

ARTIFICIAL MECHANICAL SYSTEMS for the UPPER EXTREMITY

DICK H. PLETTENBURG

BIOMECHATRONICS WB2432

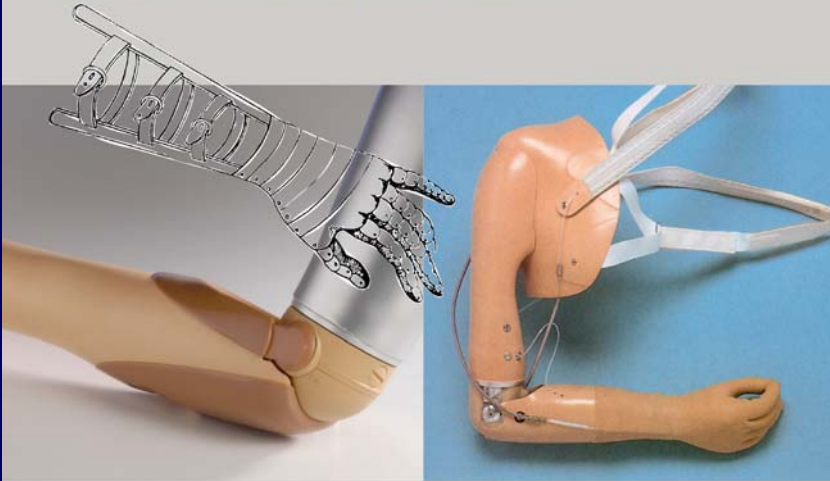
2007-03-07 STATE OF THE ART IN UE PROSTHETICS

2007-03-14 CONTROL

2007-03-21 ACTUATION

UPPER EXTREMITY PROSTHETICS

CURRENT STATUS & EVALUATION



Dick H. Plettenburg

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STATE OF THE ART IN UPPER EXTREMITY PROSTHETICS

PROSTHESIS

=

ARTIFICIAL SUBSTITUTE OF A MISSING
PART OF THE BODY

- #
- History
- Classification
- Suspension
- Available prostheses
- Concluding remarks

#

NUMBER OF UPPER EXTREMITY PROSTHESES IN THE NETHERLANDS:

1350 CONGINITAL DEFECTS

2400 AQUURED DEFECTS

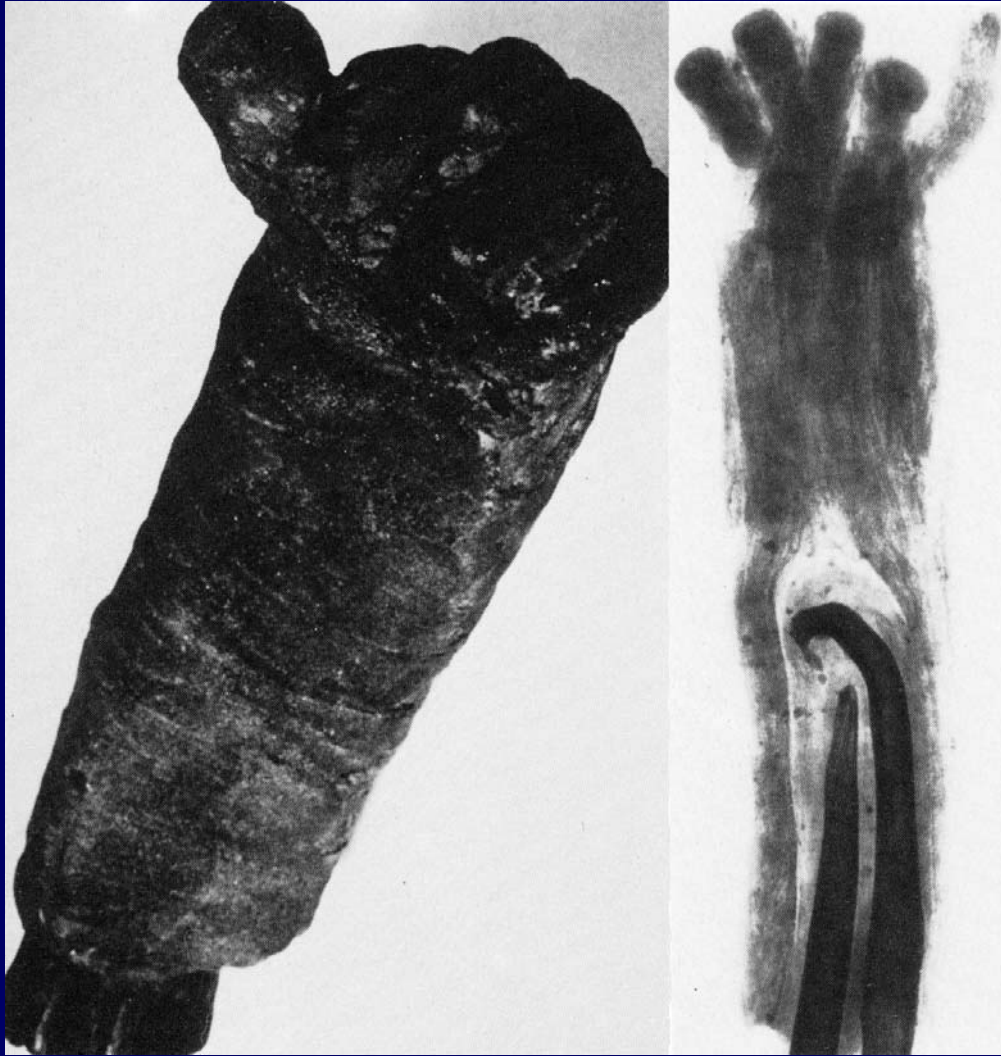
Van Dijk, 2004

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History

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PROSTHESES IN THE PAST



Egypt, 330 BC [Löffler, 1984]

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PROSTHESES IN THE PAST



Florence, 15th century [Löffler, 1984]

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PROSTHESES IN THE PAST

Götz von Berlichingen

1480 - 1562



Götz von Berlichingen, ± 1504 [Löffler, 1984]

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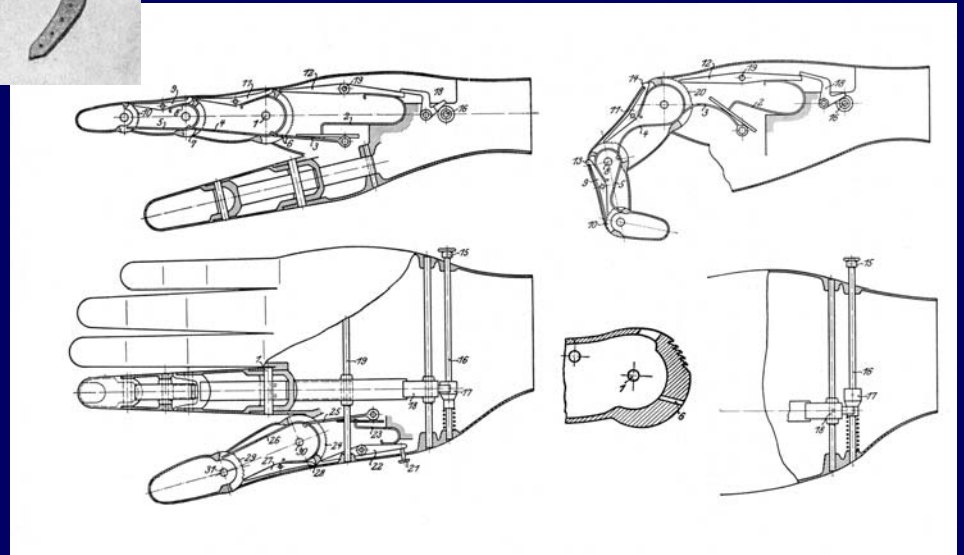
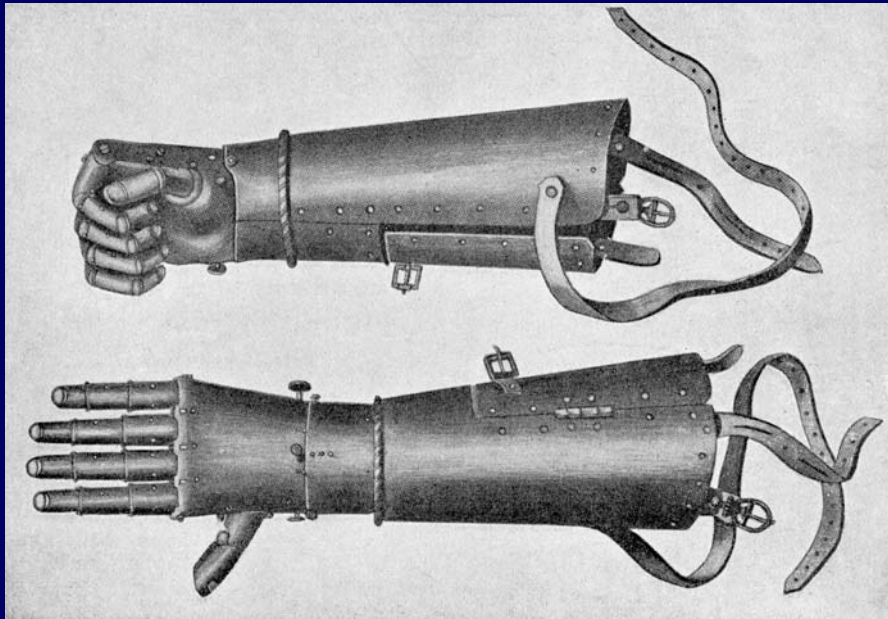
PROSTHESES IN THE PAST



