

A Formal Framework for the Analysis of Human-Machine Interactions

PhD Public Defence

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Automated interactive systems



People are interacting with technology everyday!

Automated interactive systems



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Automated interactive systems



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Automated interactive systems



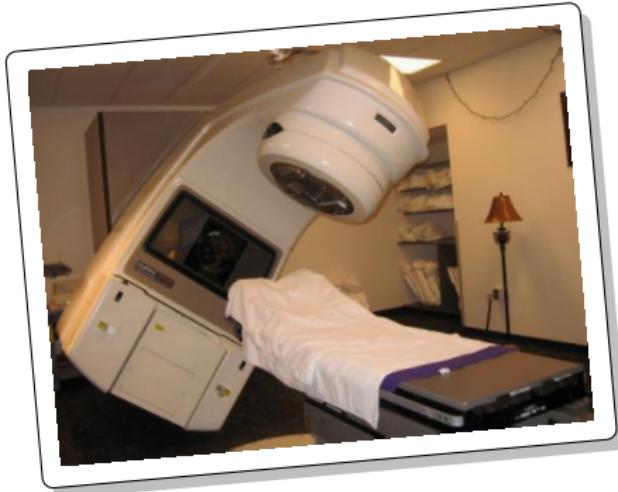
People are interacting with technology everyday!

Automated interactive systems



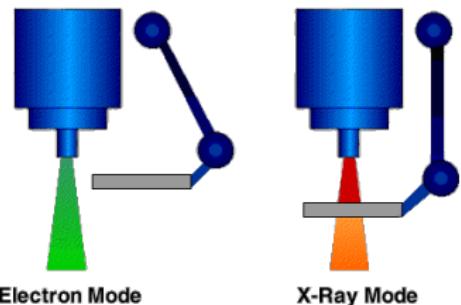
People are interacting with technology everyday!

Automation surprise



Therac-25

1985–1987

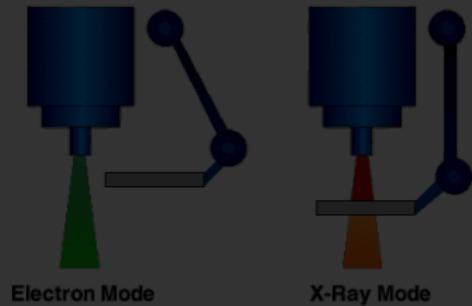


Automation surprise



Therac-25

1985–1987

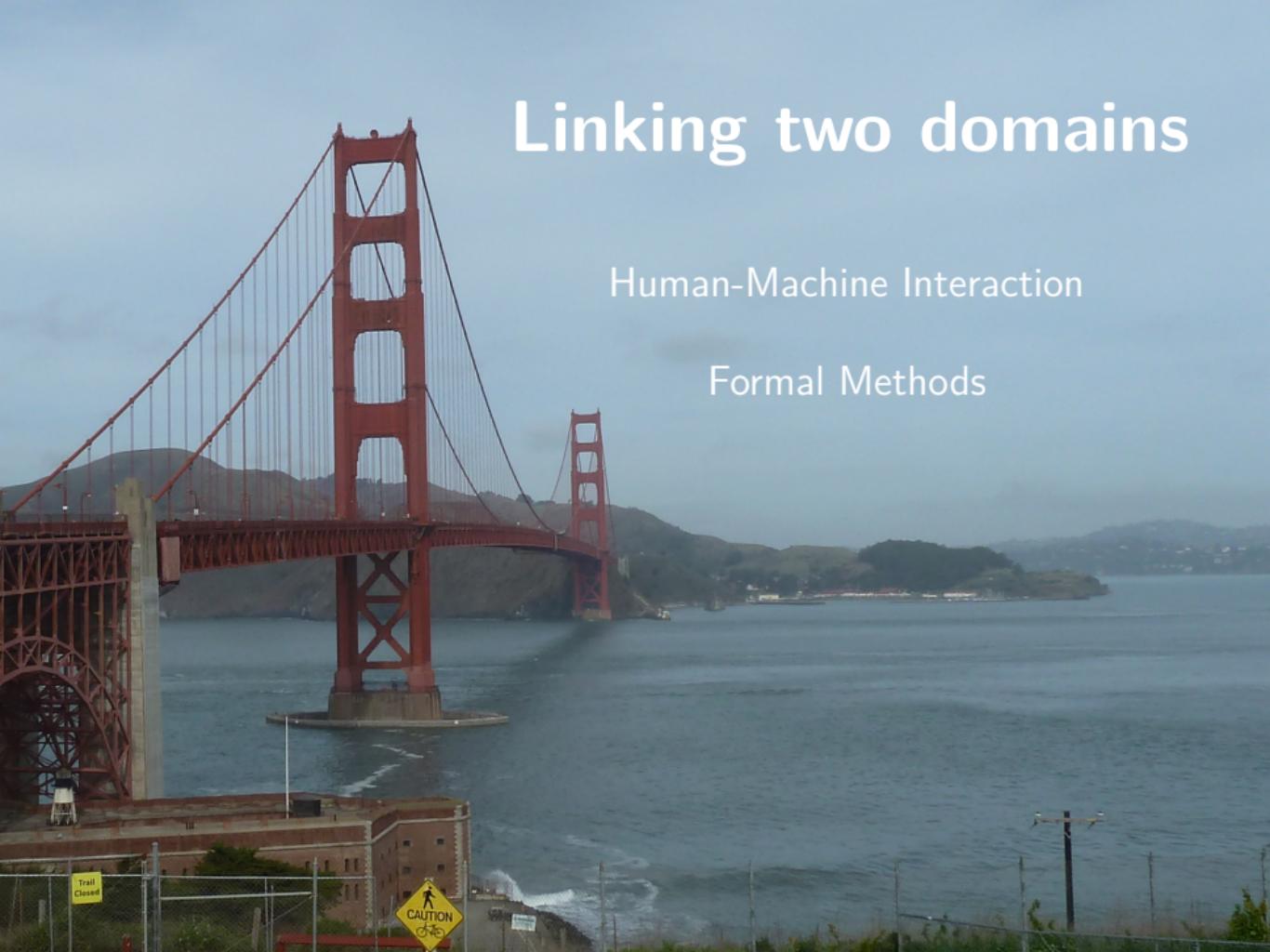


Did you said bug?



Did you said bug?



