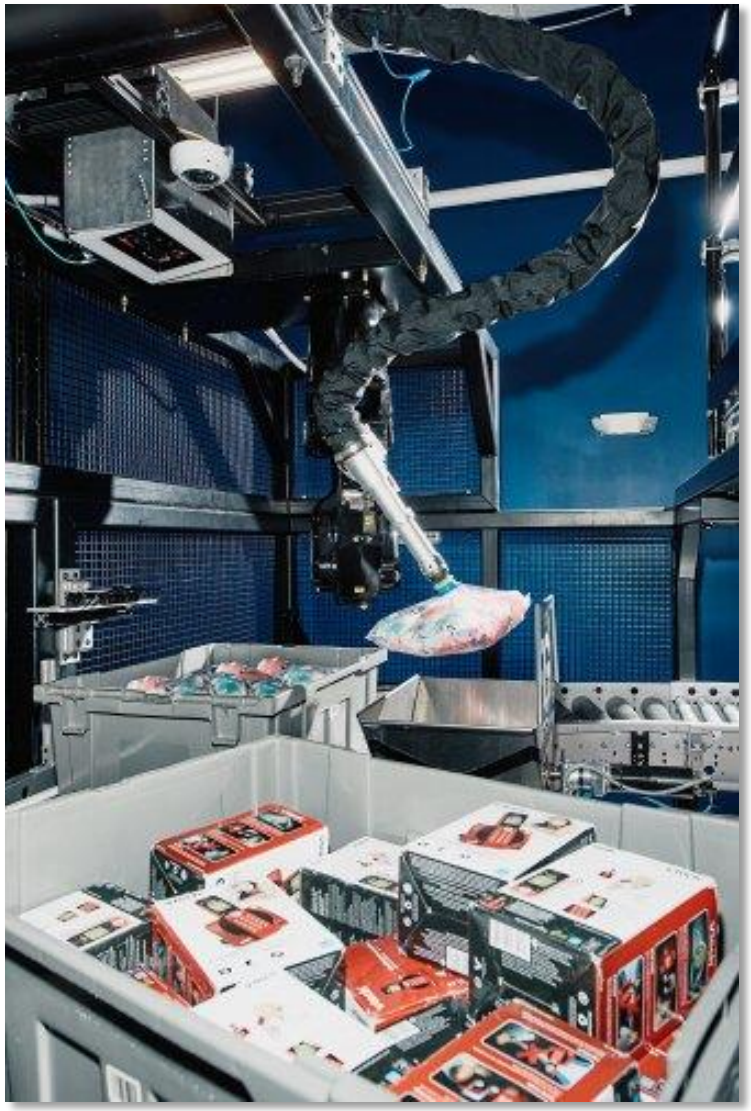




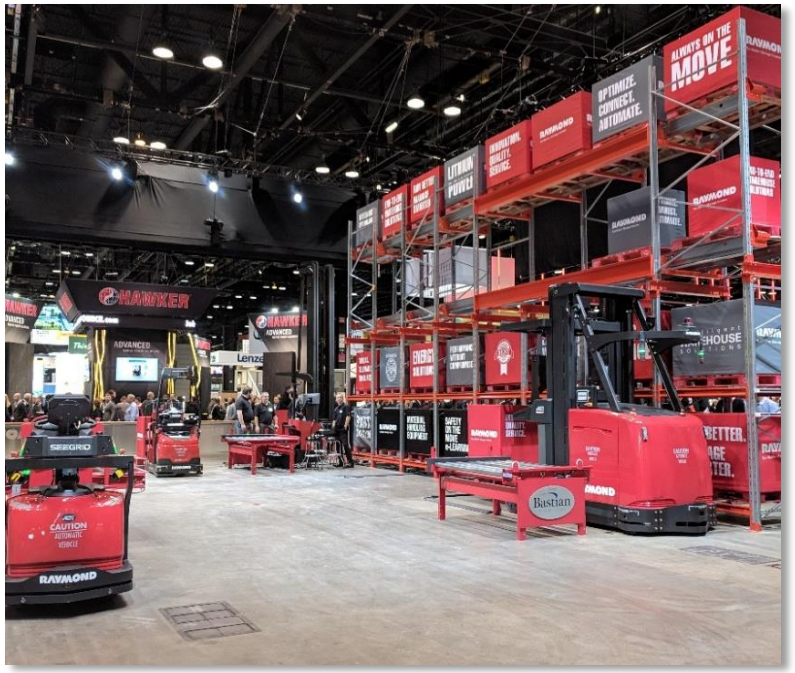




Fetch robotics



Berkshire Grey

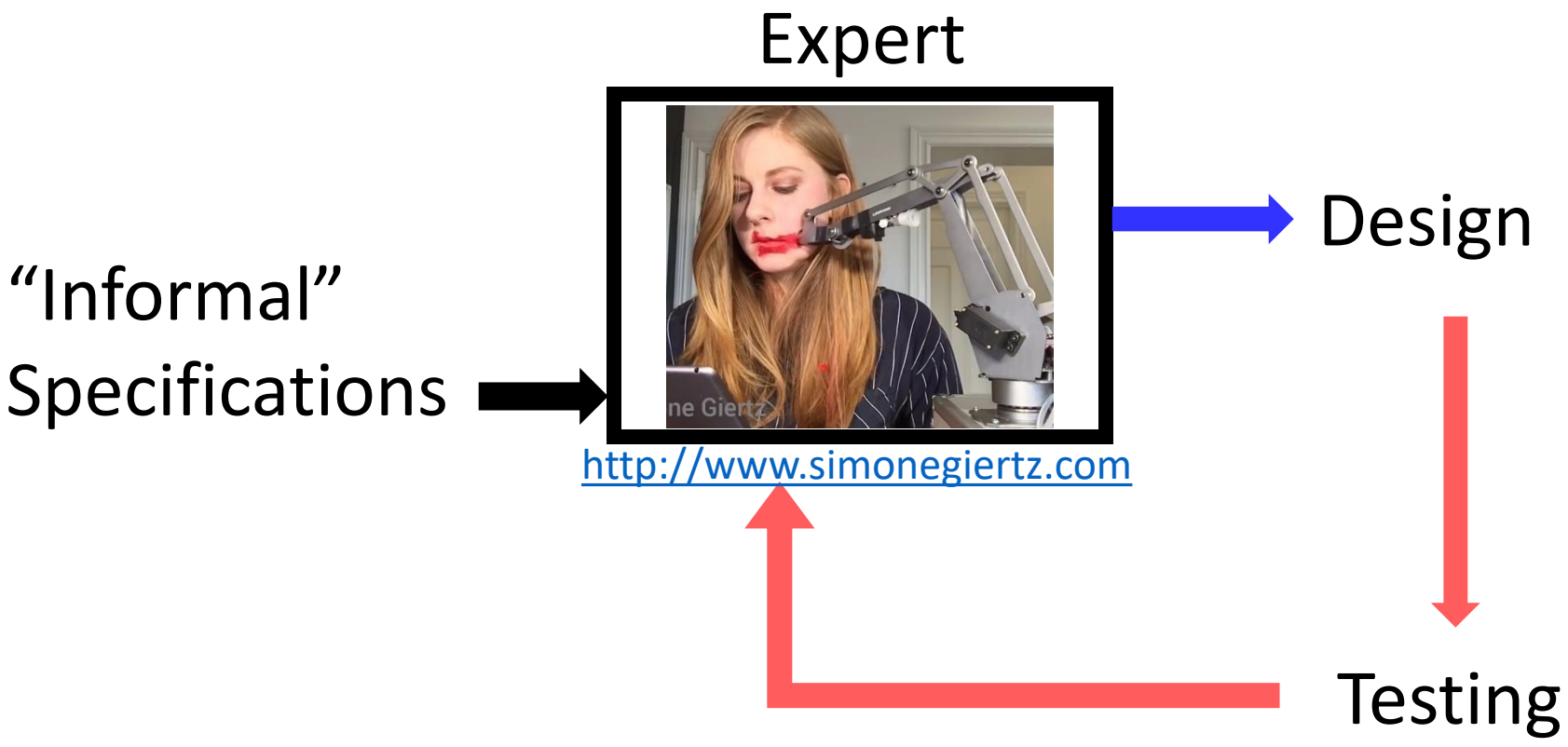


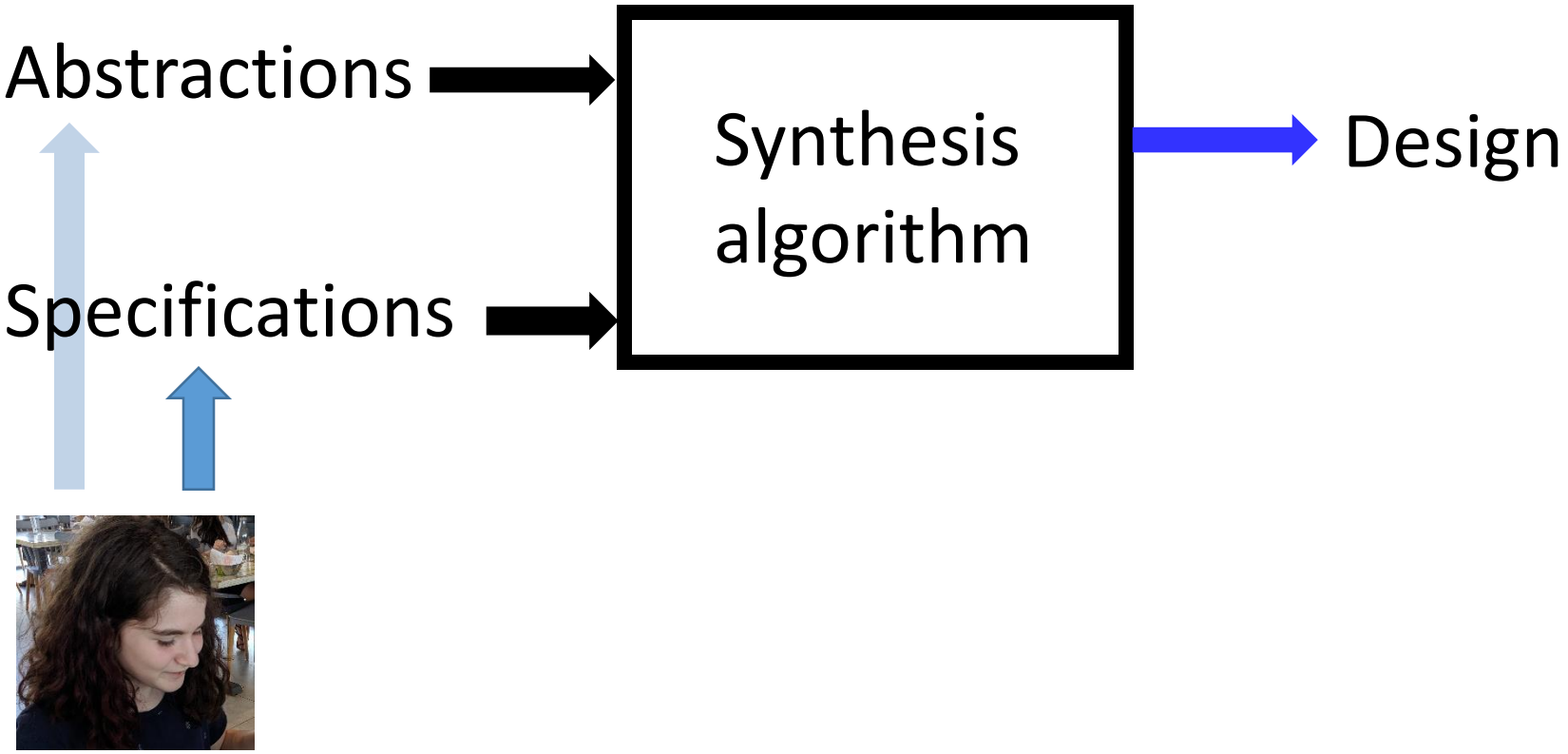