Johann Wolfgang Goethe, 1773

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PROSTHESES IN THE PAST



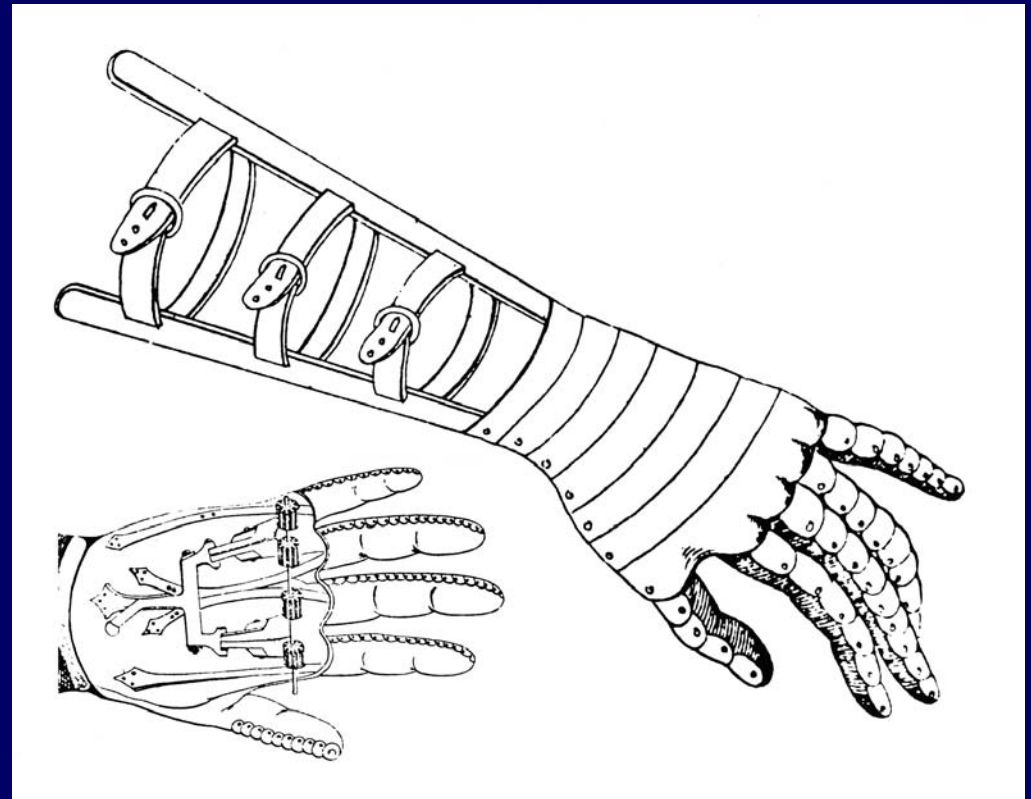
Götz von Berlichingen, 1509 [Borchardt et.al., 1919]

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PROSTHESES IN THE PAST

Ambroise Paré

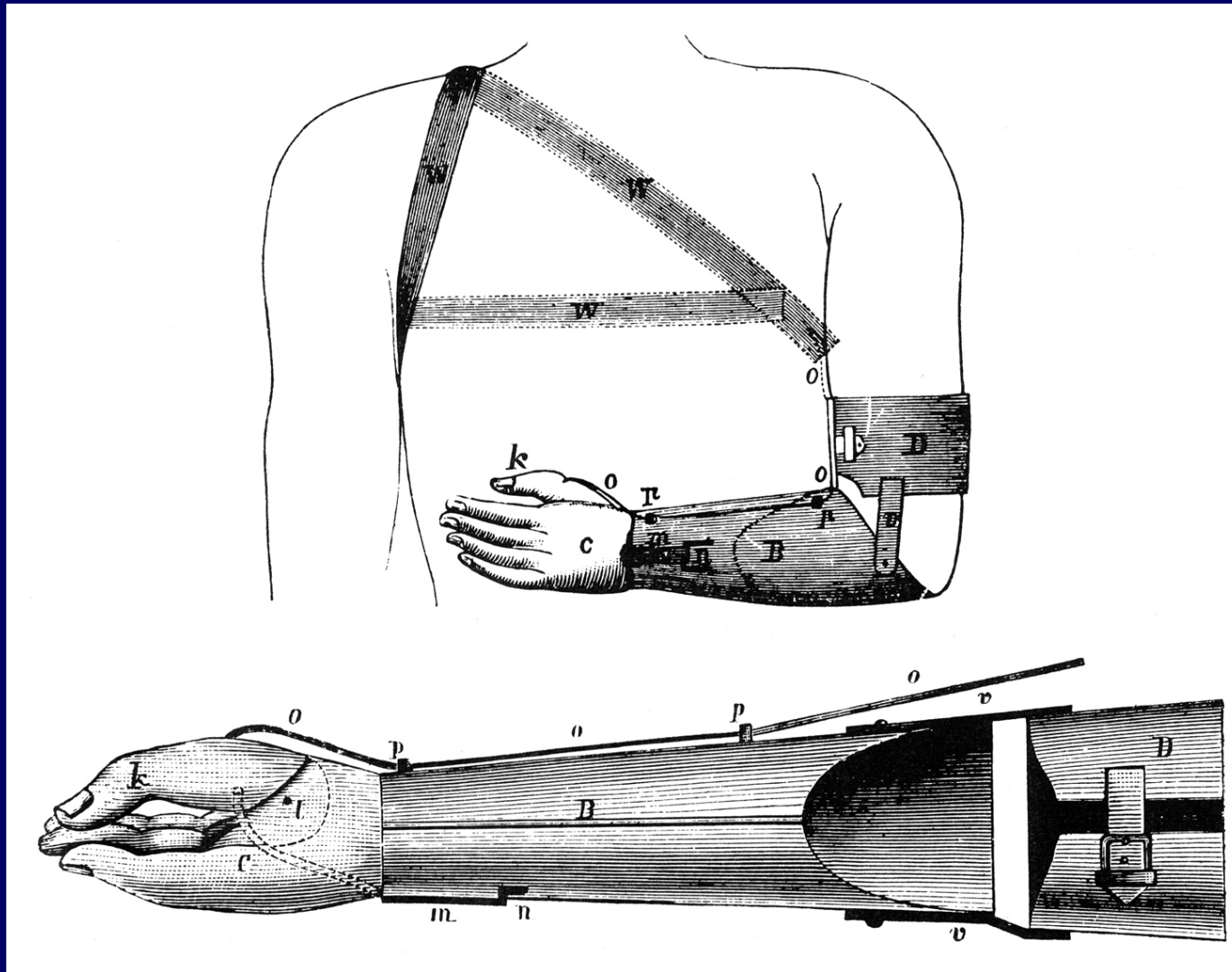
1510 - 1590



Ambroise Paré, 16th century [Löffler, 1984]

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PROSTHESES IN THE PAST

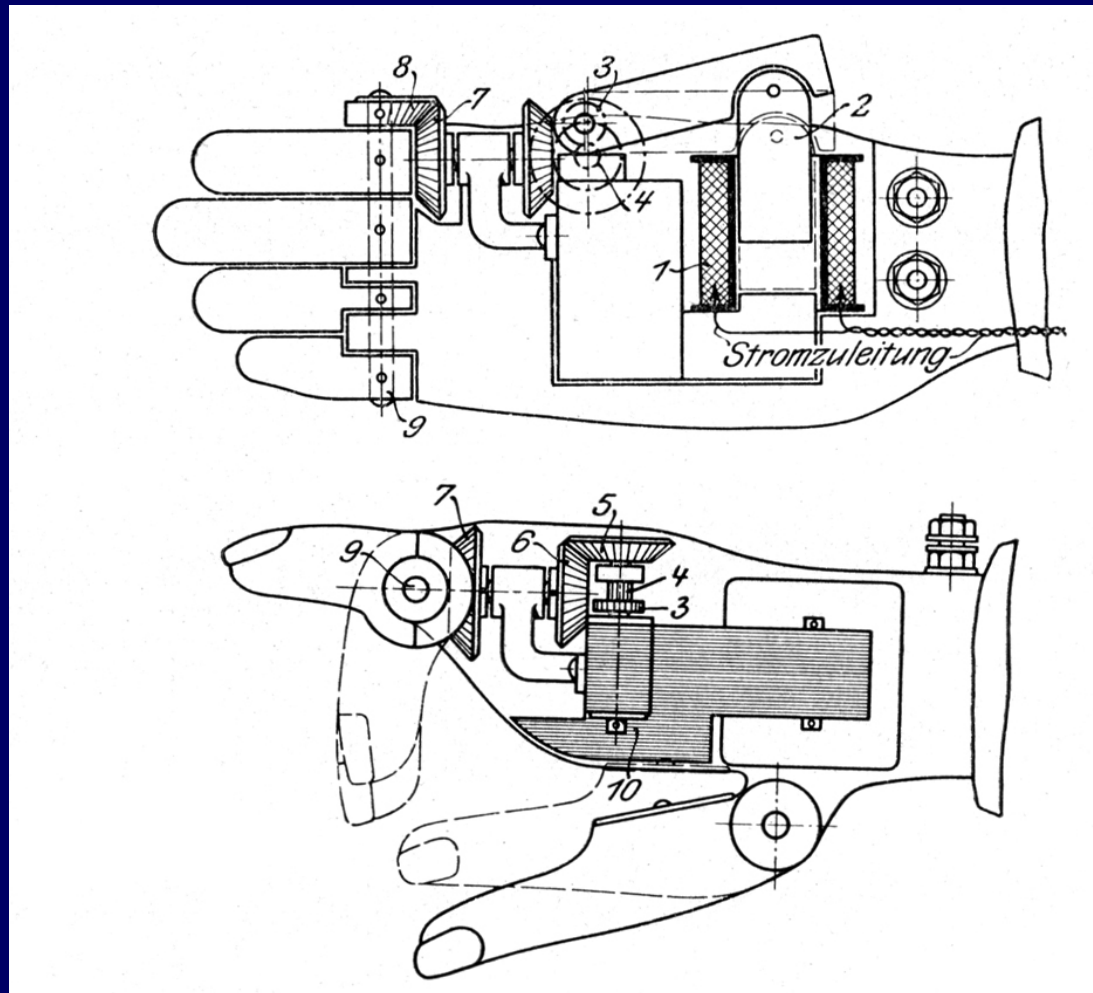


Count of Beaufort, 1860
[Löffler, 1984]

