Appendix

Articulating Novelty in Science and Art

Julian Stubbe

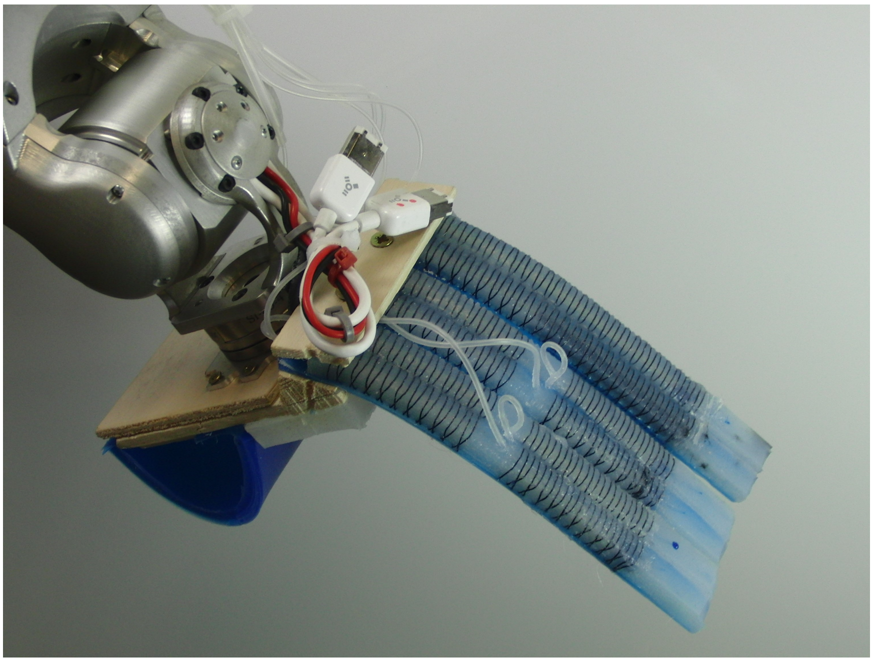


Figure 1: The RBO Hand (source, Deimel and Brock 2013).

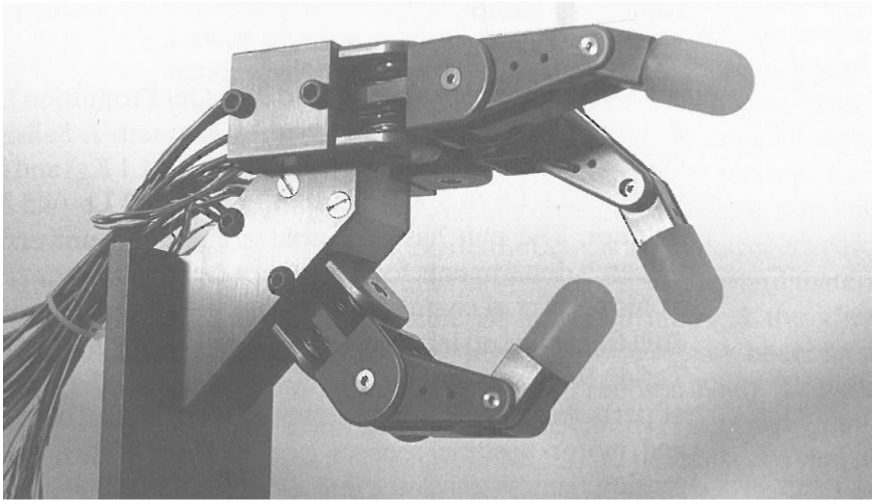


Figure 2: The Salisbury Hand (source, Rosheim 1994).

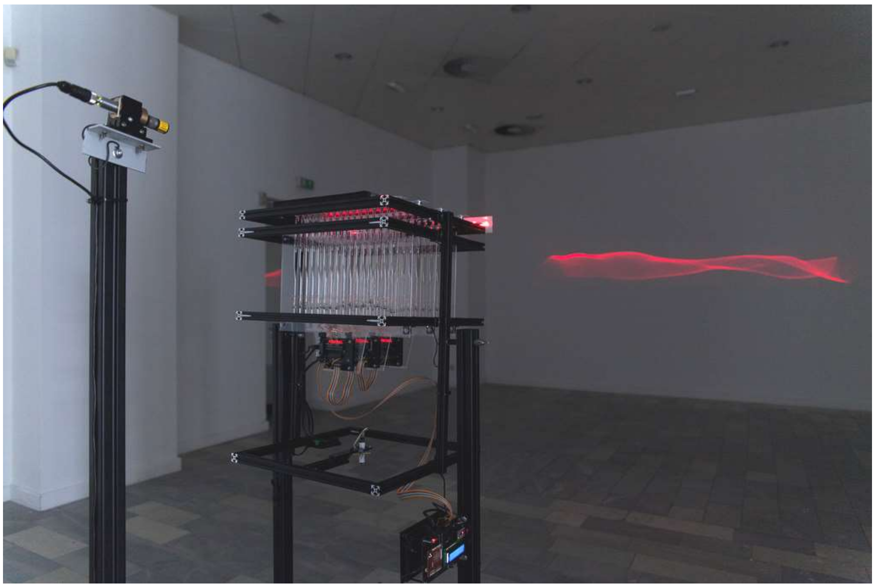


Figure 3: *Mirage* (source, Ralf Baecker 2014).

Figure 4: Gordon Pask's *The Colloquy of Mobiles* (source, *Cybernetic Serendipity*, ICA London, 1968).