Raymond

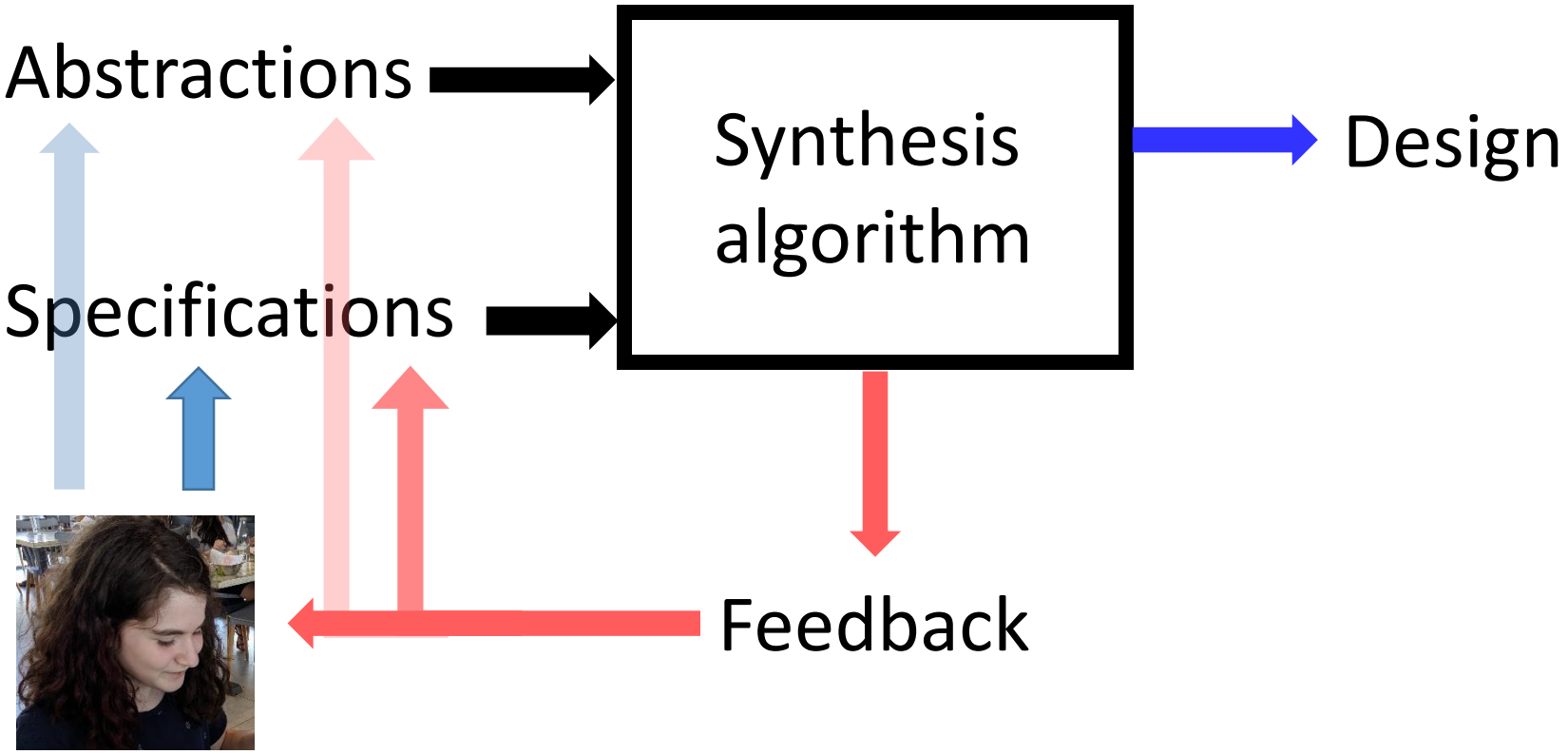
OTTO motors

Flexible
Customizable
Programmable
Safe

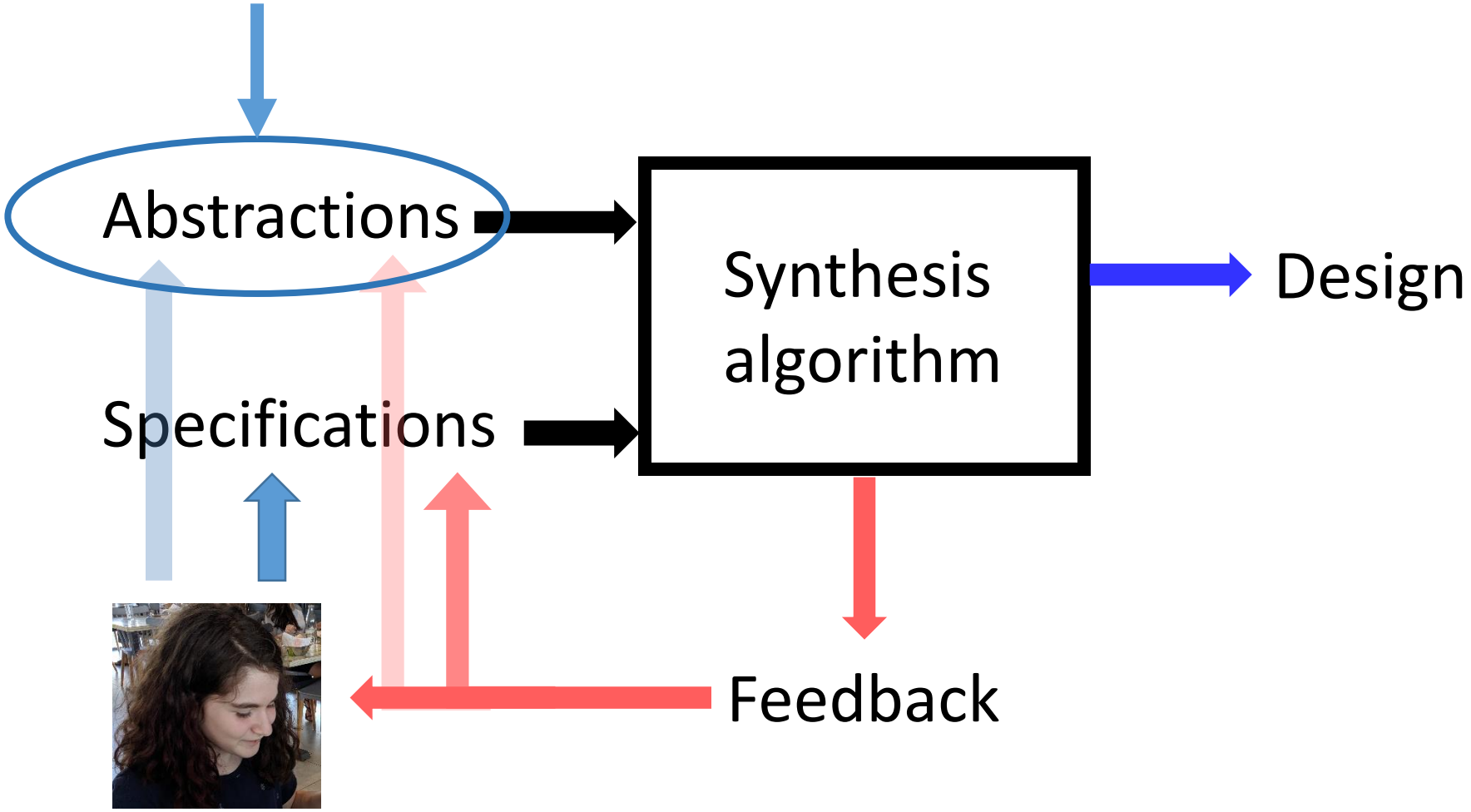
Automated


Expert
“Informal”
Specifications
Design
Testing