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PROSTHESES IN THE PAST

ELECTRICAL

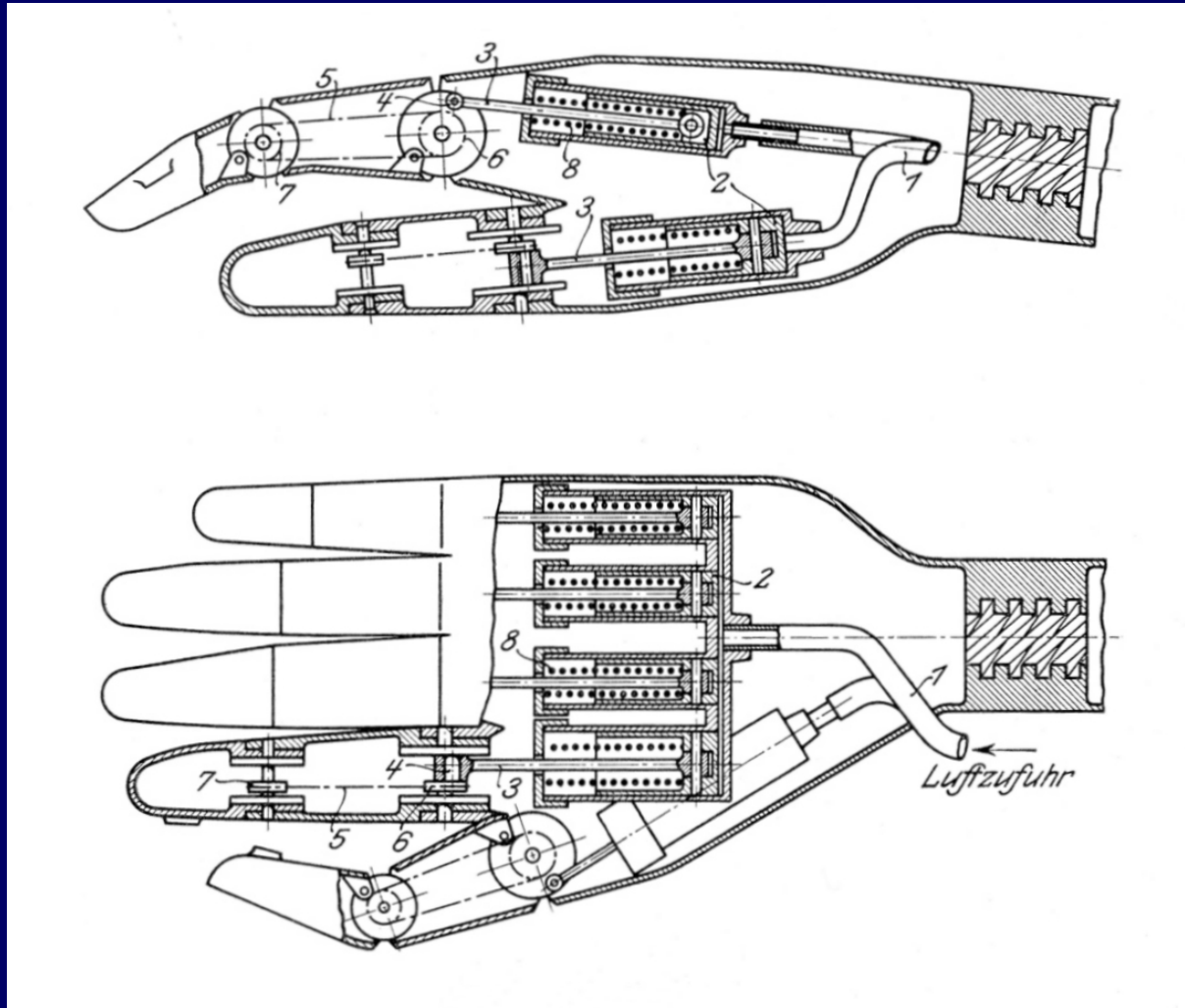


Borchardt et.al., 1919

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PROSTHESES IN THE PAST

PNEUMATICAL



Borchardt et al., 1919

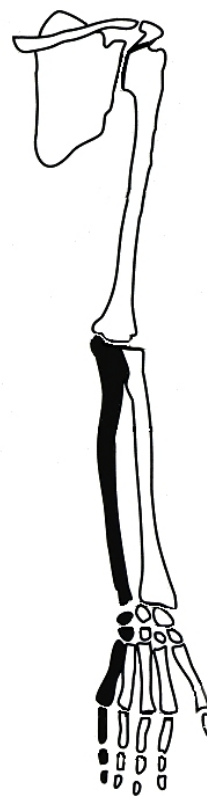
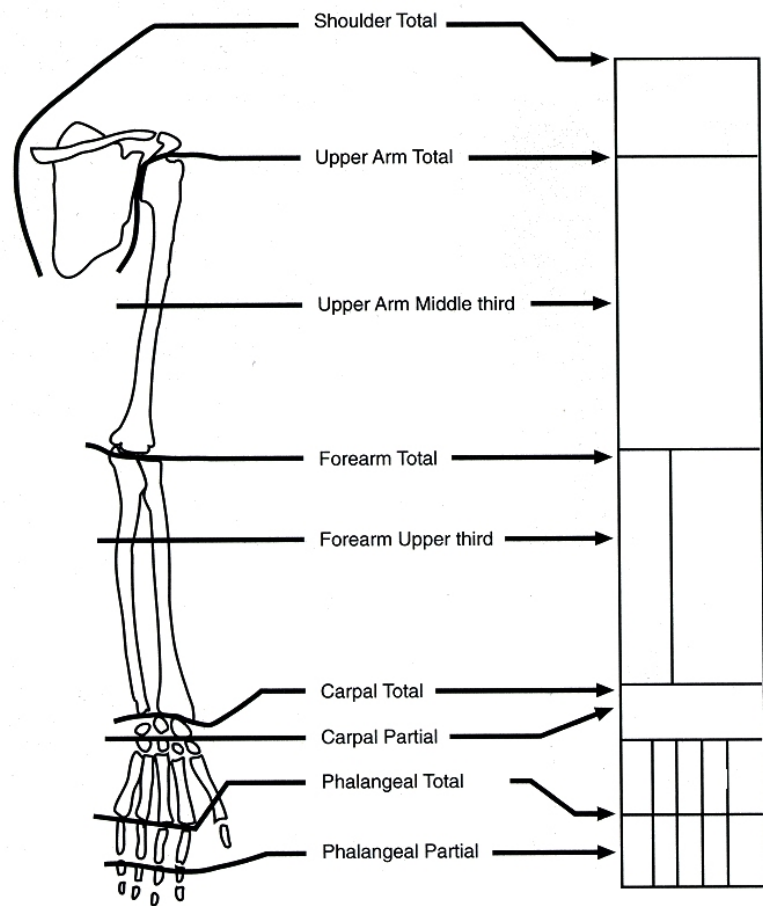
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Classification

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CLASSIFICATION [ISO – 1989]

- congenital
- transverse
- longitudinal



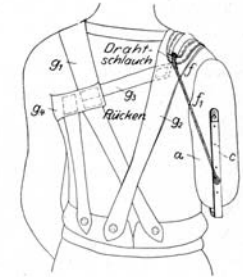
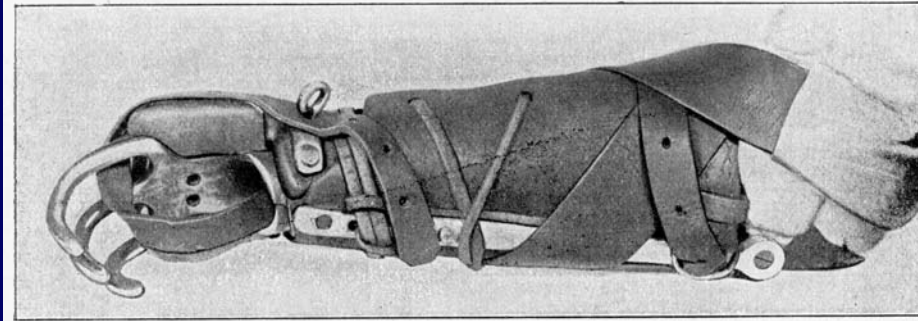
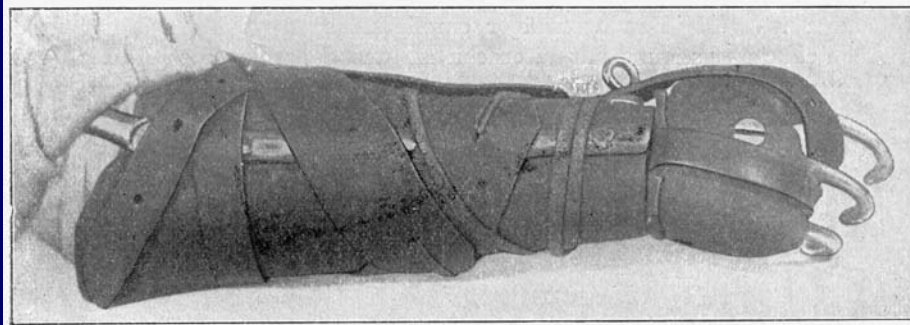
Longitudinal
 Ulna Total
 Carpal Partial
 Ray 5 Total