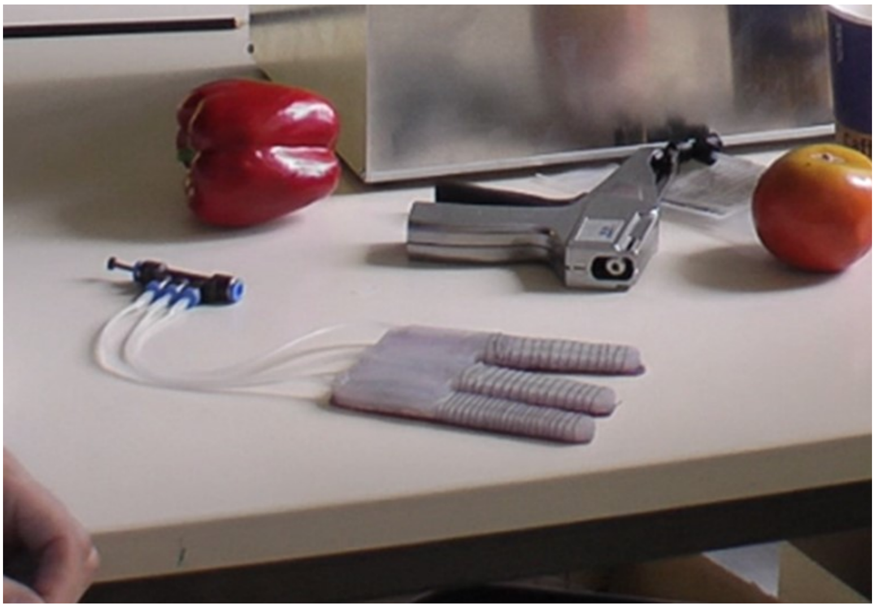


Figure 5: Hand-like shape in the laboratory's workshop (own picture).

Figure 6: Structure for testing the translation of the electric signal into a mechanical pull (own picture).

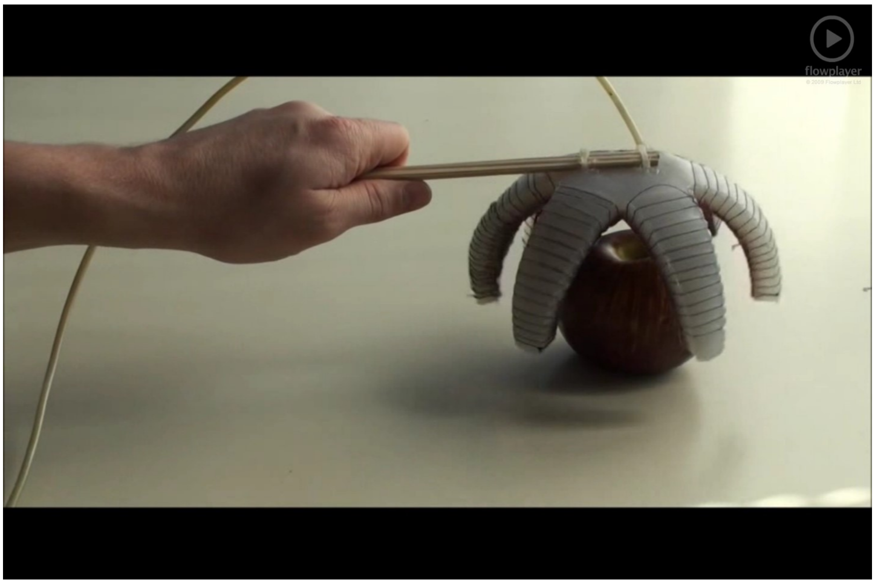


Figure 7: Starfish Grabber (source, Robotics and Biology Laboratory).

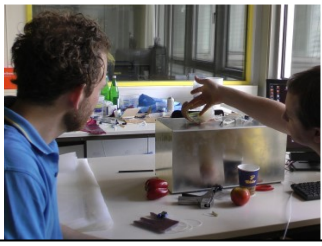
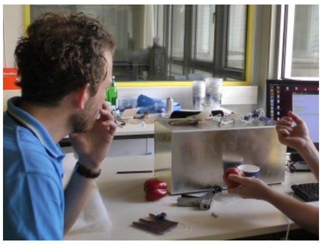
	Time	Still of the Video	Transcript
I.	00:55		Deimel: "*You only need one signal: inflating, releasing. But you can make very complex deformations from that. This is usually not done in robotics. Typically, electric motors have very good, linear characteristics. With these rubbers, many interactive things happen with the environment.* [presses some keys; the silicone hand coils up]
II.	01:45		[positions his spread fingers between the finger tips and palm of the silicone hand] *It is soft.* [puts an artificial apple into the silicone hand] *When something gets into the hand, its form adapts to it.*
III.	01:56		[mimics a round form with his hand; the apple rolls out of the silicone hand] *This is exactly what we want to make use of here. That the hand is not steered; where the fingers have to be or how much pressure or power has to be applied. We create another kind of communication of the hand.*
IV.	02:24		[takes the apple in his hand, waves it, and puts it back onto the box] *And we just try to establish as much surface for contact as possible. The more contact surface you have, the better it grasps. Surely, it does not always work, but this is generally the basic principle."*

Figure 8: Enacting the silicone's softness and potential for grasping (own video).

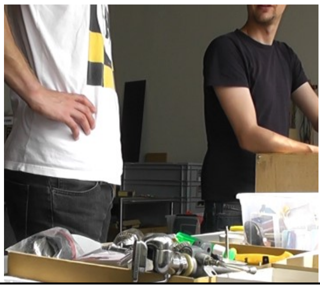
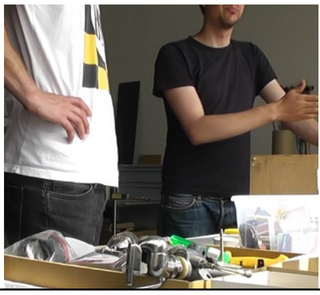
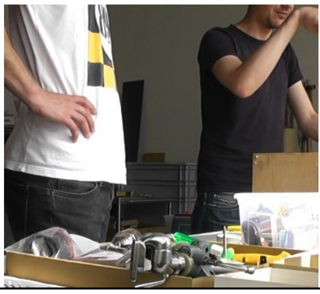
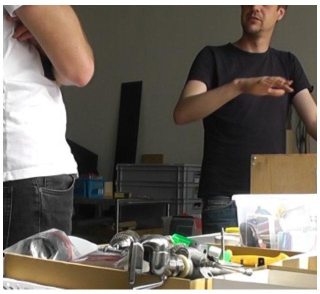
	Time	Still of the video	Transcript
I.	02:35		Baecker: *"When you attach this one, then it moves…* [points to the pulley] *The idea is now, if you build in an elastic element; so when I make the movement here, it arrives over there three seconds later, as a kind of delay. Then a string is tightened between the parts.*
II.	03:06		*Then you have a kind of line, which propagates through it.* [makes a snake movement with his hand] *And to have that in several dimensions, so you have a row. I would additionally hang that separate.* [orientates his gaze and hands towards the wooden panels] *… so this is hard.*
III.	03:35		*Imagine this was there in every row, like four, five times, then I would replace this hanger with that.* [makes a bow movement with his hand] *So the whole system is hung in two dimensions, totally detached, totally sprung. Only at every entrance does a signal enter.* [points to the end of the wooden structure] *So there is a motor or a cord entered here and here.*
IV.	04:10		*And you actually have a wafting area. You have a wafting area through which this is wandering through slowly. The best is a closed circuit that is only triggered once. I always had something like a landscape situation in mind."* [continues to pull the string through the eyelets]

Figure 9: Enacting the "landscape situation." (own video)

Figure 10: The SDM Hand (source, Dollar and Howe 2010).