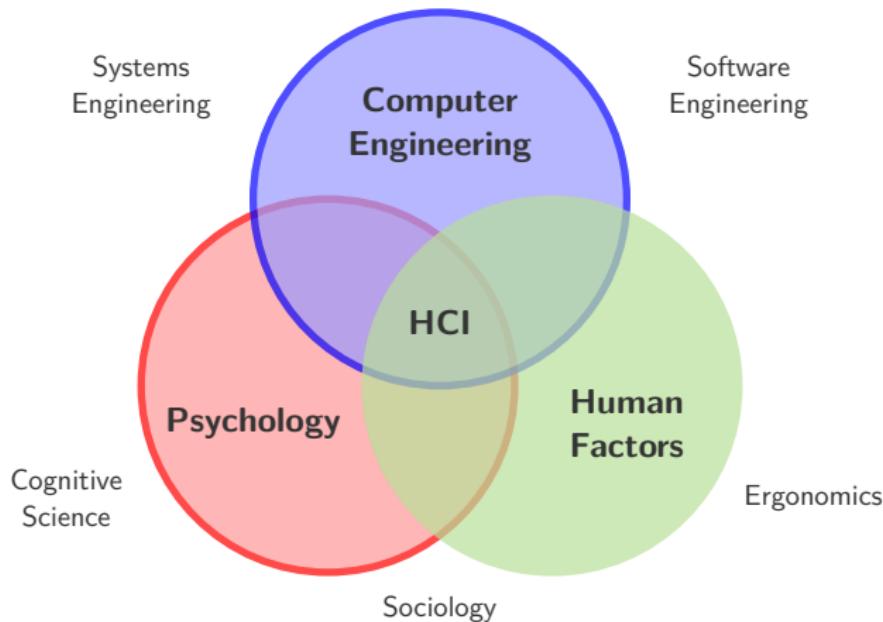


Linking two domains

Human-Machine Interaction

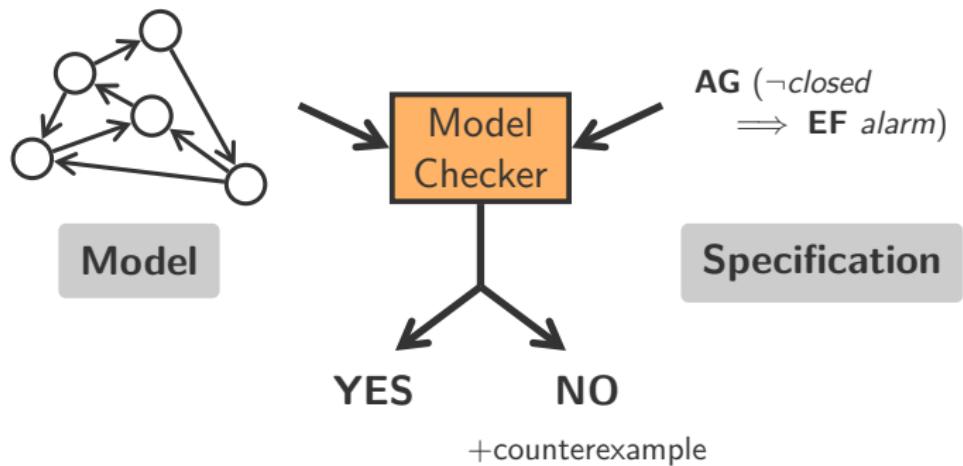
Formal Methods

Human-computer interaction



Design, evaluation and implementation of
interactive computing systems for human use

Formal methods



Specification, development and verification of hardware and software systems using mathematical techniques

A metal sculpture of a figure with a large head and small body, standing on a long, thin white balance beam. The figure is leaning forward, holding a yellow object in its right hand. The beam is positioned horizontally across the frame, set against a background of dark green water.

Modelling the world around us

Simplification of the analyses

Validation of models

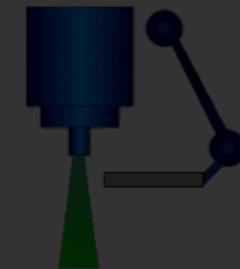
False positives and negatives

Automation surprise

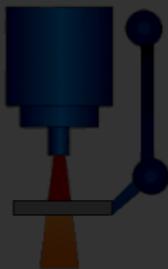


Therac-25

1985–1987



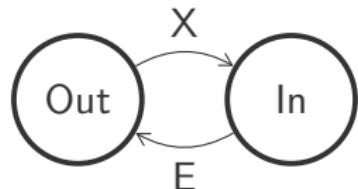
Electron Mode



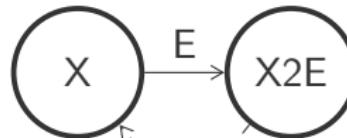
X-Ray Mode

Automation surprise

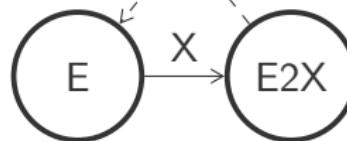
Spreader



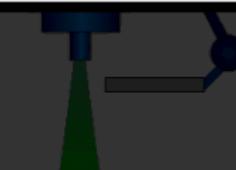
BeamLevel



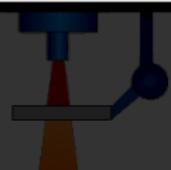
X-ray mode



E-beam mode

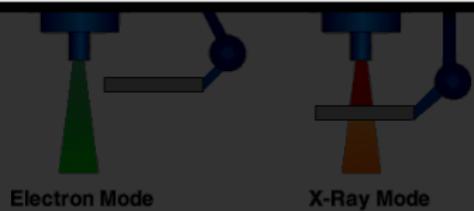
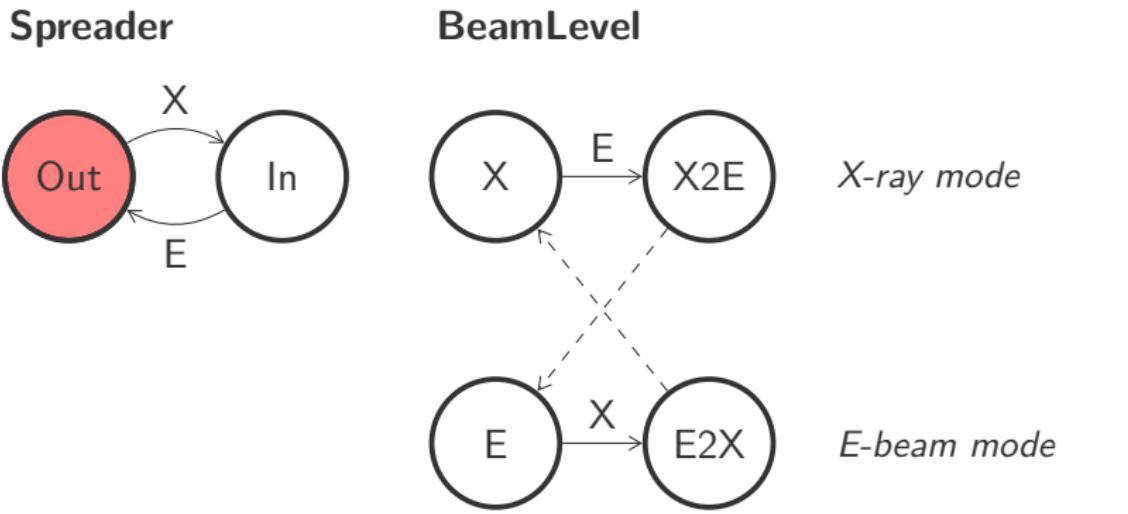