Suspension

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SUSPENSION

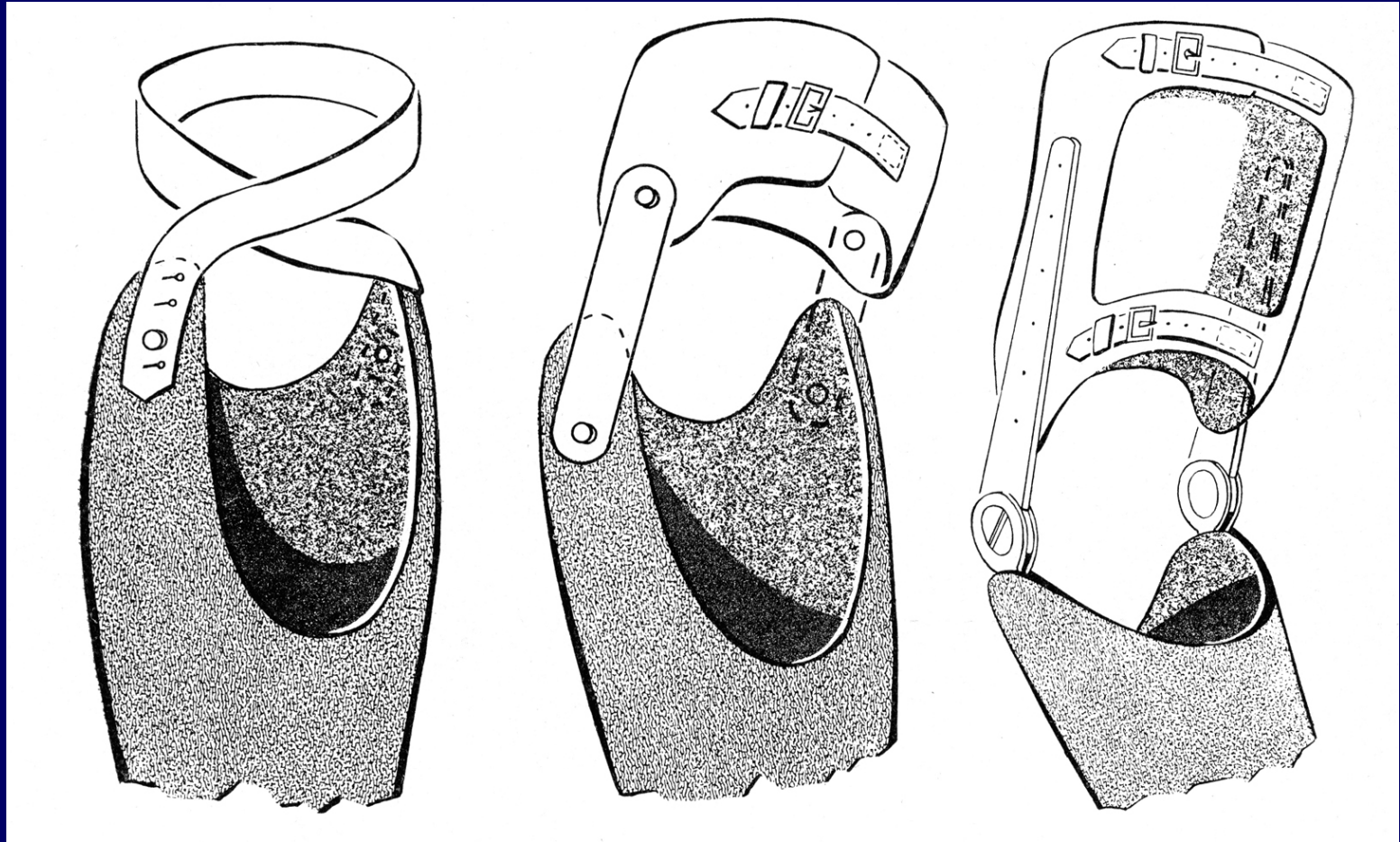


Borchardt et.al., 1919

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SUSPENSION

- BELOW ELBOW PROSTHESES

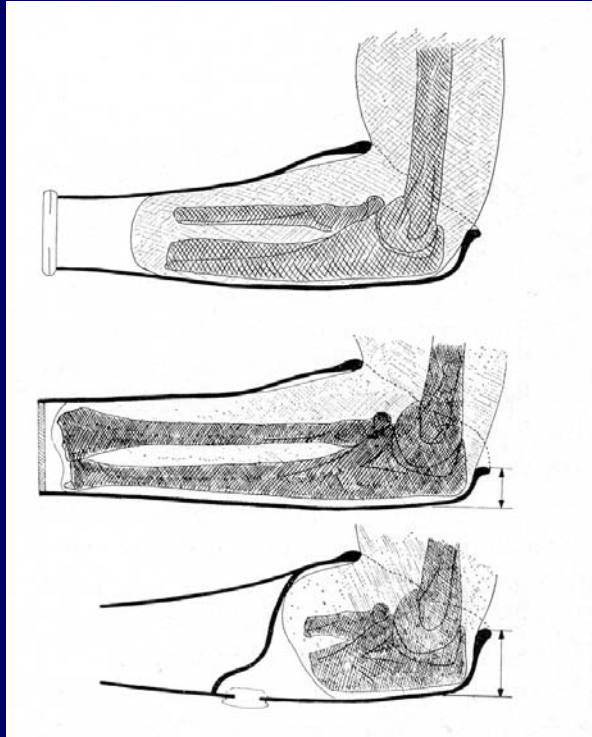


Püschel, 1954

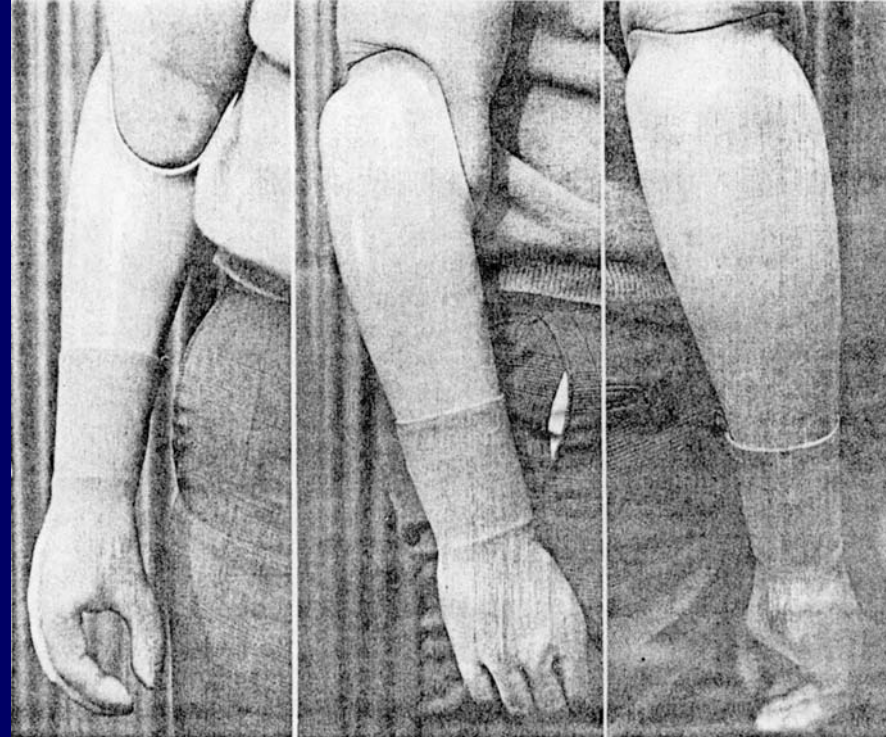
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SUSPENSION