http://www.simonegiertz.com


Abstractions
Specifications
Synthesis algorithm
Design


Abstractions
Specifications
Synthesis algorithm
Design
Feedback

Prof. Zeilinger's and Dr. Matthews' talks!



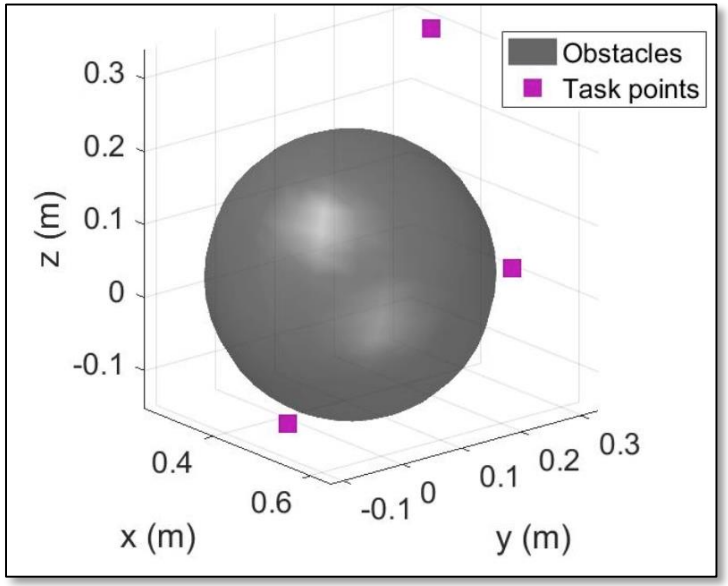
Program Synthesis (Sketch)

Specifications

Design

Feedback

[Campos, Inala, Solar-Lezama, and KG, ICRA ‘19]

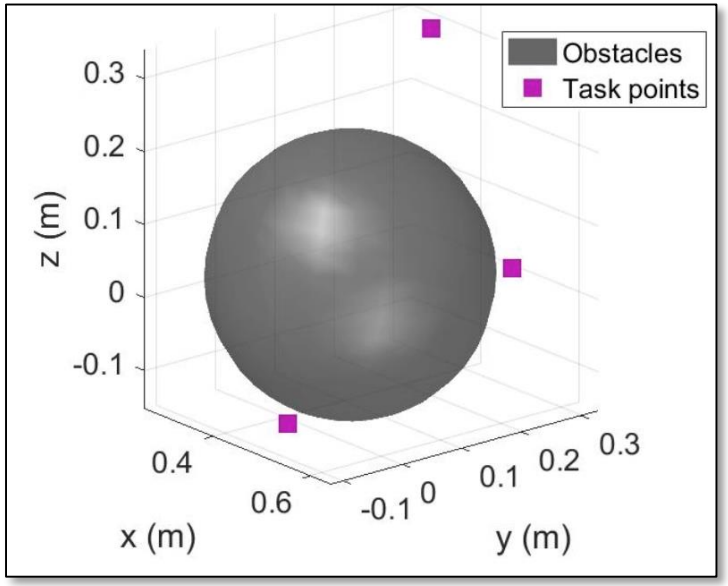


Program Synthesis (Sketch)