Electron Mode

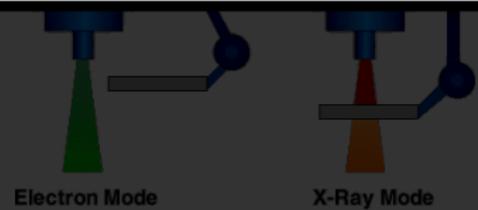
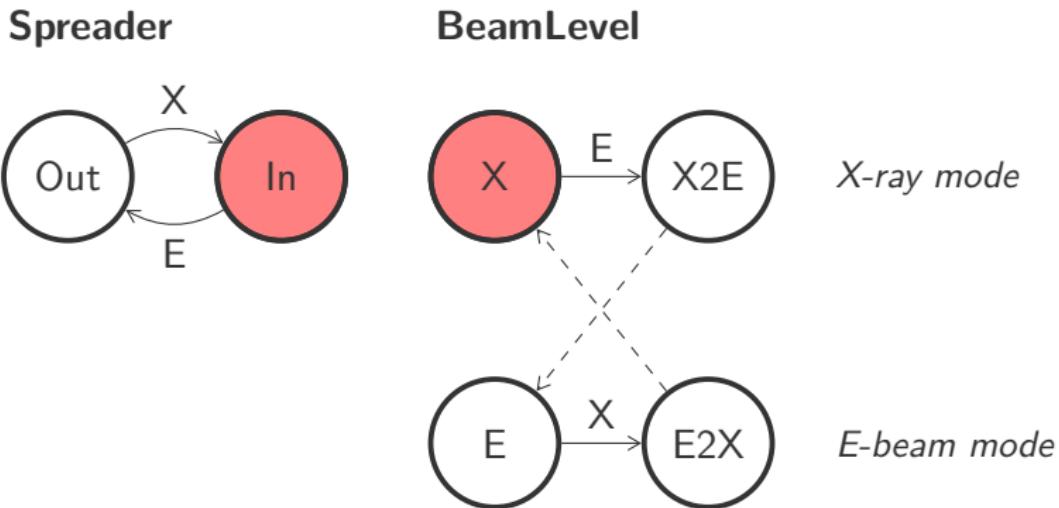


X-Ray Mode

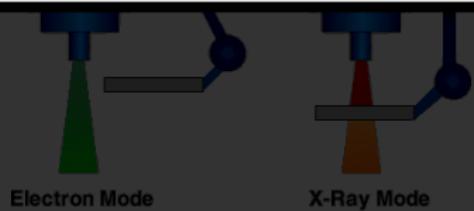
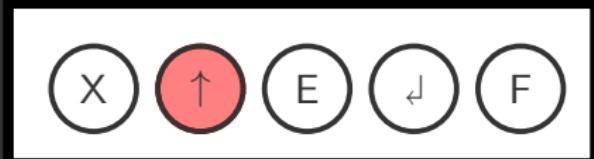
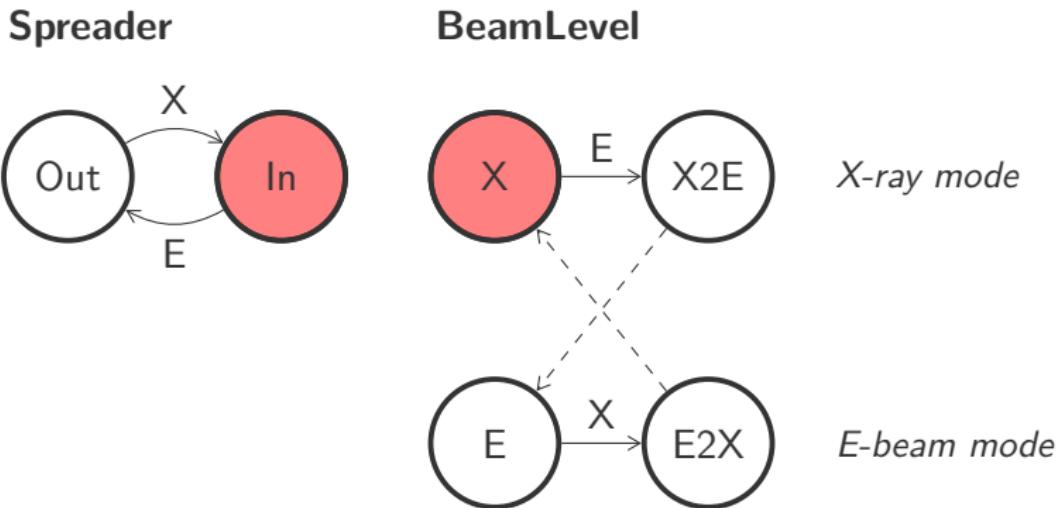
Automation surprise