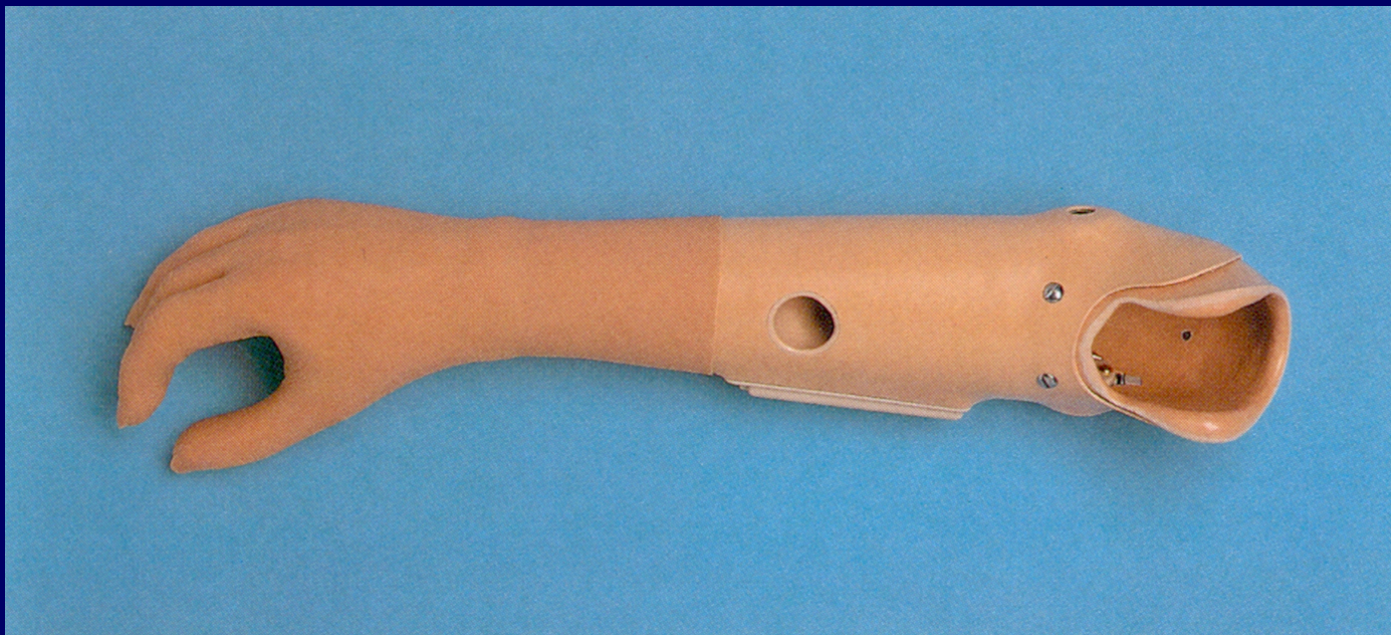
- BELOW ELBOW PROSTHESES



Kuhn, 1968



Billock, 1972

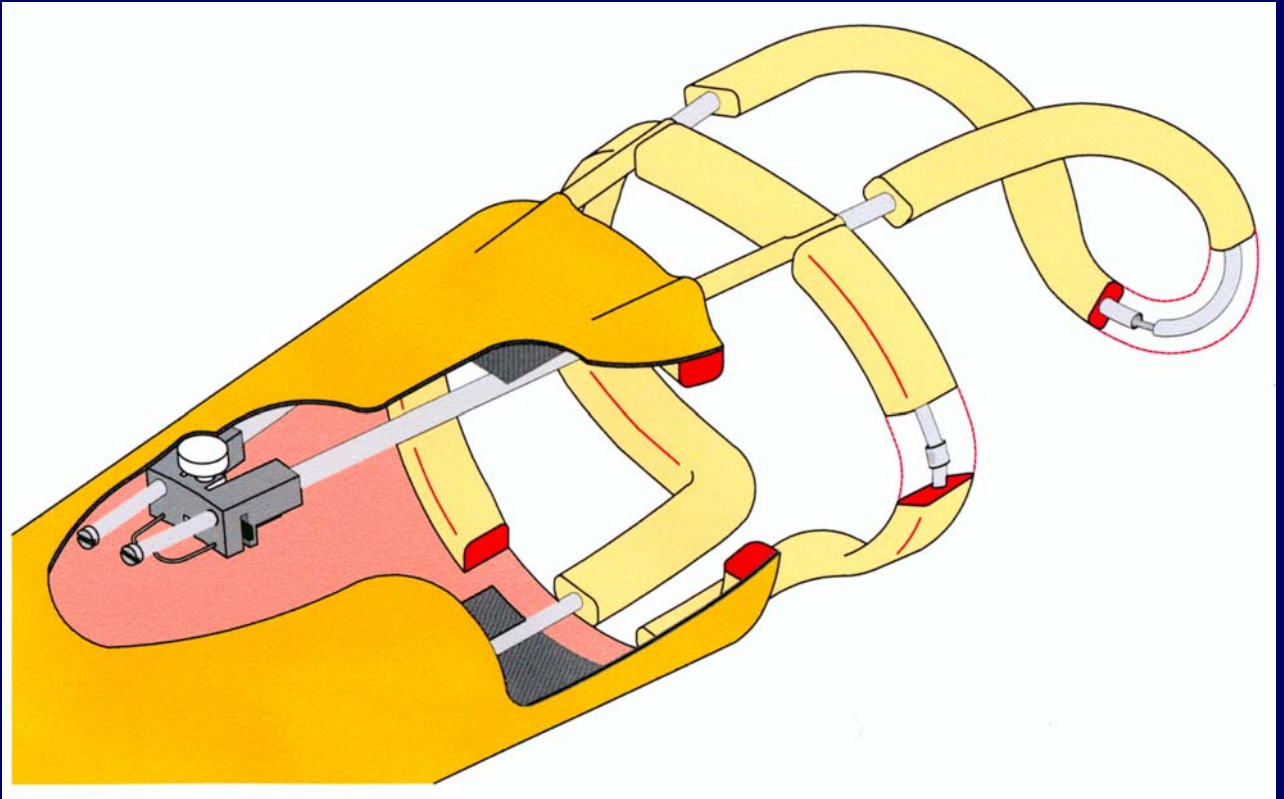


Näder, 1990

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SUSPENSION

- BELOW ELBOW PROSTHESES

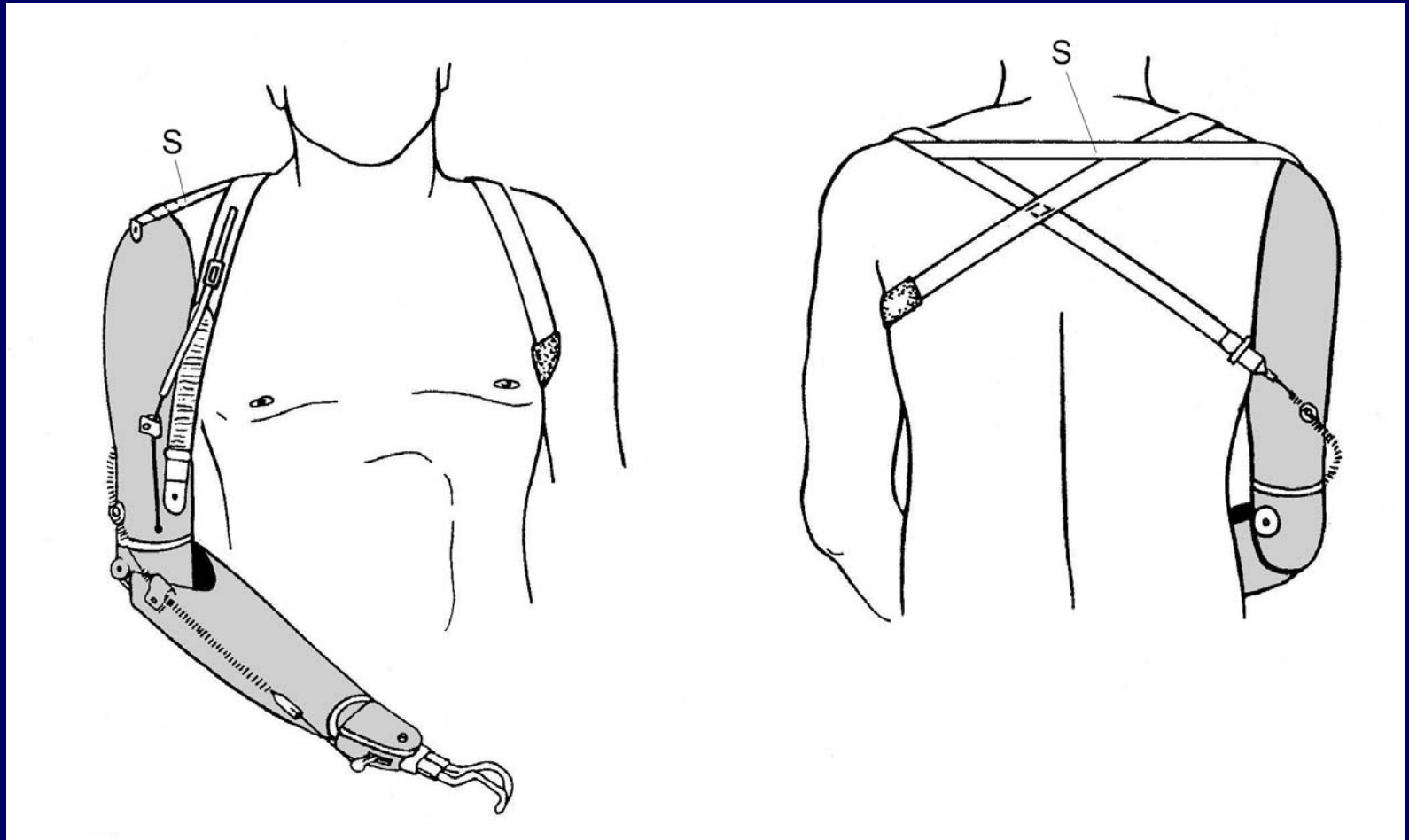


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SUSPENSION

- ABOVE ELBOW PROSTHESES

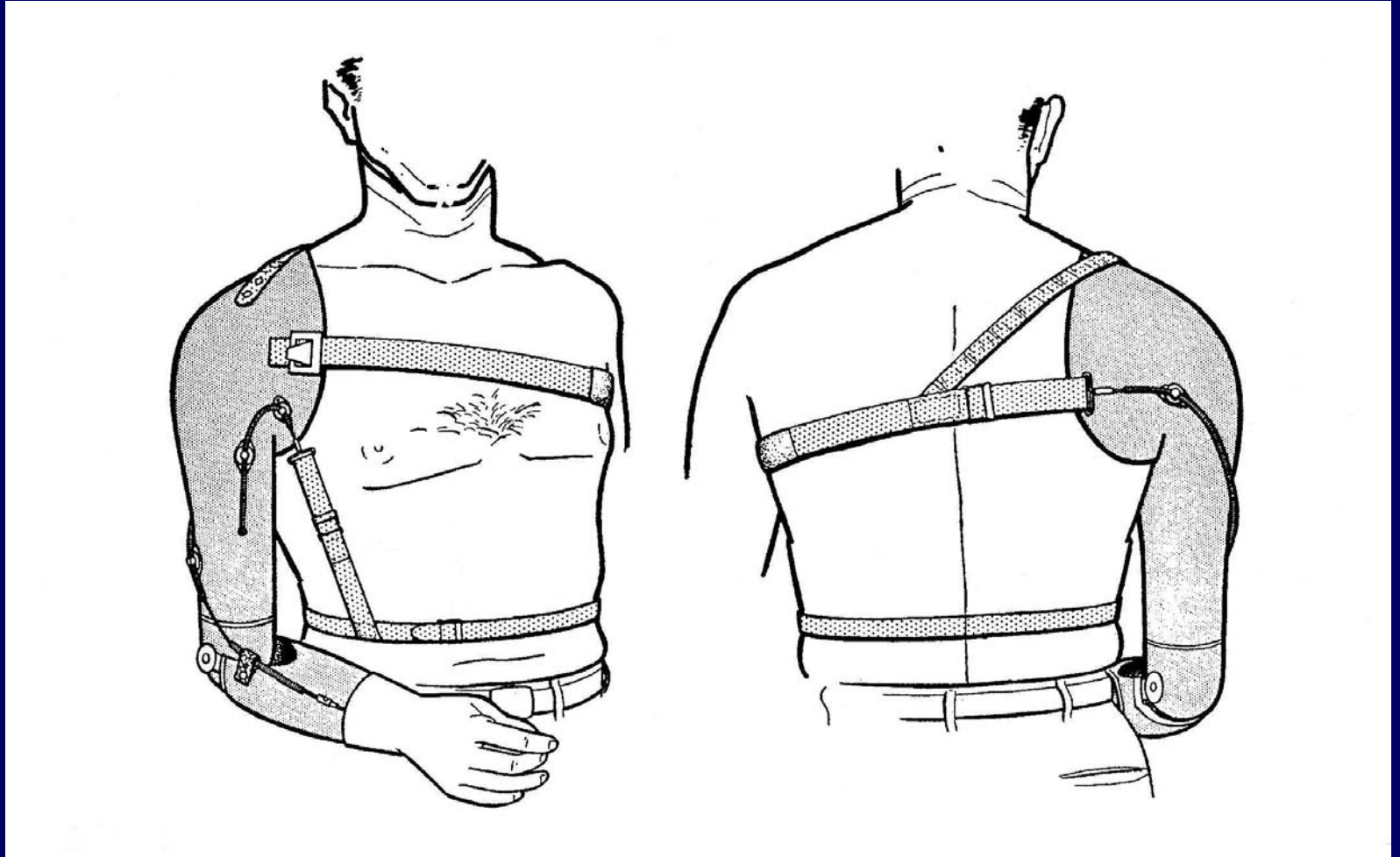


Bowker & Michael, 1992

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SUSPENSION

- SHOULDER DISARTICULATION PROSTHESES



Bowker & Michael, 1992

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SUSPENSION

- SHOULDER DISARTICULATION PROSTHESES



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SUSPENSION

- SILICONE ROLL-ON SOCKET BELOW ELBOW PROSTHESES



Össur, Iceland

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SUSPENSION

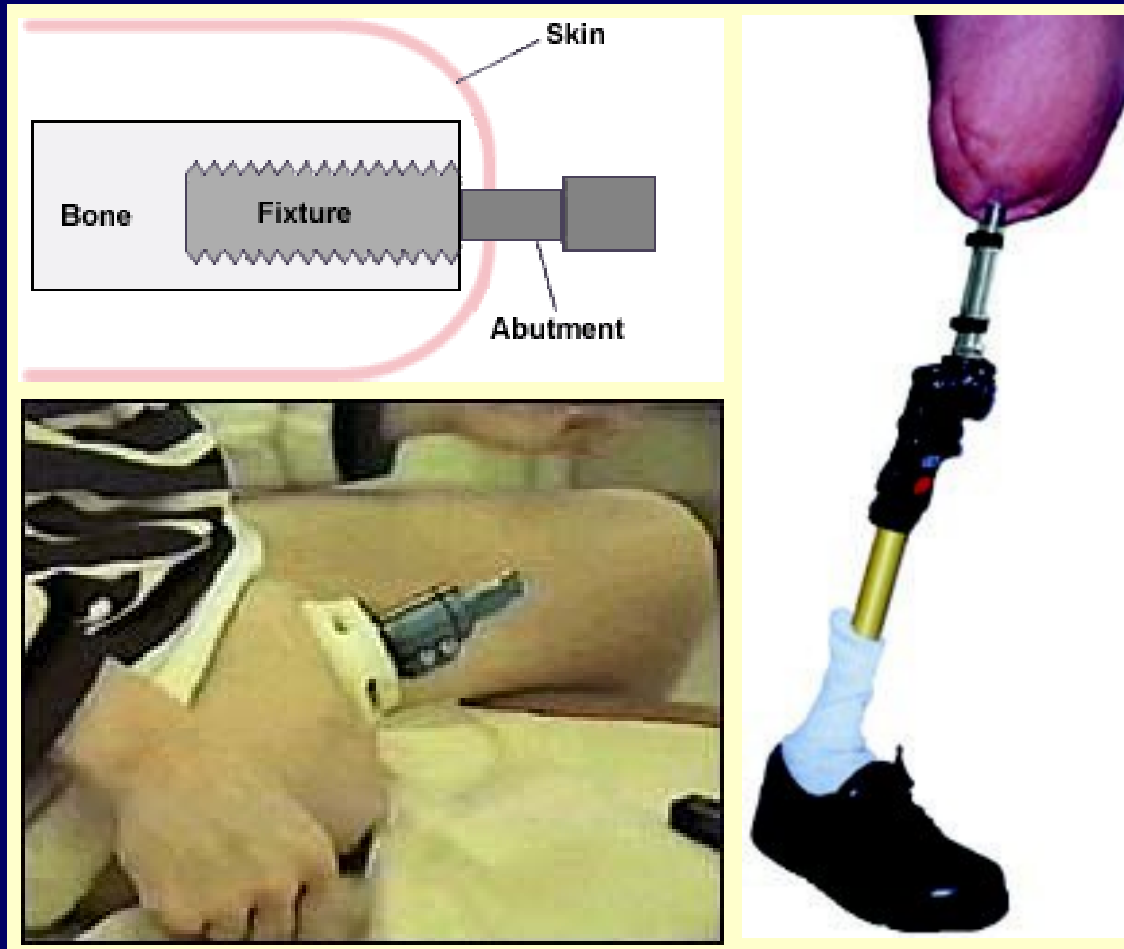