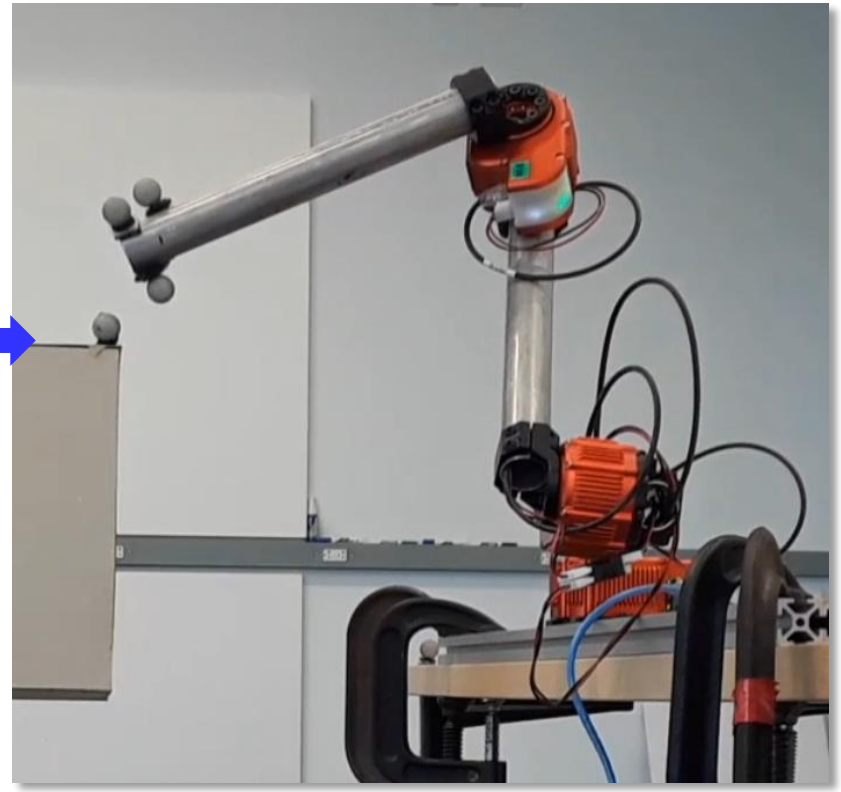
Design

Feedback

[Campos, Inala, Solar-Lezama, and KG, ICRA '19]

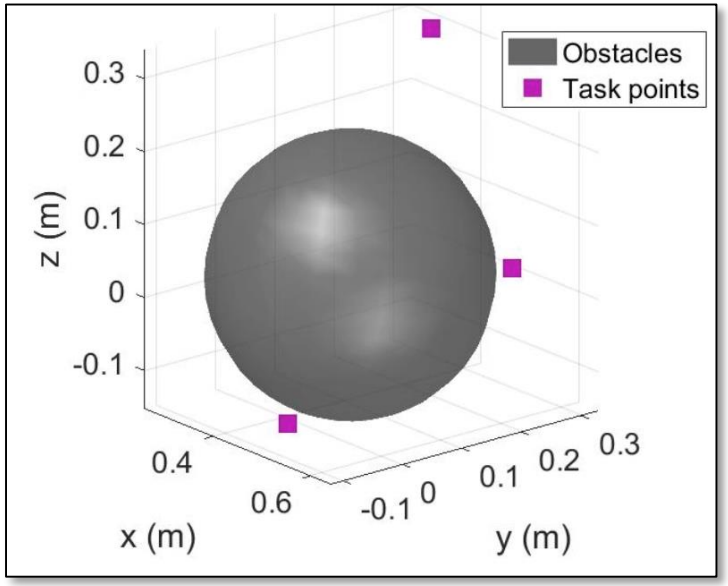


Program Synthesis (Sketch)

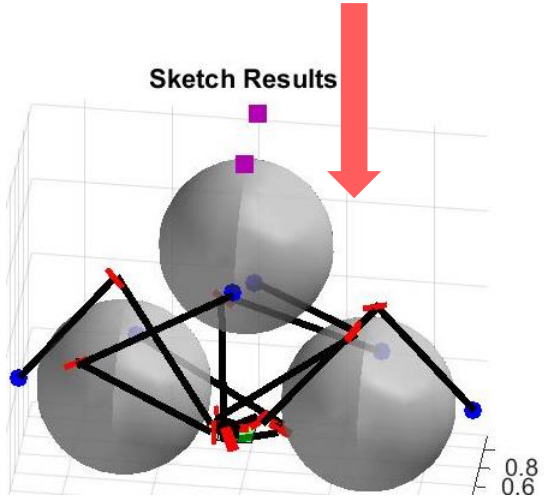


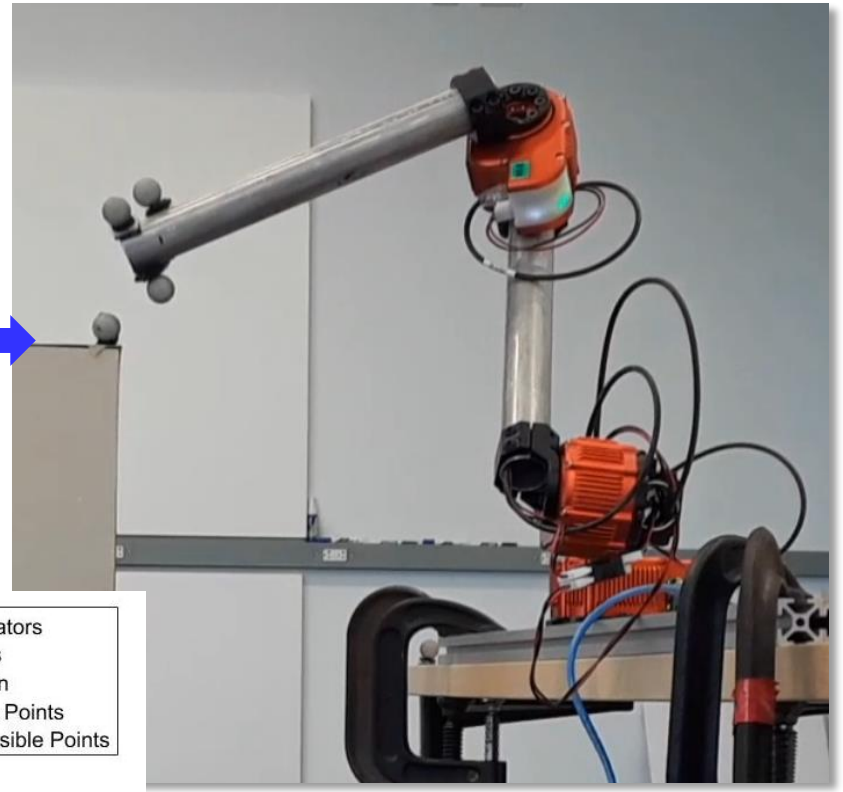
Feedback

[Campos, Inala, Solar-Lezama, and KG, ICRA ‘19]