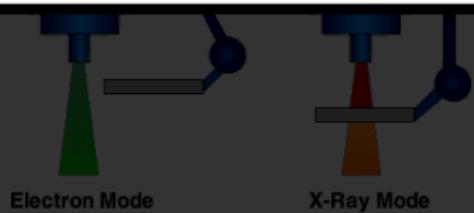
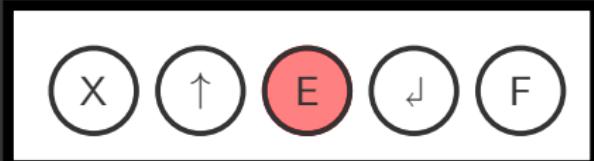
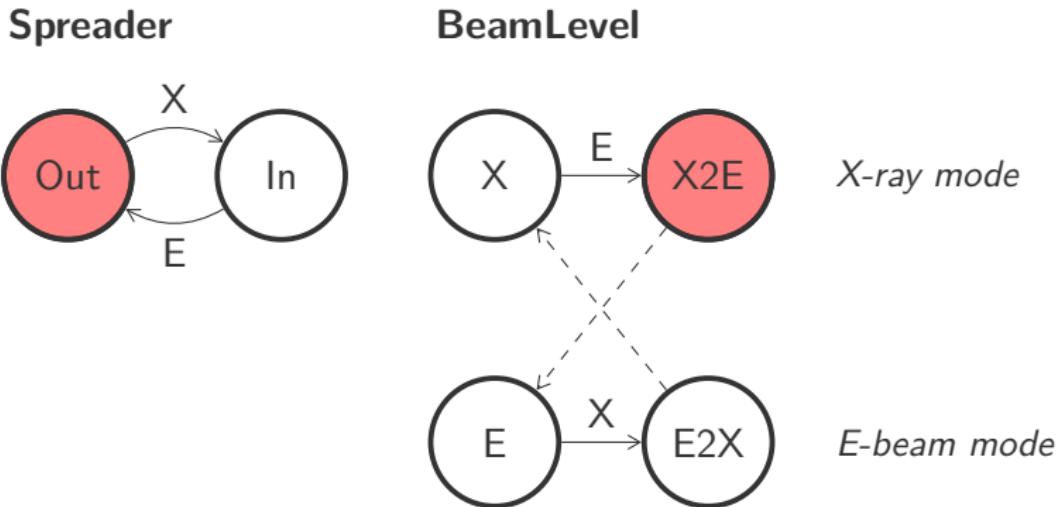
Automation surprise



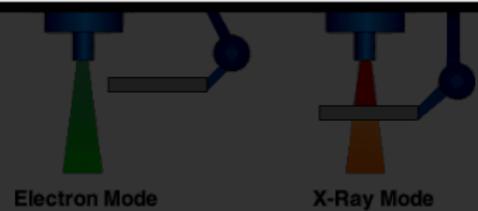
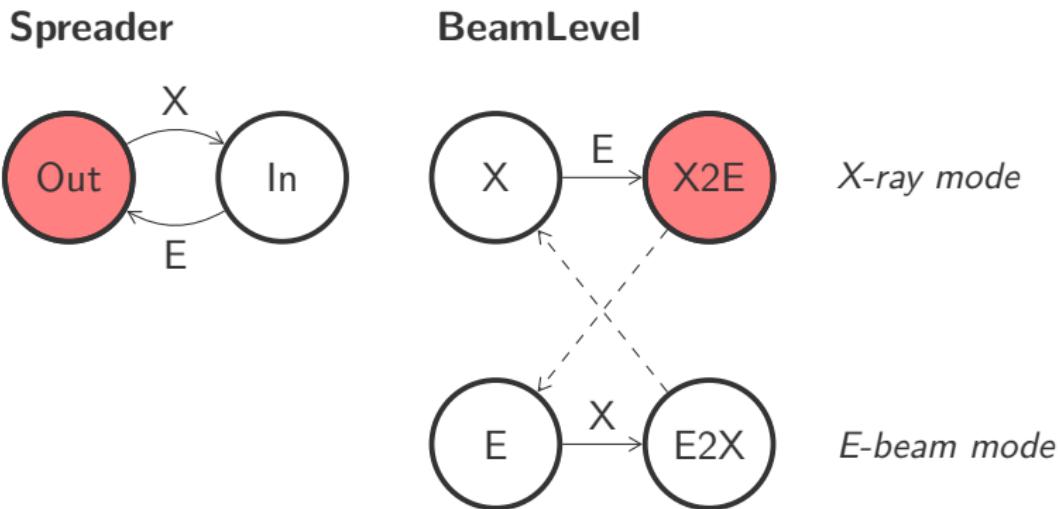
Automation surprise



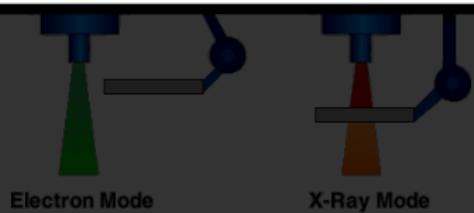
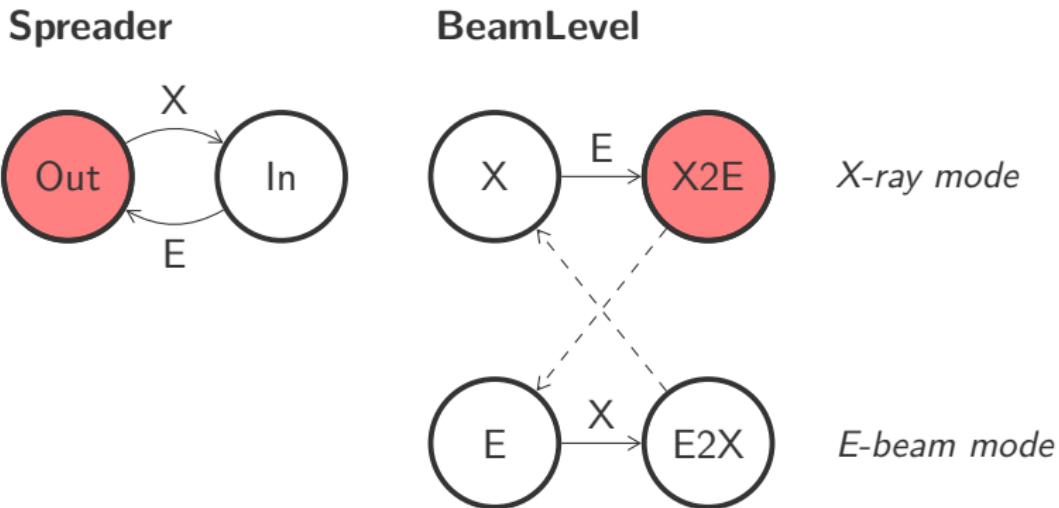
Automation surprise