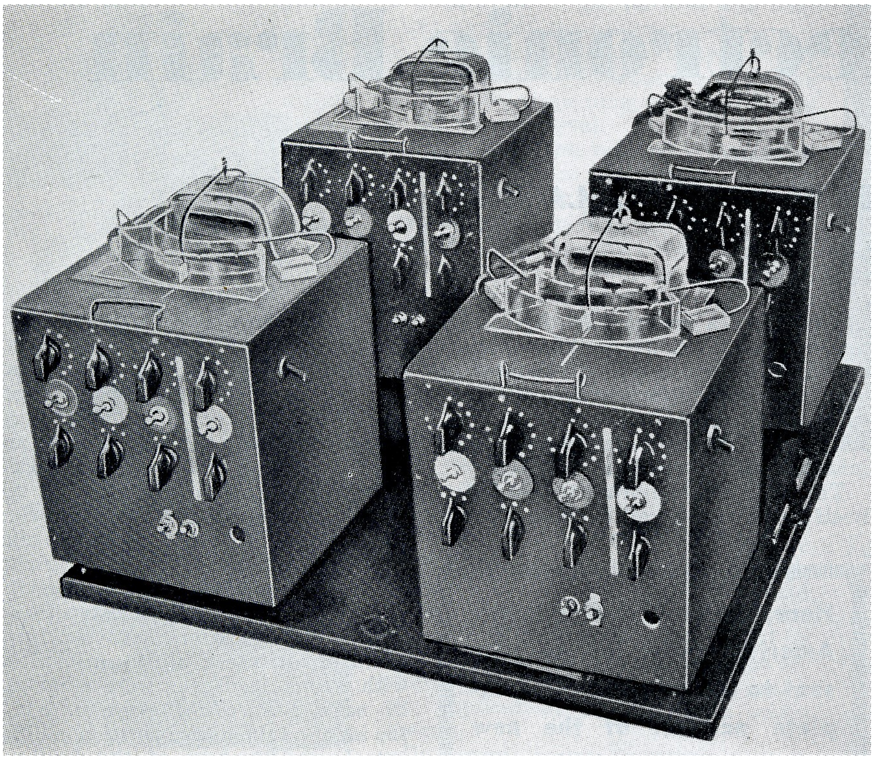


Figure 11: Ross Ashby's Homeostat (source, The W. Ross Ashby Digital Archive).[30]

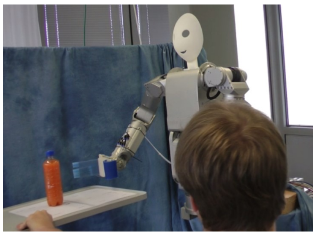
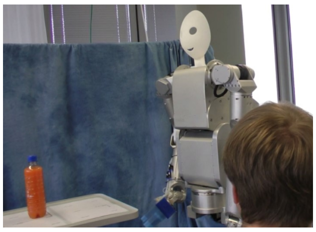
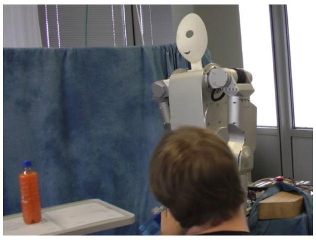
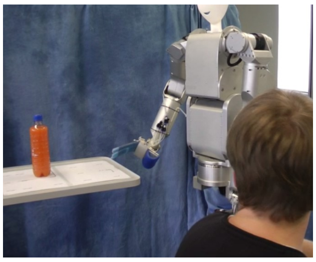
	Time	Still of the video	Transcript
.	04:28		Deimel programs the steering software of the Meka A2. He looks at the table and pulls it out of the Hand's reach.
II.	04:37		He continues programming. After writing, he hits the keyboard like pressing Enter. The Meka A2 drives downwards and stops parallel to the robot torso.
III.	04:55		Deimel looks at the new position and pushes the Meka A2 slightly with his left hand. The robotic arm moves outwards and swings back to its original position. Its movements are constrained through its active system mode. It behaves similar to a human arm with contracted muscles.
IV.	05:08- 05:27		Deimel orientates back to the monitor. He writes code, presses enter again and puts his left hand on the emergency button. The Meka A2 moves backwards. Then it turns slightly around its axis and moves up-wards. It stops in a 90° angle to the torso. He continues programming.

Figure 12: Inquiry patterns in the RBO Laboratory (own video).

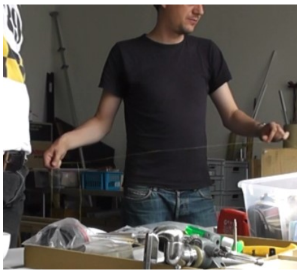
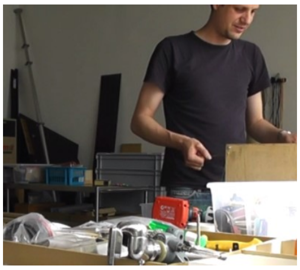
	Time	Still of the video	Transcript
I.	05:10		Baecker threads the line through three hooks and pulls it several times softly. The line pulls back every time due to the elastic element. He threads the line through another hook, stands upright and pulls the line ten times. Every pull is slightly different from the one before.
II.	06:15 – 07:00		Baecker keeps on pulling the line slightly. Baecker: *"There is already too much friction on it; it won't work that way."* He stops pulling and starts to decoil the line. Baecker: *"It is already too tight."*

Figure 13: Baecker using his body as actuator and epistemic tool (own video).