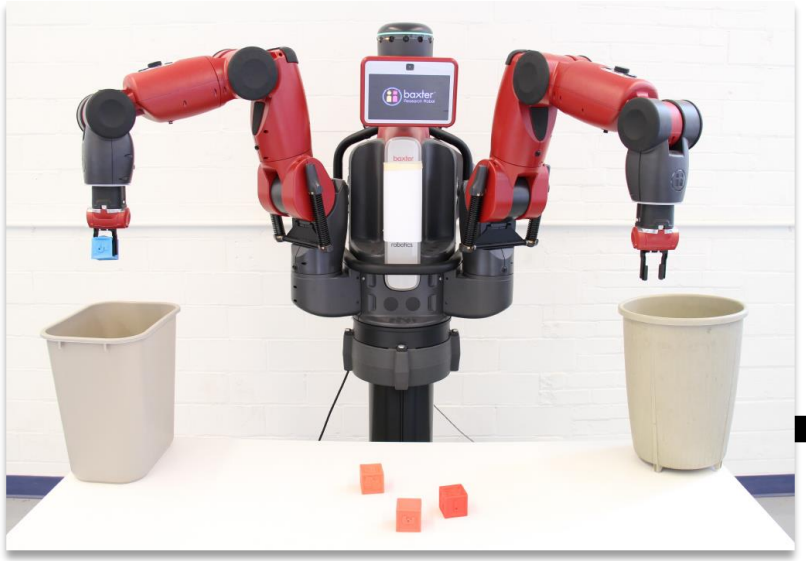


Program Synthesis (Sketch)





[Campos, Inala, Solar-Lezama, and KG, ICRA ‘19]



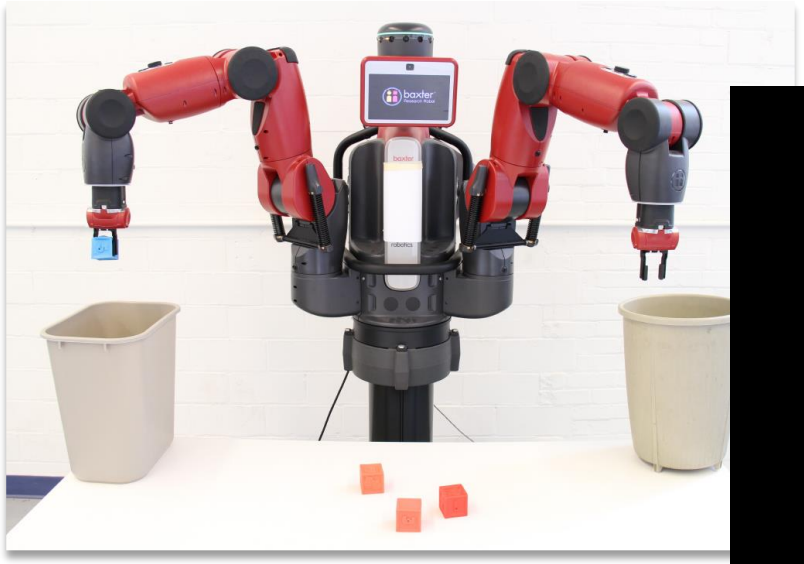
"Pick up the blue block and drop it in the box on your right. Pick up the red block and drop it in the box on your left"

Reactive Synthesis (LTL)