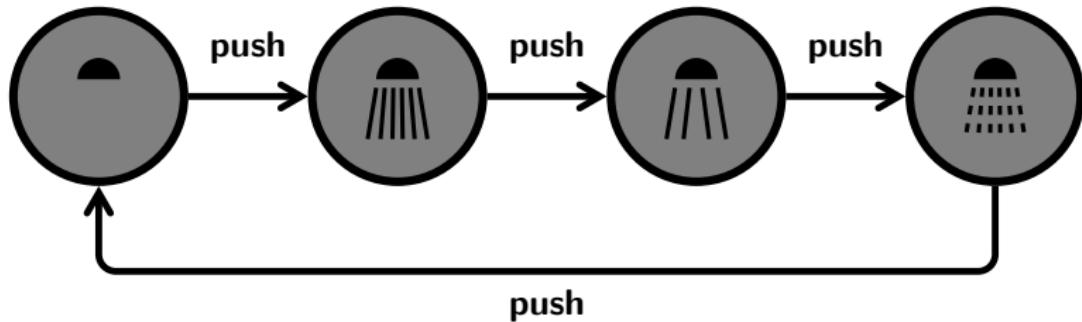
Automation surprise



Automation surprise

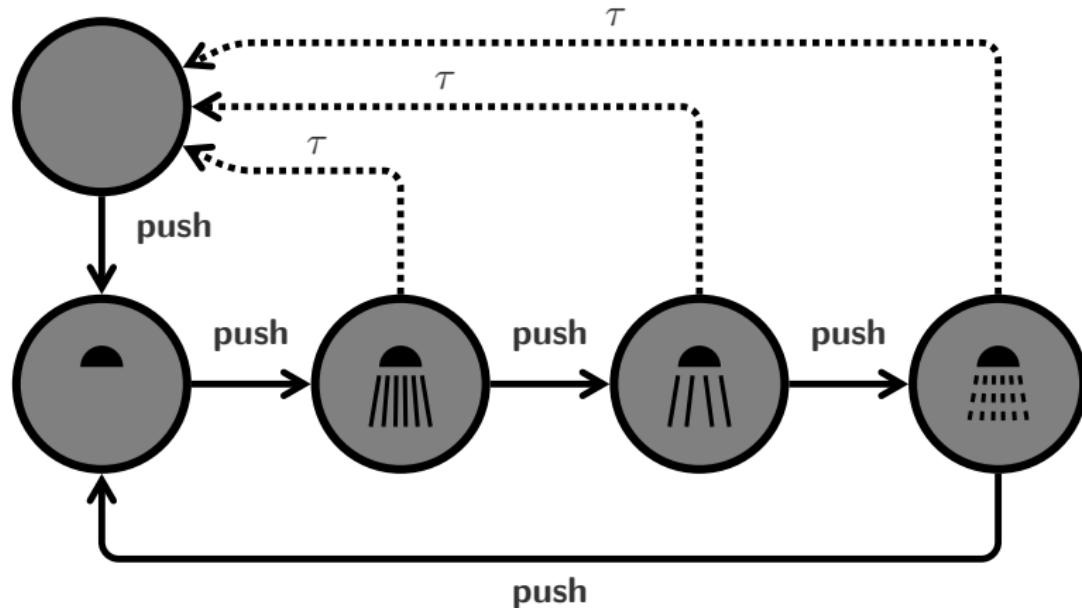


Model of the system



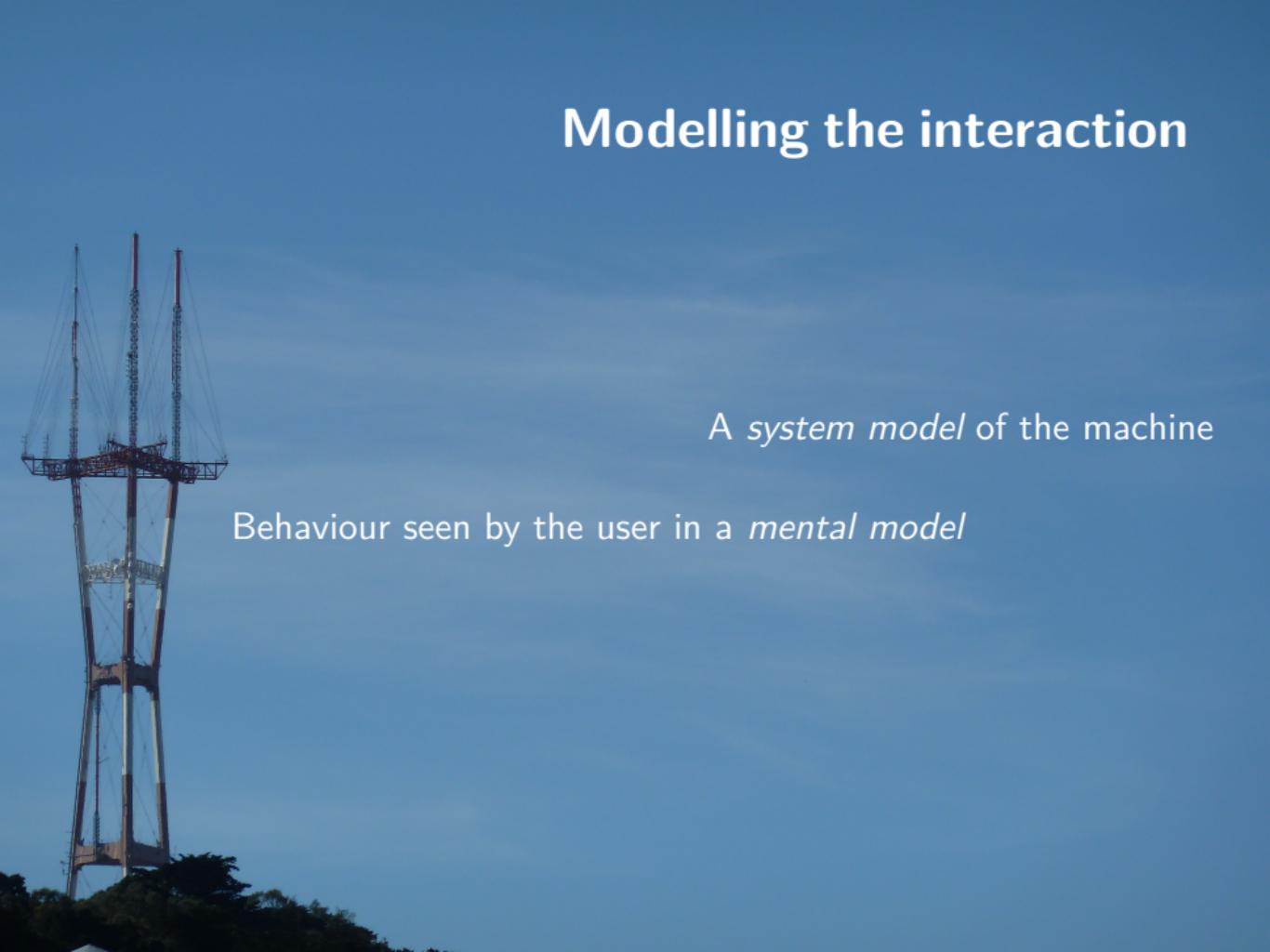
That model do NOT reflect the actual behaviour of the system!