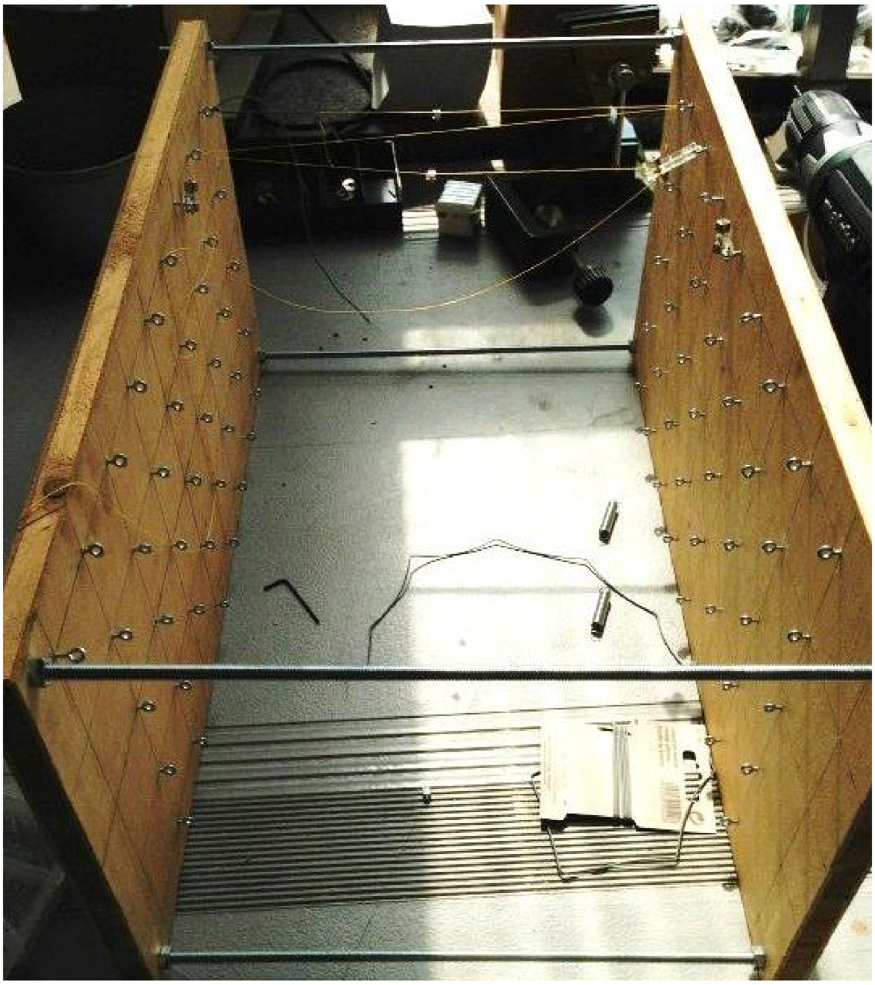


Figure 14: Test structure made from wooden plates, hooks, and strings (own picture).

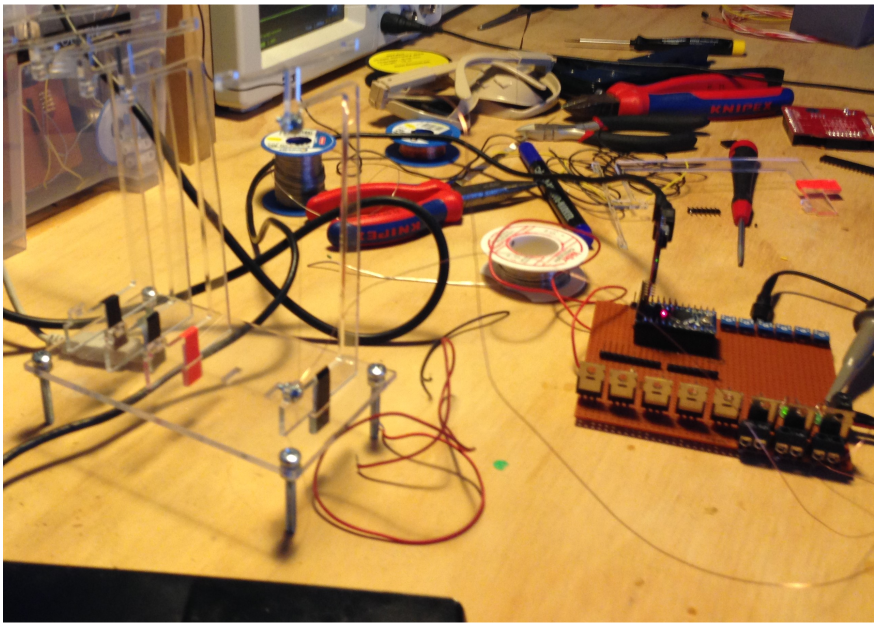


Figure 15: Test structure made from Arduino board, bows of acrylic glass, and wires (own picture).

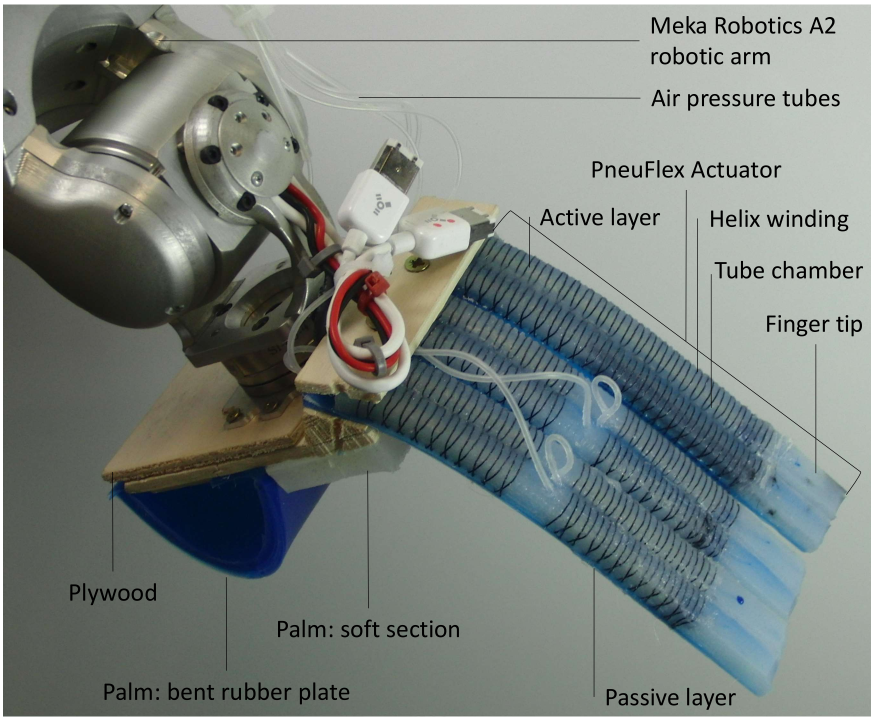


Figure 16: The RBO Hand's technical form (own annotations, Deimel and Brock 2013, Figure 1).