- SILICONE ROLL-ON SOCKET ABOVE ELBOW



Sears & Rendi, 1999

SUSPENSION

- EXPERIMENTAL: OSSEOINTEGRATION



Dr. P-I Brånemark, Sweden

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SUSPENSION

- EXPERIMENTAL: OSSEOINTEGRATION



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SUSPENSION

- EXPERIMENTAL: OSSEOINTEGRATION



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Available prostheses

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PROSTHESES

CONTROL

ALWAYS BY THE BODY

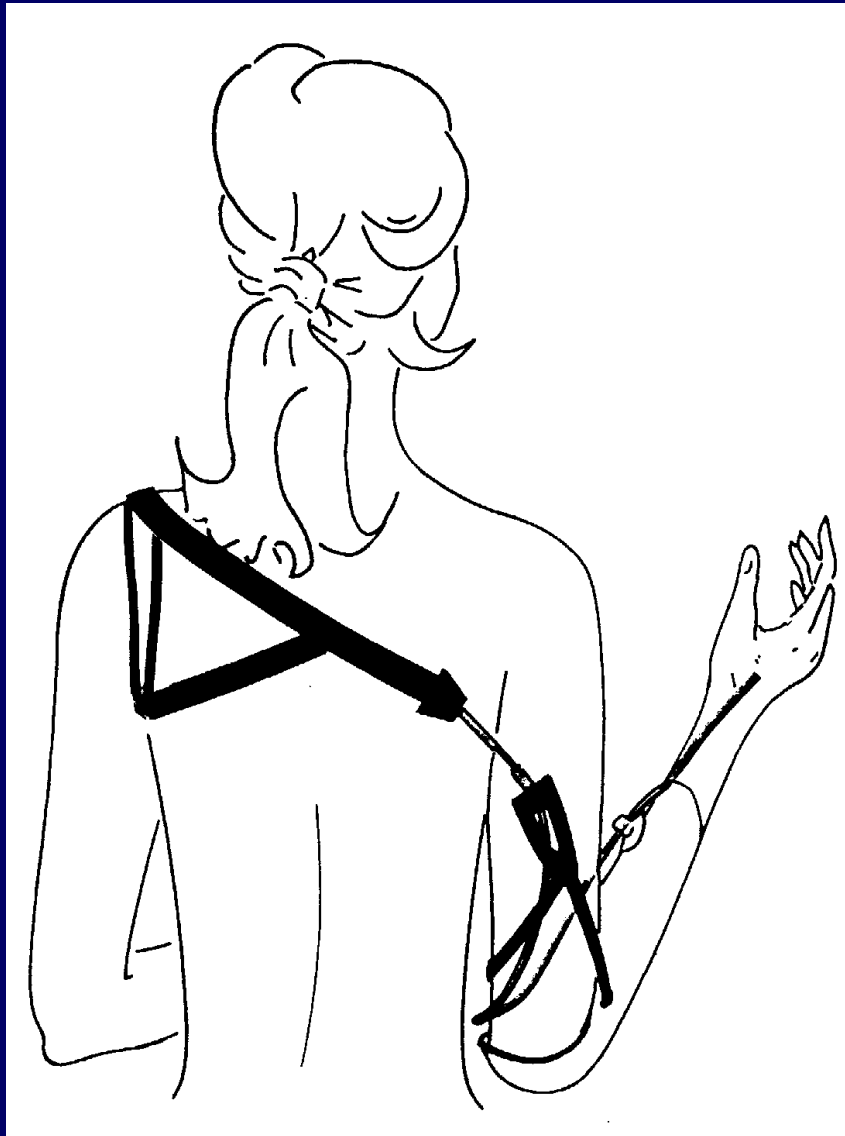
MECHANICAL

ELECTRICAL

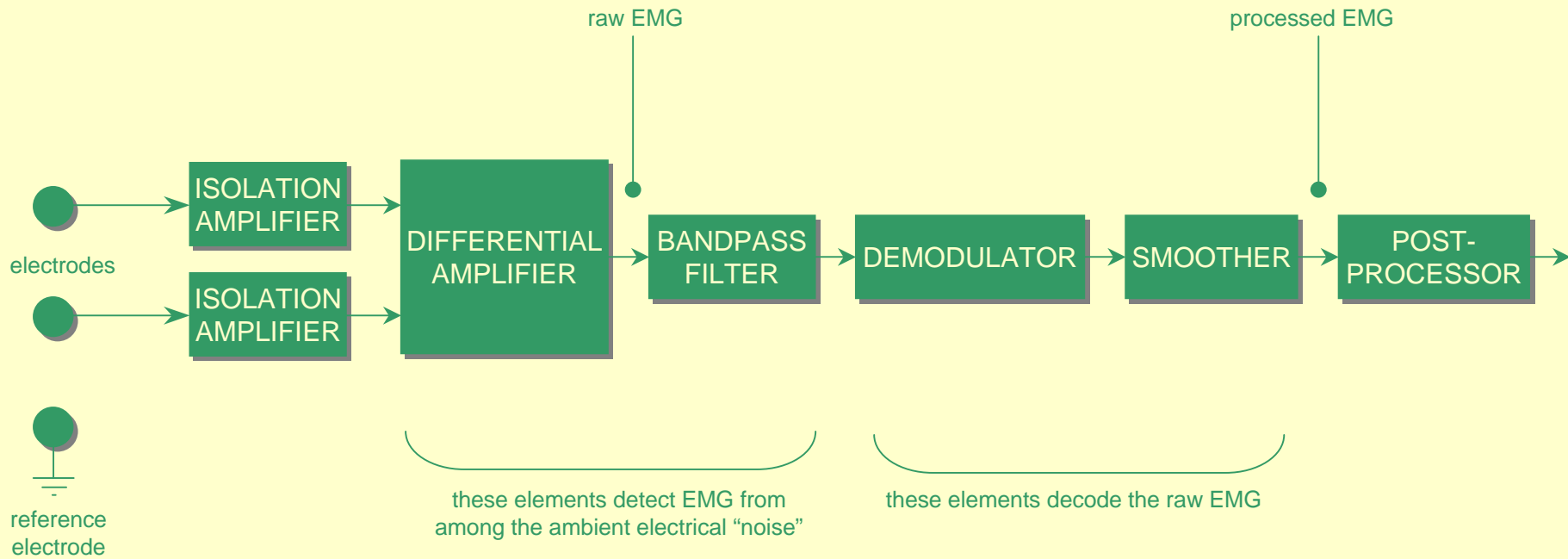
POWER

FROM THE BODY

EXTERNALLY



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TYPES OF PROSTHESES

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PARTIAL HAND PROSTHESES

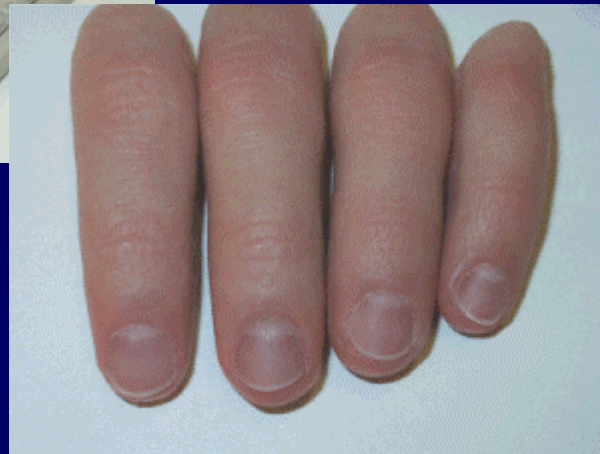
- FINGER[S]



Buckner & Michael, 1993

PARTIAL HAND PROSTHESES

- FINGER[S]