Actual model of the system



Internal changes are occurring autonomously in the system!

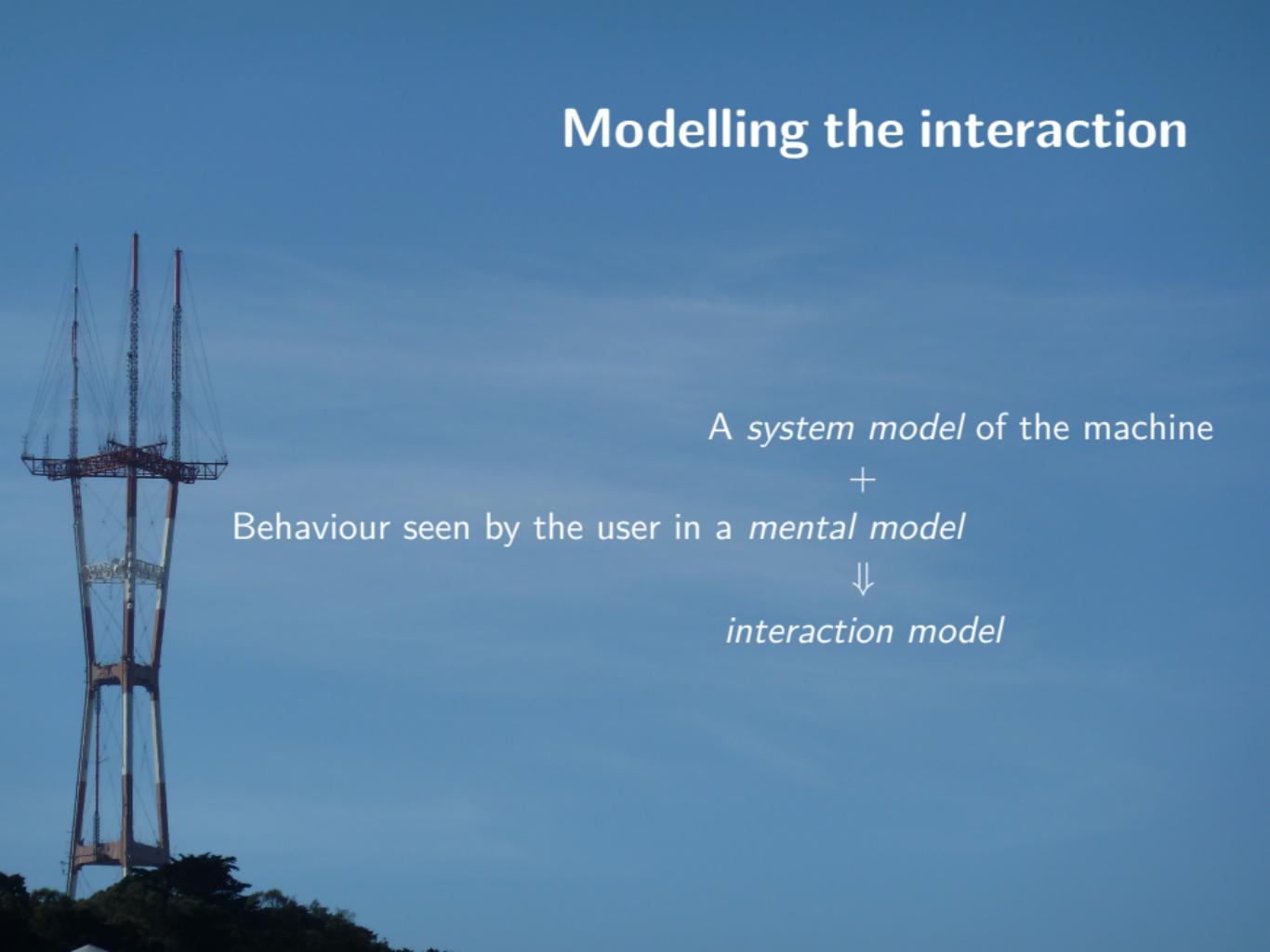
Modelling the interaction



Behaviour seen by the user in a *mental model*

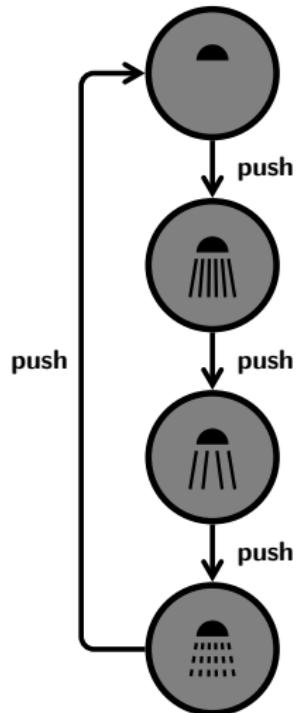
A *system model* of the machine

Modelling the interaction

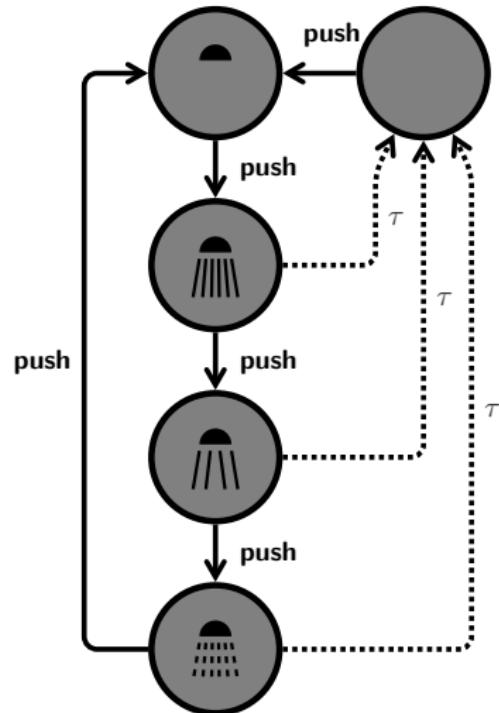


A *system model* of the machine
+
Behaviour seen by the user in a *mental model*
↓
interaction model