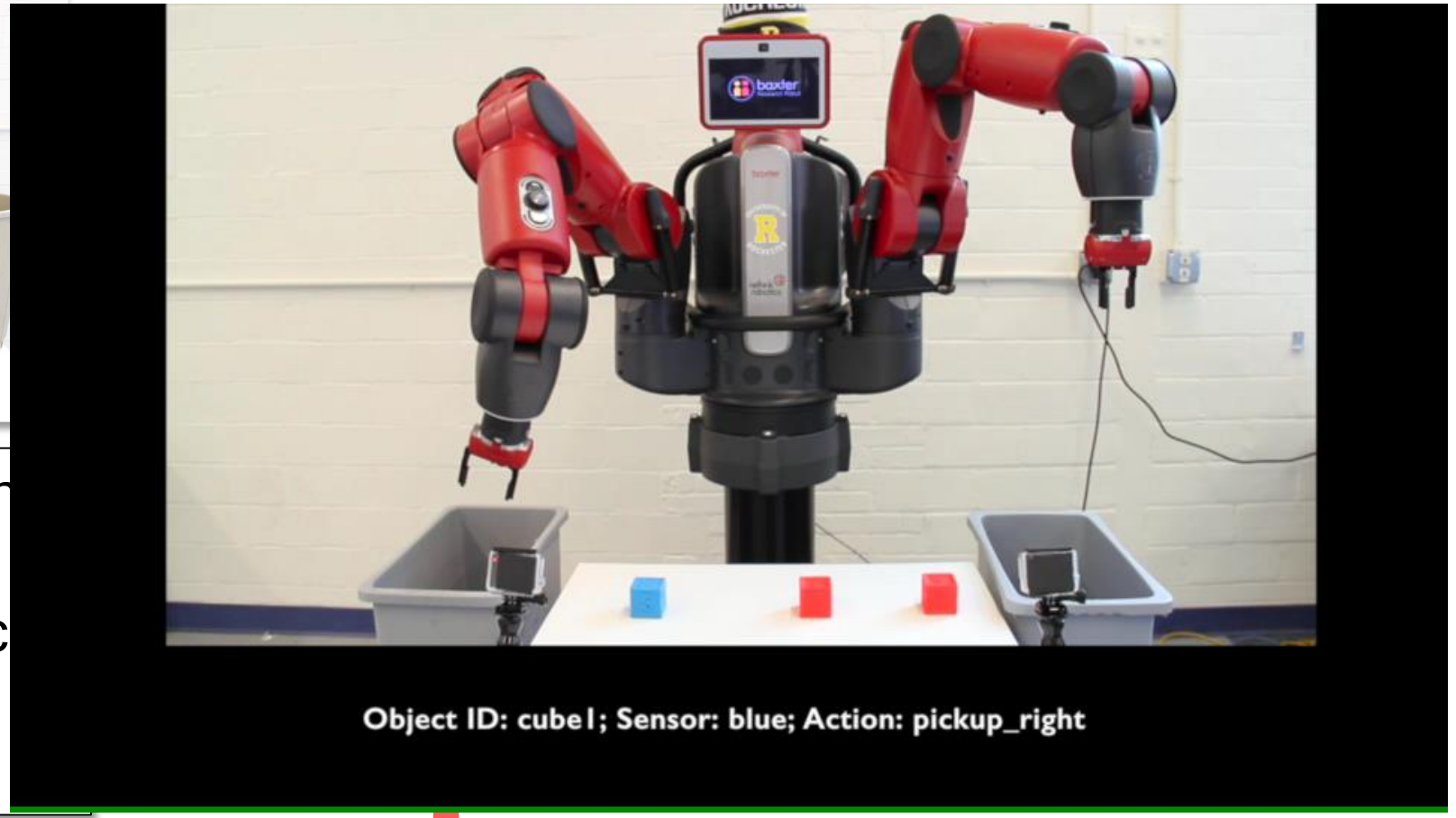
Design

Feedback

[Boteanu, Howard, Arkin, and KG, IROS '16, AAAI Fall Symposium '17]

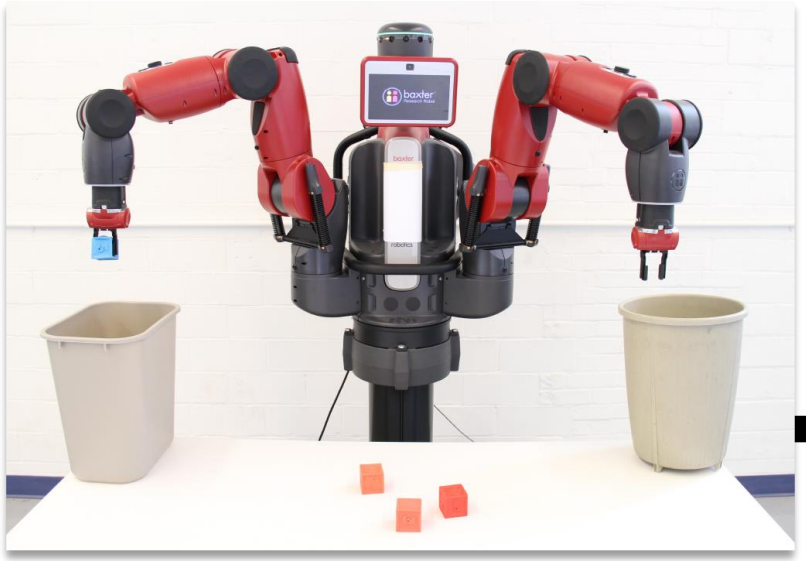


"Pick up the blue block ar
drop it in the box on your
right. Pick up the red bloc
and drop it in the box on
your left"



Feedback

[Boteanu, Howard, Arkin, and KG, IROS '16, AAAI Fall Symposium '17]



"Pick up the blue block and drop it in the box on your right. Pick up the red block and drop it in the box on your left"

Reactive Synthesis (LTL)

Design

I do not see a red block, so I cannot pick it up

[Boteanu, Howard, Arkin, and KG, IROS '16, AAAI Fall Symposium '17]

Synthesis for Robots: Guarantees and Feedback for Robot Behavior

Hadas Kress-Gazit,[1] Morteza Lahijanian,[2] and Vasumathi Raman[3]

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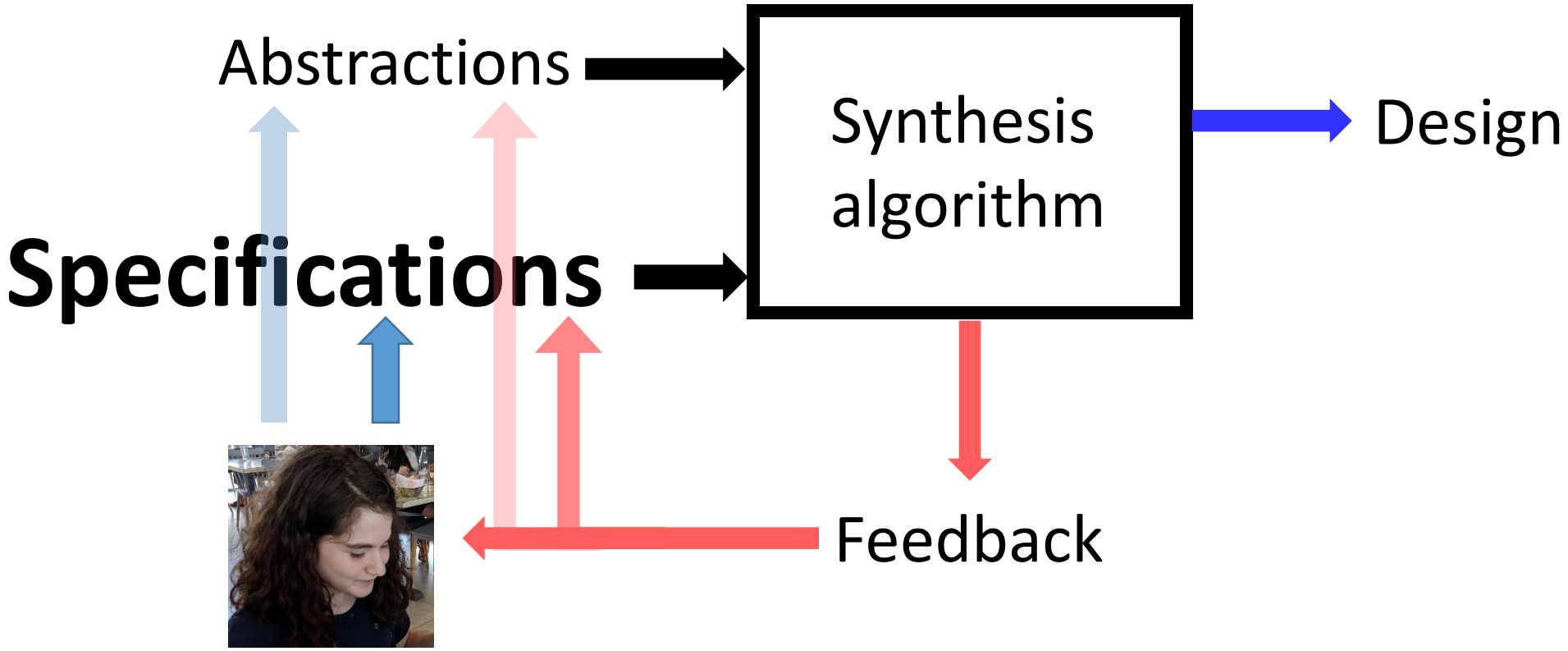