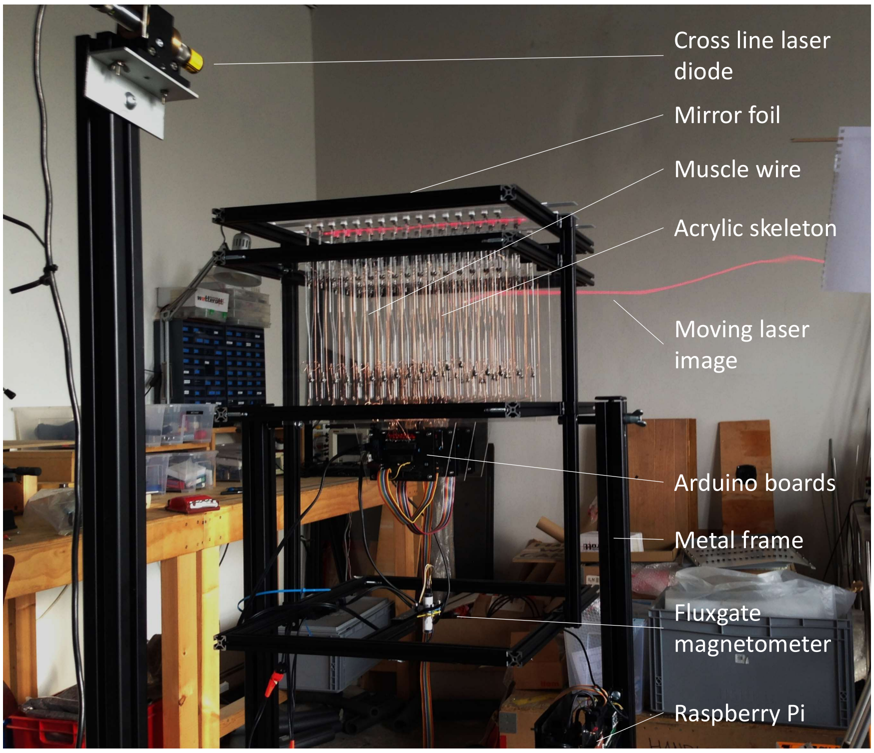


Figure 17: *Mirage's* technical form in Baecker's studio, close to its first exhibition (own picture).

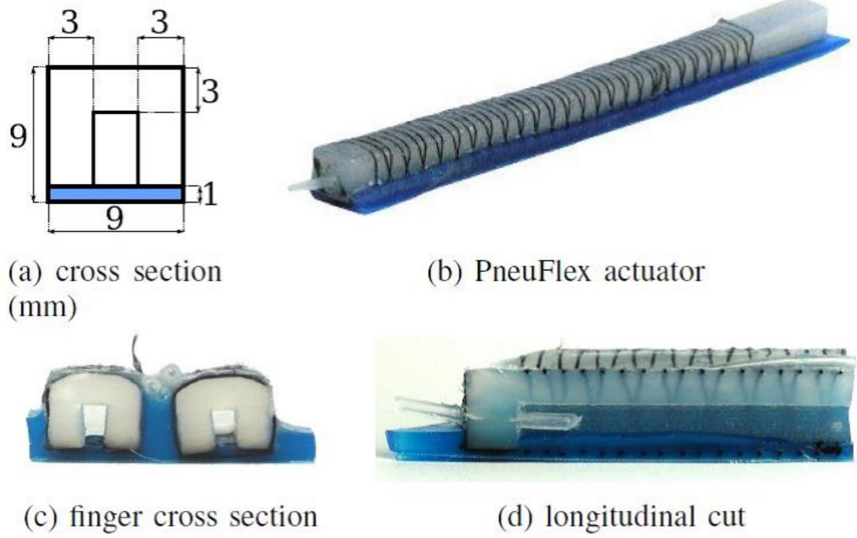


Figure 18: The composition of the PneuFlex Actuator (source, Deimel and Brock 2013, 2040, Figure 2).