Interaction model

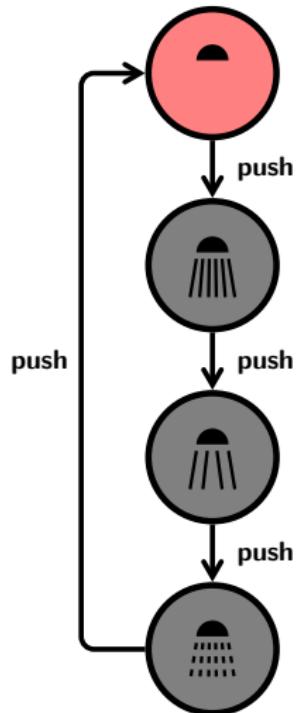


Mental model

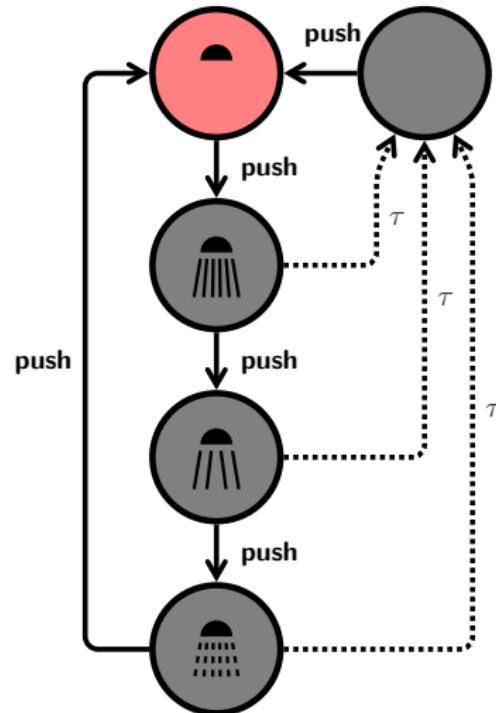


System model

Interaction model

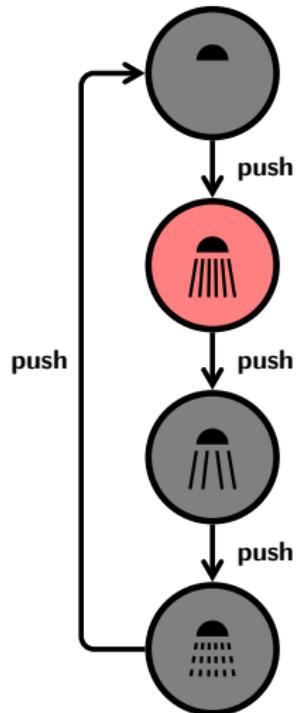


Mental model

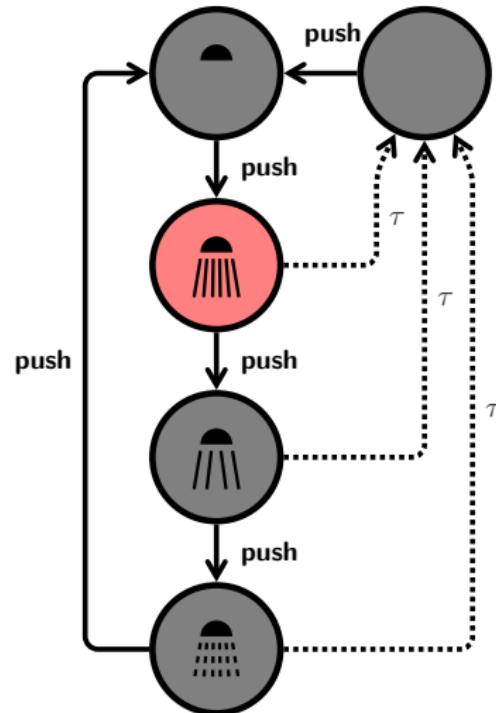


System model

Interaction model

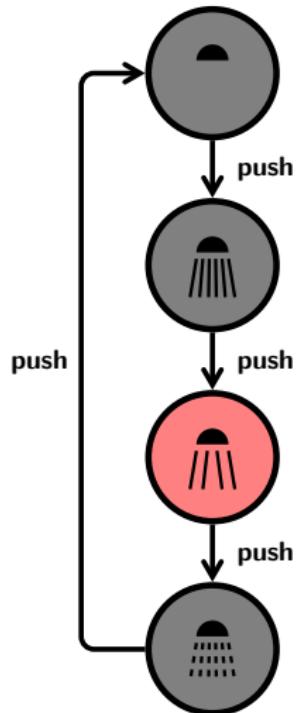


Mental model

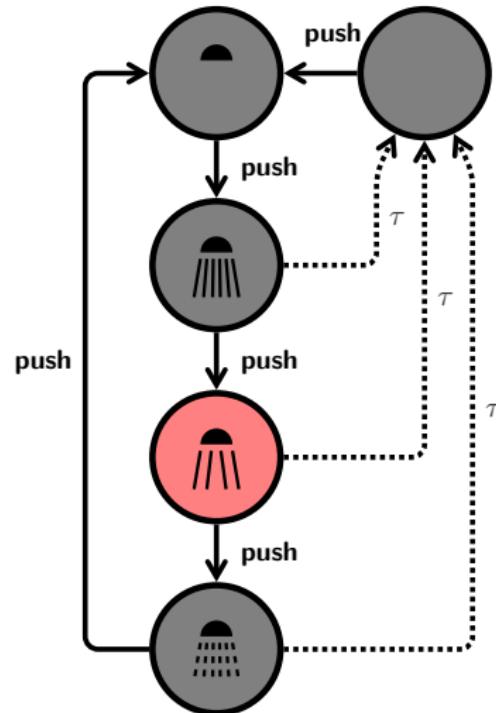


System model

Interaction model

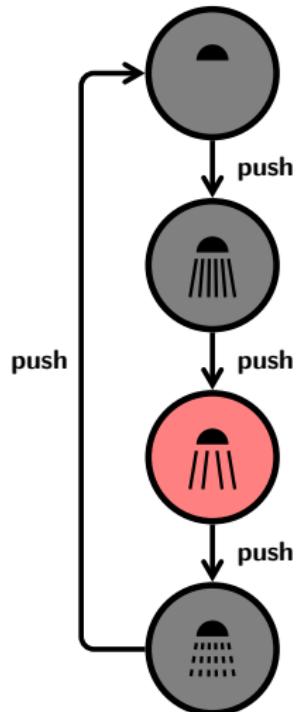


Mental model

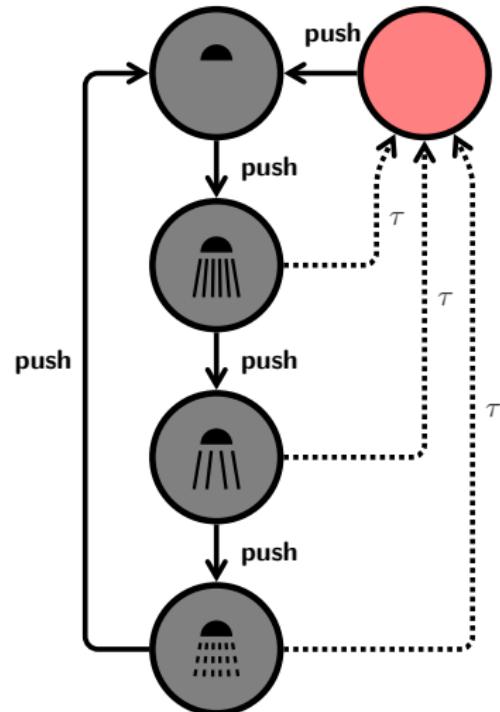


System model

Interaction model

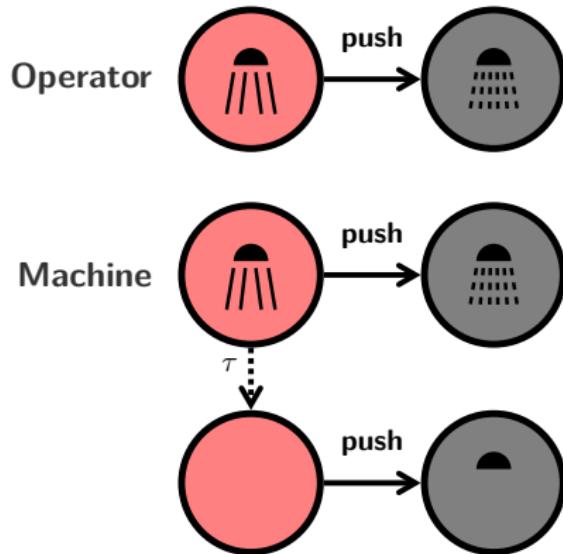


Mental model

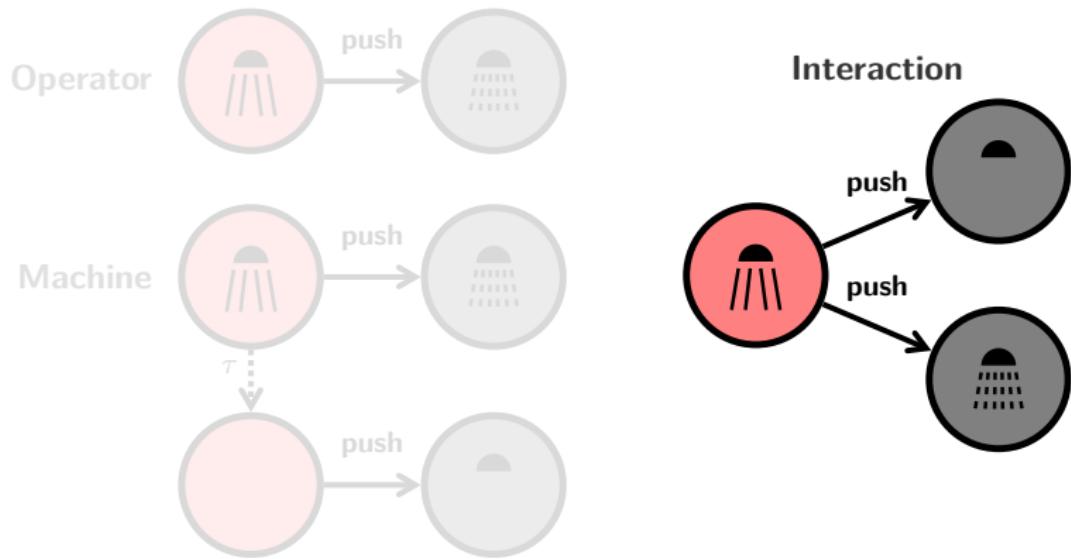


System model

Mode confusion



Mode confusion



The operator does NOT understand the machine anymore!

This thesis

Choosing models for systems and humans

Defining and characterising full-control

Implementing generation algorithms

Evaluating the approach on case studies



Credits

- Sébastien Combéfis, January 27, 2012, <https://www.flickr.com/photos/157142794@N06/51103085983>.
- Tom Benson, September 21, 2012, <https://www.flickr.com/photos/40928097@N07/8010490396>.