Abstractions
Specifications
Synthesis algorithm
Design
Feedback

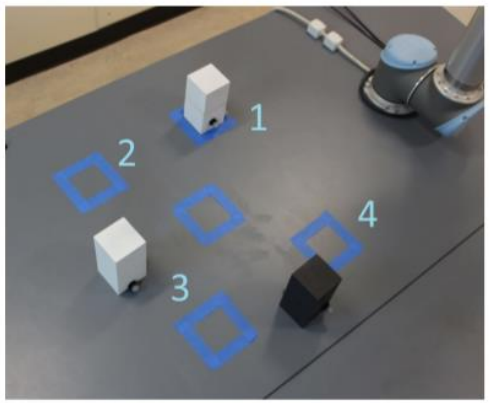
Specifications

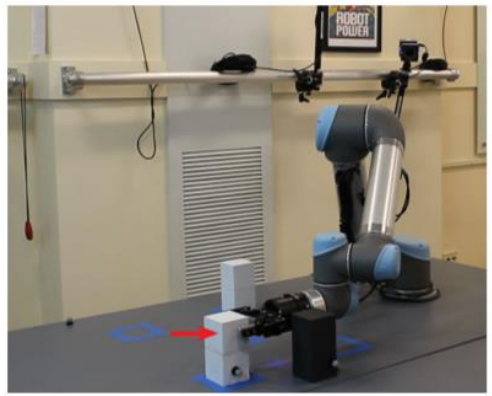
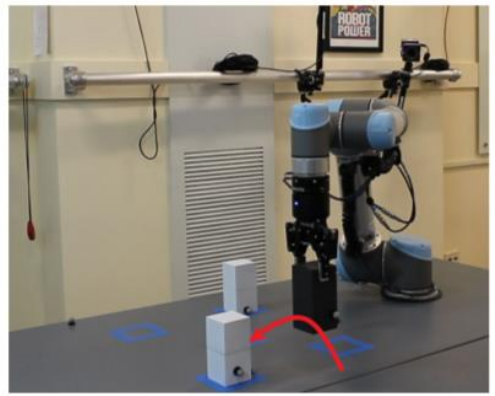
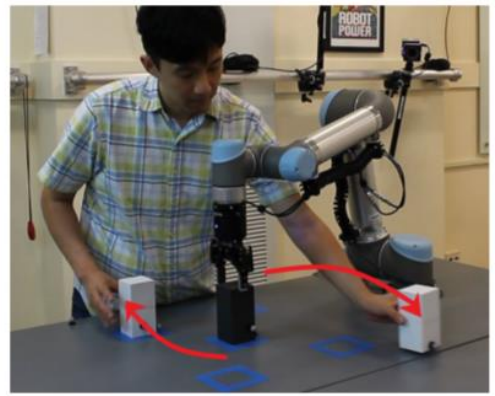
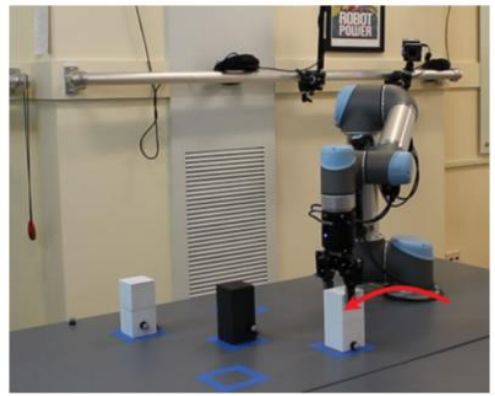
- Formal syntax and semantics
- Capture properties of interest
  - Ordering of events
  - Time
  - Probabilities of success
  - Safety
  - Liveness/goals
- Can be **automatically** and **correctly** transformed into control of a system

Automated Abstraction of Manipulation Domains for Cost-Based Reactive Synthesis

Keliang He[1], Morteza Lahijanian[2], Lydia E. Kavraki[1], and Moshe Y. Vardi[1]

$$\Diamond\Big(p_{\text{black,center}} \wedge \big((p_{\text{white},1} \wedge p_{\text{white},3}) \vee (p_{\text{white},2} \wedge p_{\text{white},4})\big)\Big)$$



A few more examples of robotics domains, the specification formalism and what is can capture

Correct-by-construction synthesis for smart manufacturing

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