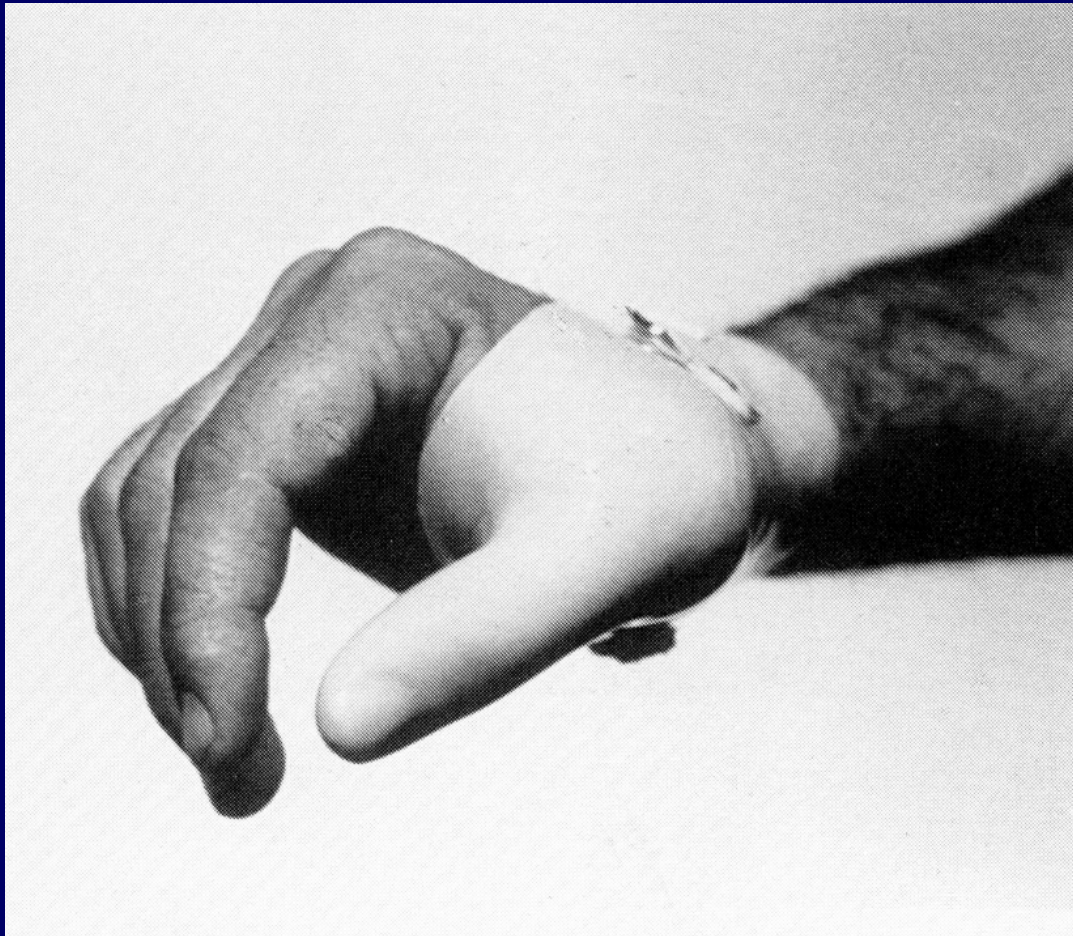


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PARTIAL HAND PROSTHESES

- THUMB

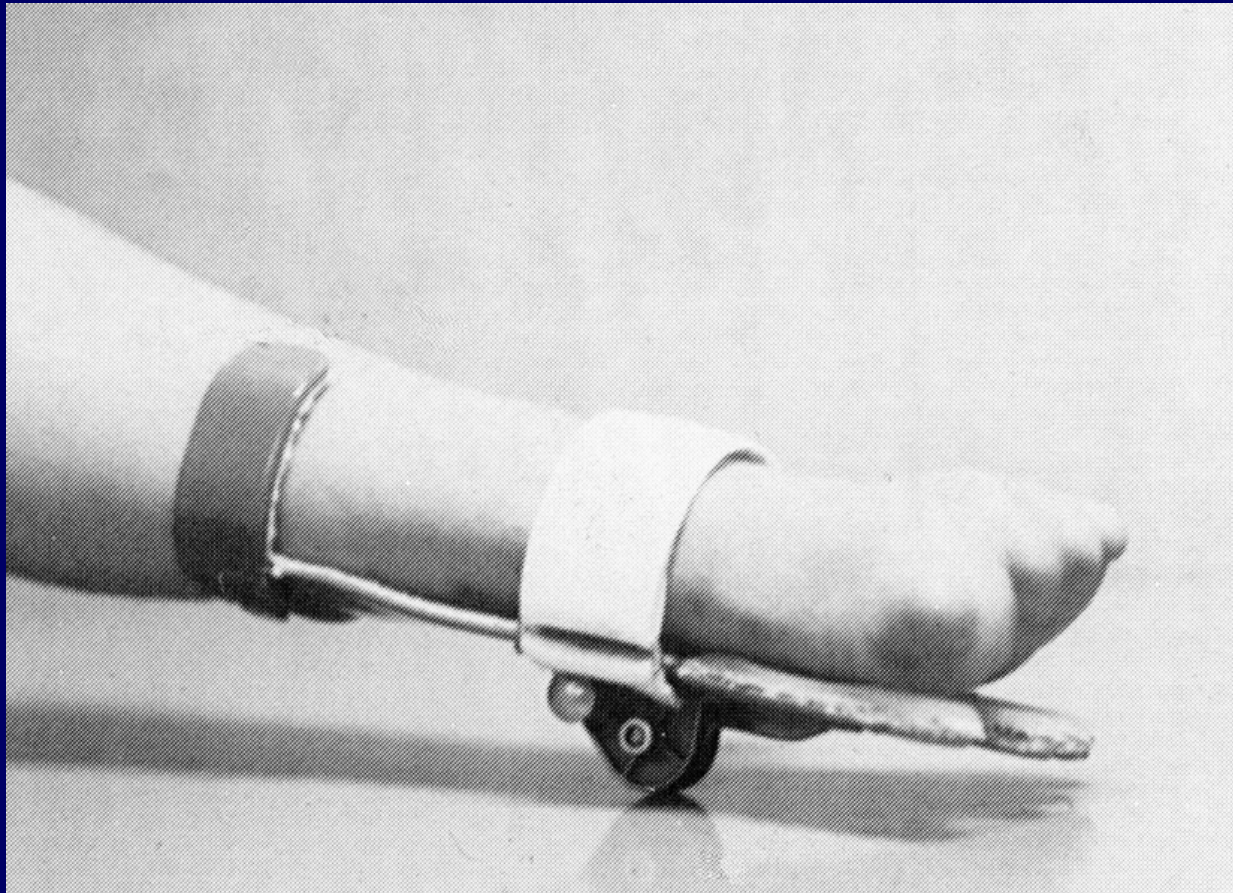


Atkins & Meier, 1989

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PARTIAL HAND PROSTHESES

- TRANSMETACARPAL

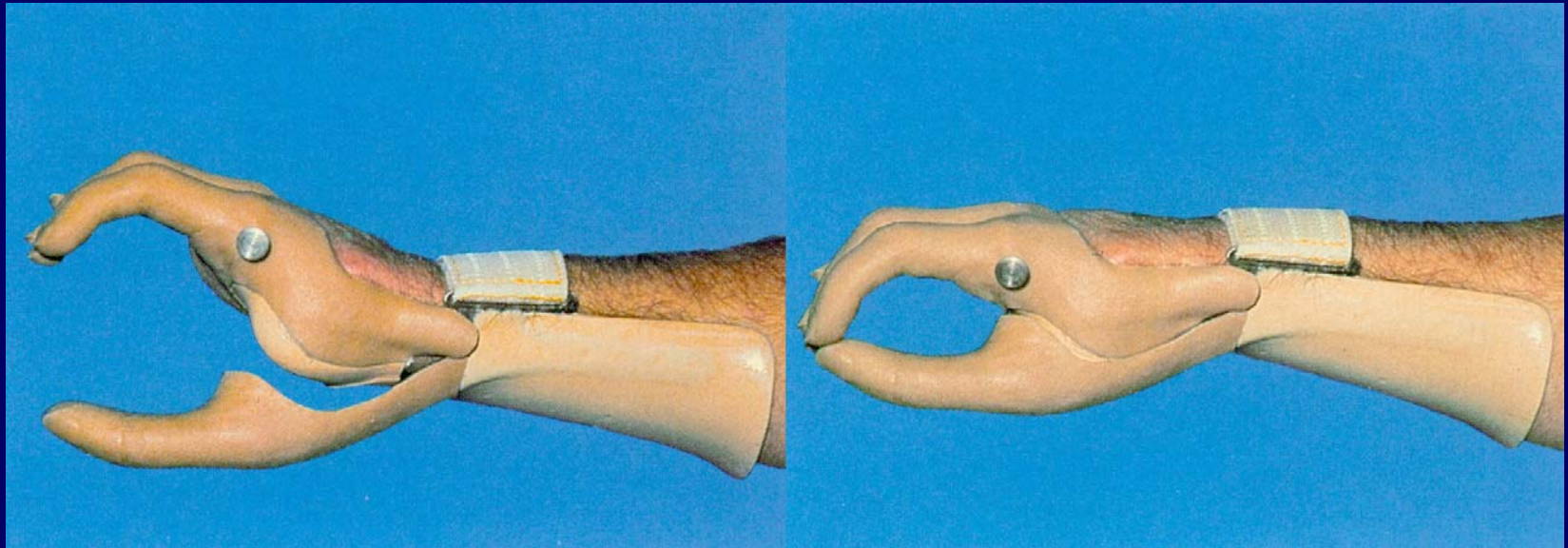


Atkins & Meier, 1989

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PARTIAL HAND PROSTHESES

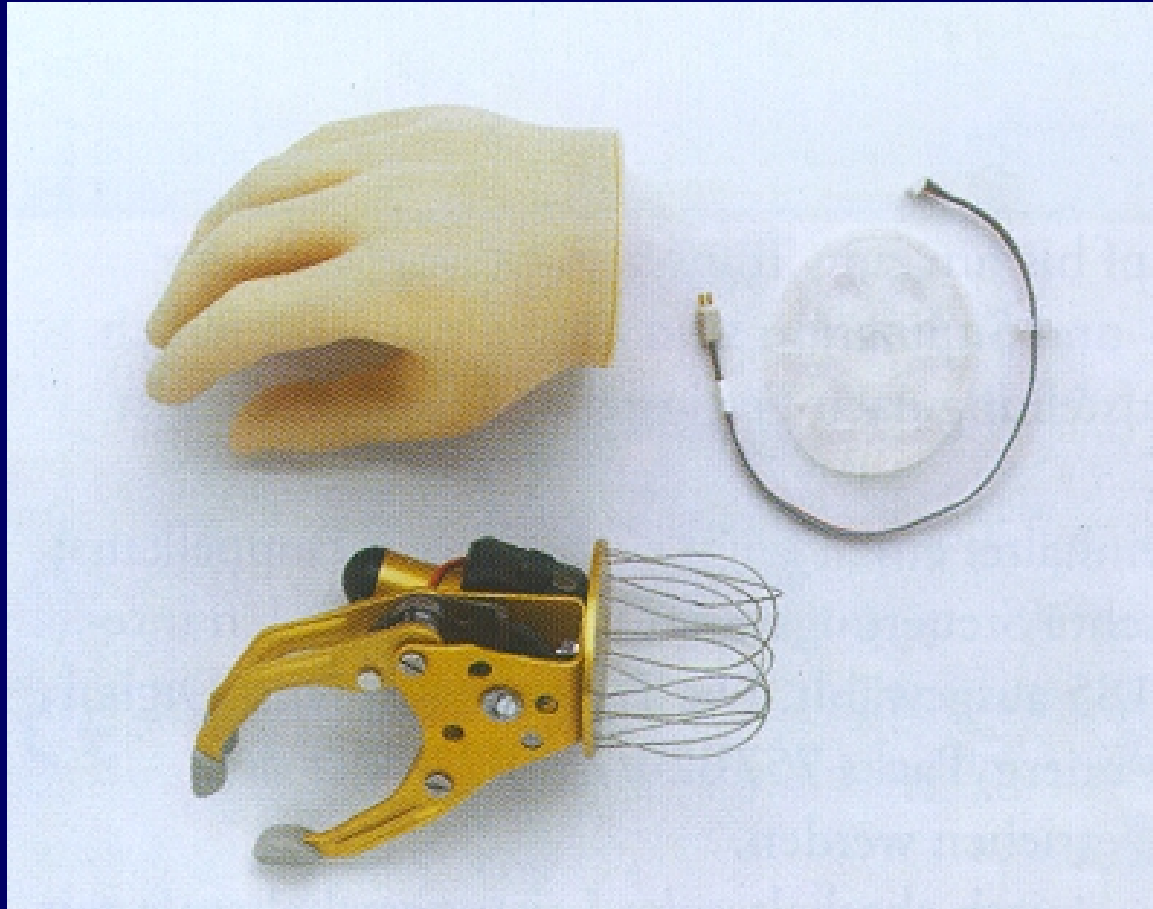
- TRANSMETACARPAL