- Abhisek Das, June 6, 2012, <https://www.flickr.com/photos/technocruze/7160616423>.
- Edo, February 14, 2011, <http://www.flickr.com/photos/10nl/5488167982>.
- yum9me, July 1, 2008, <https://www.flickr.com/photos/yum9me/2652549976>.
- Dino Borelli, May 29, 2012, <https://www.flickr.com/photos/deeknow/7293270982>.
- KOBUS 2C, January 28, 2007, https://www.flickr.com/photos/taken_by_tom/931401890.
- Catalina Márquez, January 12, 2007, <https://commons.wikimedia.org/wiki/File:Therac-25.jpg>.
- Carlos Caballero, May 8, 2019, <https://www.carloscaballero.io/software-architecture-therac-25>.
- Sébastien Combéfis, May 13, 2013, <https://www.flickr.com/photos/157142794@N06/51102862181>.
- Sébastien Combéfis, January 24, 2012, <https://www.flickr.com/photos/157142794@N06/51102866161>.
- Sébastien Combéfis, April 10, 2013, <https://www.flickr.com/photos/157142794@N06/51103971065>.
- Sébastien Combéfis, January 28, 2012, <https://www.flickr.com/photos/157142794@N06/51102943434>.
- Sébastien Combéfis, January 24, 2012, <https://www.flickr.com/photos/157142794@N06/51103973940>.