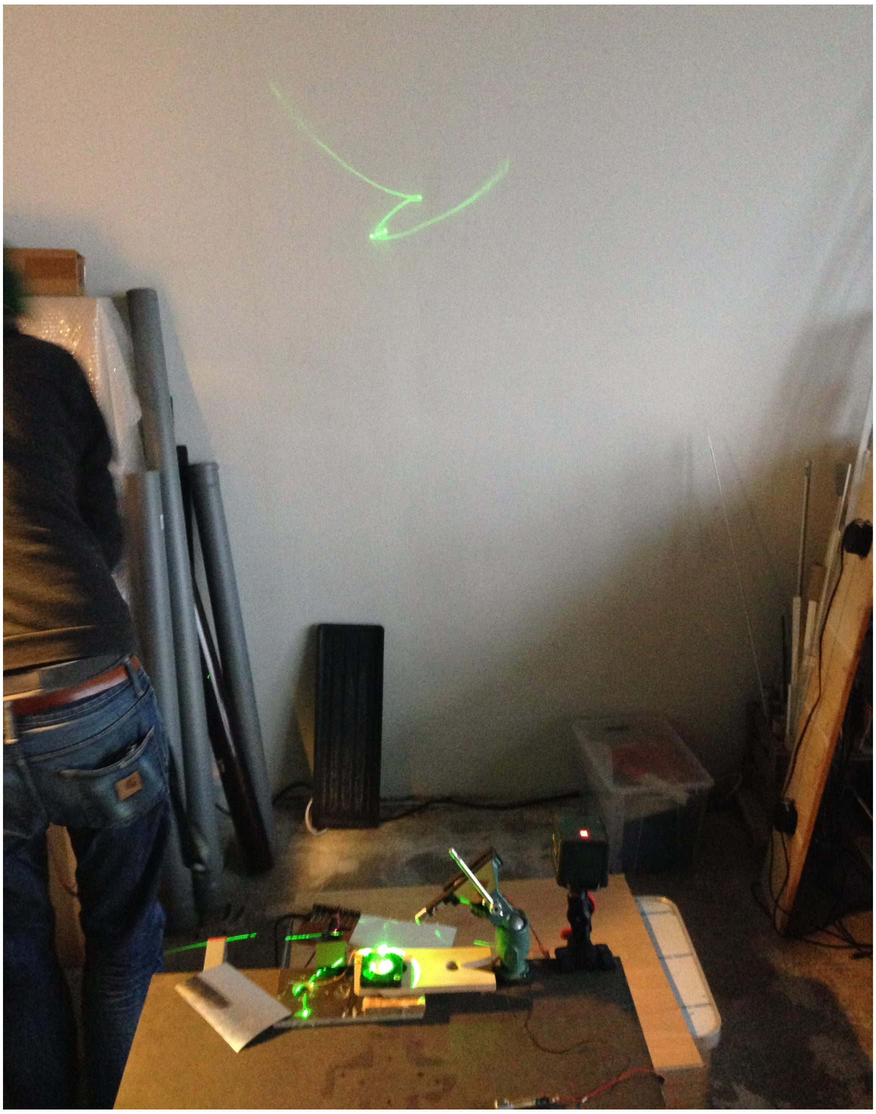


Figure 19: Early experimental setup of cross-line laser and mirror (own picture).

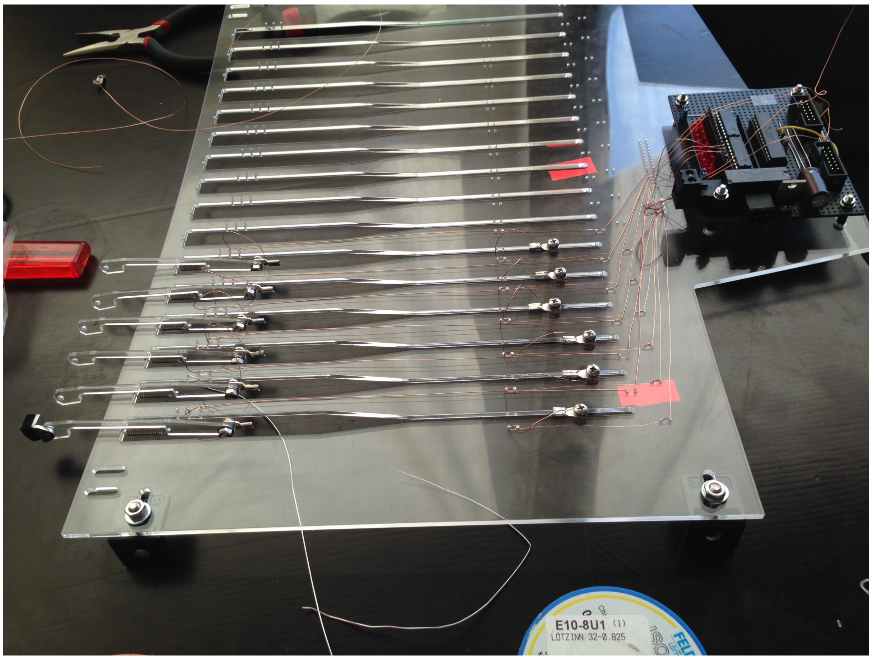


Figure 20: Skeleton made of acrylic glass (own picture).

Figure 21: Computer screen showing frequently changing signals and their algorithmic variation (own picture).

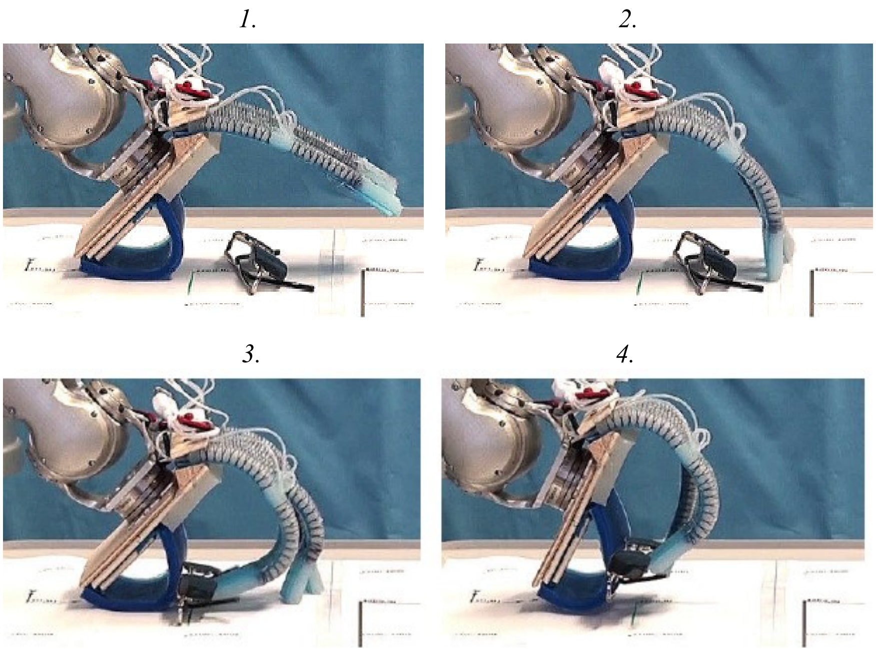


Figure 22: The RBO Hand performing a surface-constrained grasp (source, Deimel and Brock 2013, 2045, Figure 9).

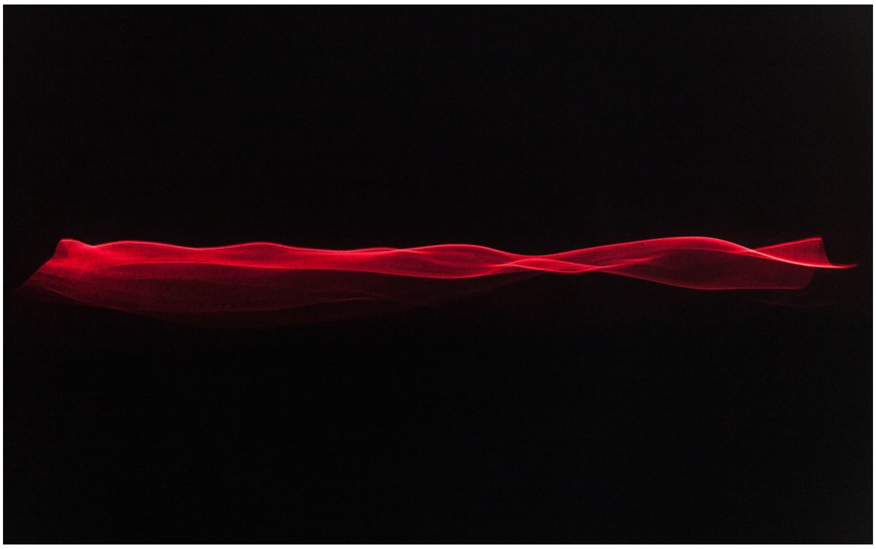


Figure 23: *Mirage's* moving image (source, Ralf Baecker).

Figure 24: Shadow Hand holding a light bulb (source, Shadow Robot Company).

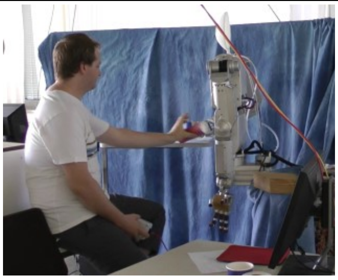
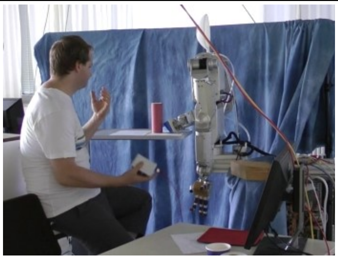
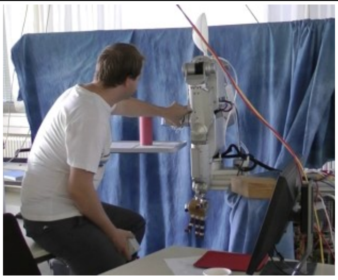
	Time	Still of the video	Transcript
I.	25:43		Deimel sits beside the ensemble of RBO Hand, Meka arm, and torso. The robotic arm drives the RBO Hand toward the bottle, the Hand grasps, and the bottle falls. To prevent the bottle from falling off the table Deimel grabs it. The arm continues the programmed movement and lifts the Hand without the bottle.
II.	26:00		The arm drives back to its default position. Deimel replaces the bottle onto its designated spot on the table.
III.	26:10		The arm continues with the subsequent movement. It drives the Hand into the table. Deimel immediately pushes the emergency button. He lifts his arm and sighs.
IV.	26:20		Deimel grabs the wrist with his left hand and pushes the emergency button again with his right. Thereupon the arm continues the movement and lifts the Hand without bottle; Deimel keeps holding the wrist. He pushes the red emergency button. The arm stops its movement and Deimel stands up and takes a seat in front of the computer screen.

Figure 25: Two kinds of failure in an experiment with the RBO Hand (own video).

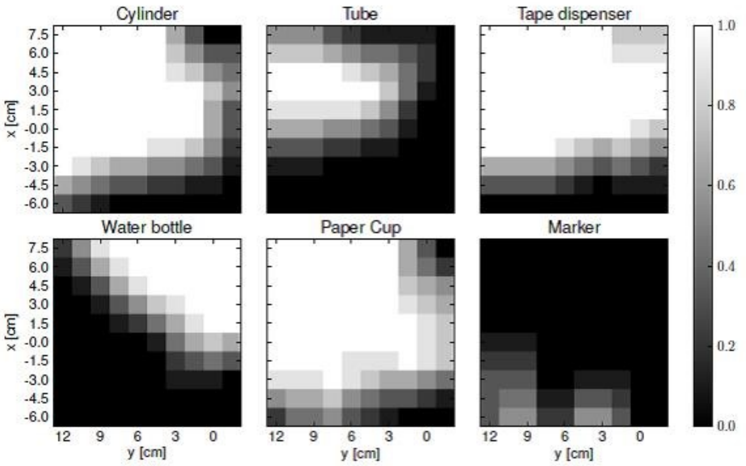


Figure 26: Graph translated from grasping experiment (source, Deimel and Brock 2013, 2043, Figure 7: Sliding grasps success probability under object placement variation).

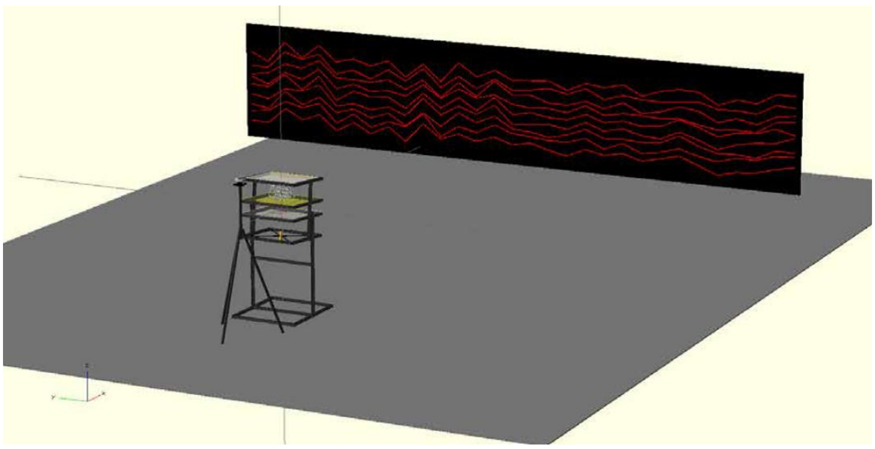


Figure 27: Technical drawing of *Mirage*'s design approximately six months prior to the exhibition (source, Ralf Baecker).

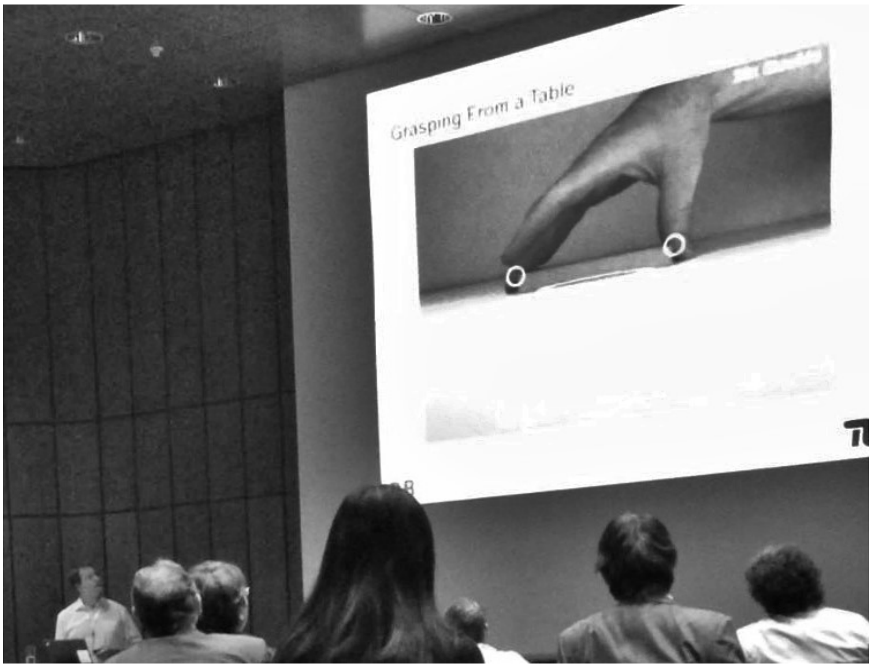


Figure 28: Video-screening of human hand grasping a sponge at the ICRA (own picture).

Figure 29: Profile of the Alps from Baecker's Twitter account (tweeted on March 16, 2015).

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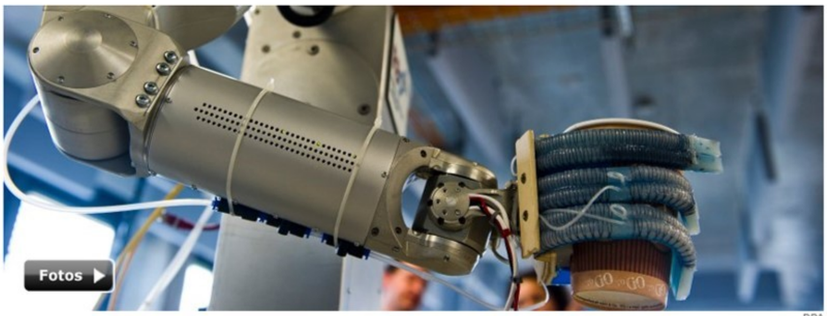
Weiche Roboterhand: Luftdruck lässt Silikonfinger greifen



DPA

Beweglicher, günstiger und einfacher in der Herstellung soll eine neuartige Roboterhand sein. Entwickelt wurde sie an der Technischen Universität Berlin. Ihre Finger bestehen aus weichem Silikon, die Rolle der Muskeln übernehmen Luftkammern.

Donnerstag, 27.06.2013 – 17:20 Uhr

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Berliner Forscher haben eine weiche Roboterhand entwickelt, die präzise nach Objekten greifen kann. Betrieben werden die Silikonfinger durch Luftdruck: Mit Hilfe von Luftkammern krümmen sich die Finger in die gewünschte Richtung.

Nach Angaben der Wissenschaftler der TU Berlin ist die Hand relativ leicht nachzubauen und deutlich günstiger als herkömmliche Roboterhände aus Metall. Sie wurde am Donnerstag auf der internationalen Konferenz "Robotics - Science and Systems" in Berlin vorgestellt.

Figure 30: Screenshot of the *Spiegel Online* article on the RBO Hand (taken on July 2, 2015).

Date	RBO Hand	*Mirage*	Data type
2012			
May	First meeting with Prof. Dr. Oliver Brock		Notes
Jun	Starfish Grabber and first hand-like prototype are realized; First interview with Raphael Deimel		Website Transcript
Jul	Interviews with several researchers from the RBO Laboratory		Transcripts
Aug	The RBO Hand receives its main form and can be mounted on the Meka robotic arm; Preparation of first grasping experiments; Conducting the experiment, whose results are partly published in the first research paper on the Hand		Ethnographic observations including video recordings, photos, and notes (EO)
Sep	Maintenance of the general research infrastructure in the RBO Laboratory		EO
2013			
Mar		Conversation with established media artist, who proposed to contact Ralf Baecker	Notes
Apr	Interview with Deimel, in which he introduces an advanced version of the RBO Hand		Transcript
May	Official publication of Deimel and Brock 2013; Presentation of the RBO Hand at the ICRA 2013 in Karlsruhe	First meeting with Baecker in his studio; *Mirage* exists as an idea for a hallucinating machine	Public document (PD), EO
Jun	Conversation with Deimel concerning his presentation at the ICRA; Presentation of the RBO Hand at the TU Berlin open night		Transcript EO
Jul	Online articles reporting on the RBO Hand	Baecker builds the test structure consisting of wooden plates, pulleys, and strings	PD, EO
Nov	Interview with Brock Deimel presents the RBO Hand 2	First tinkering sessions with crossline laser and mirror	Transcripts, EO
Dec	Experiments for Deimel and Brock 2014		EO

2014			
Jan		Application for funding including technical drawing	Provided document
Feb		Baecker manufactures metal frame	
Mar		Test and tinkering sessions that integrate sensors, actuators, and mirror foil	EO
Apr		*Mirage*'s exhibition at the LEAP Gallery	EO
Apr-Jun		Online articles discussing Mirage	PD
May		Baecker presents his work and Mirage at the Fiber Festival Honorary Mention at Prix Ars Electronica	Provided and pubic documents
Jul	Official publication of Deimel and Brock 2014 E-Mail conversation with RSS committee member		PD, provided document and e-mail dialogue

Figure 31: Timeline of events and data collection.

http://www.springer.com/978-3-658-18978-5

Articulating Novelty in Science and Art
The Comparative Technography of a Robotic Hand and
a Media Art Installation
Stubbe, J.
2017, XII, 245 p. 30 illus., Softcover
ISBN: 978-3-658-18978-5