Näder, 1990

PARTIAL HAND PROSTHESES

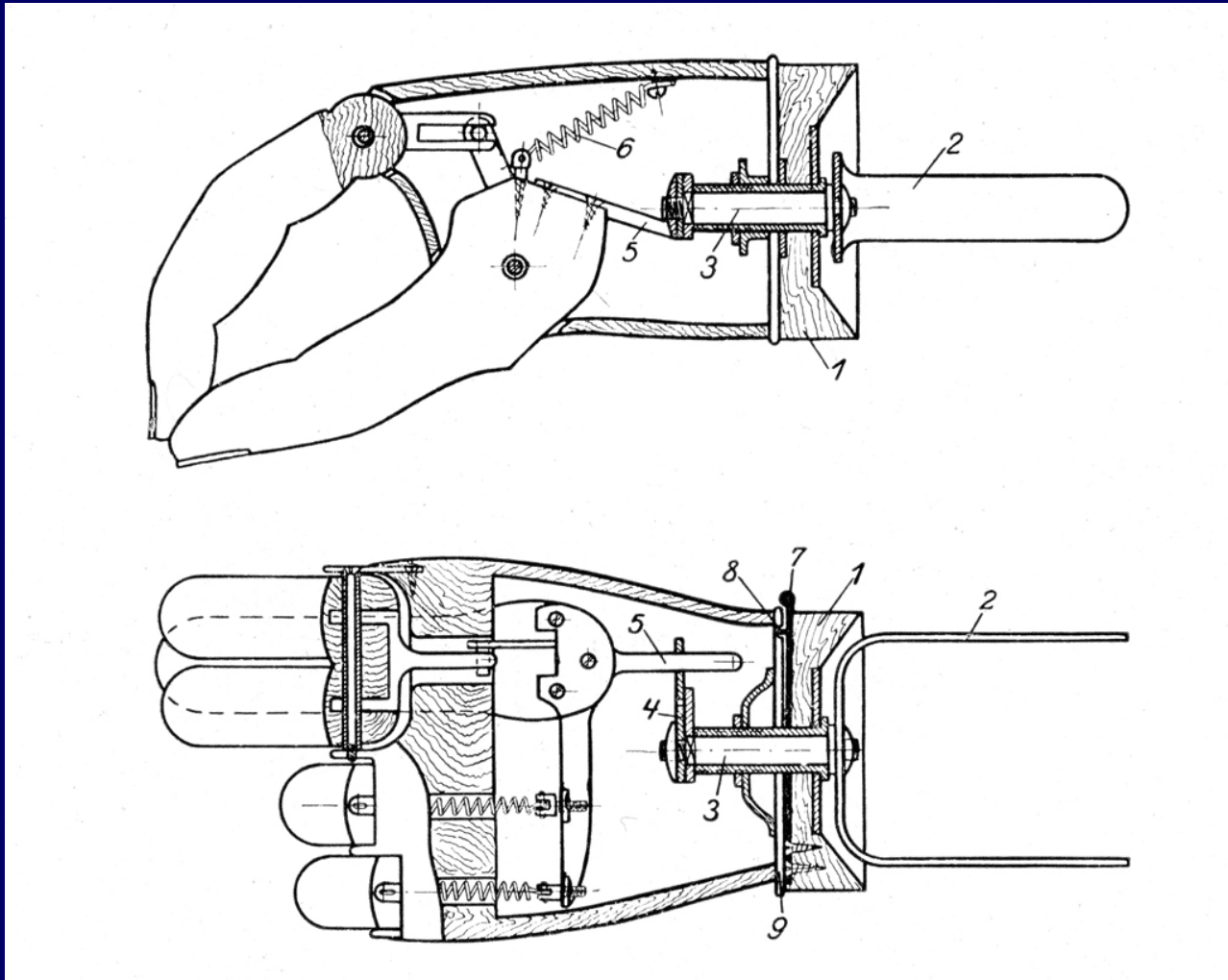
- TRANSMETACARPAL



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WRIST DISARTICULATION PROSTHESES



Borchardt et.al., 1919

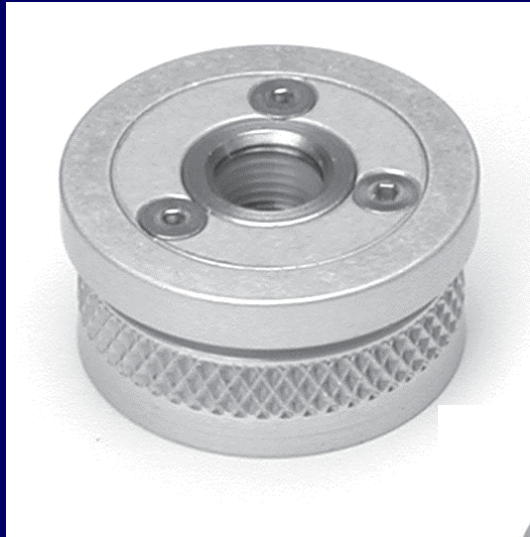
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BELOW ELBOW PROSTHESES

- SOCKET
- WRIST
- TERMINAL DEVICE: HAND
HOOK
TOOL

BELOW ELBOW PROSTHESES

- WRIST PROSTHESES



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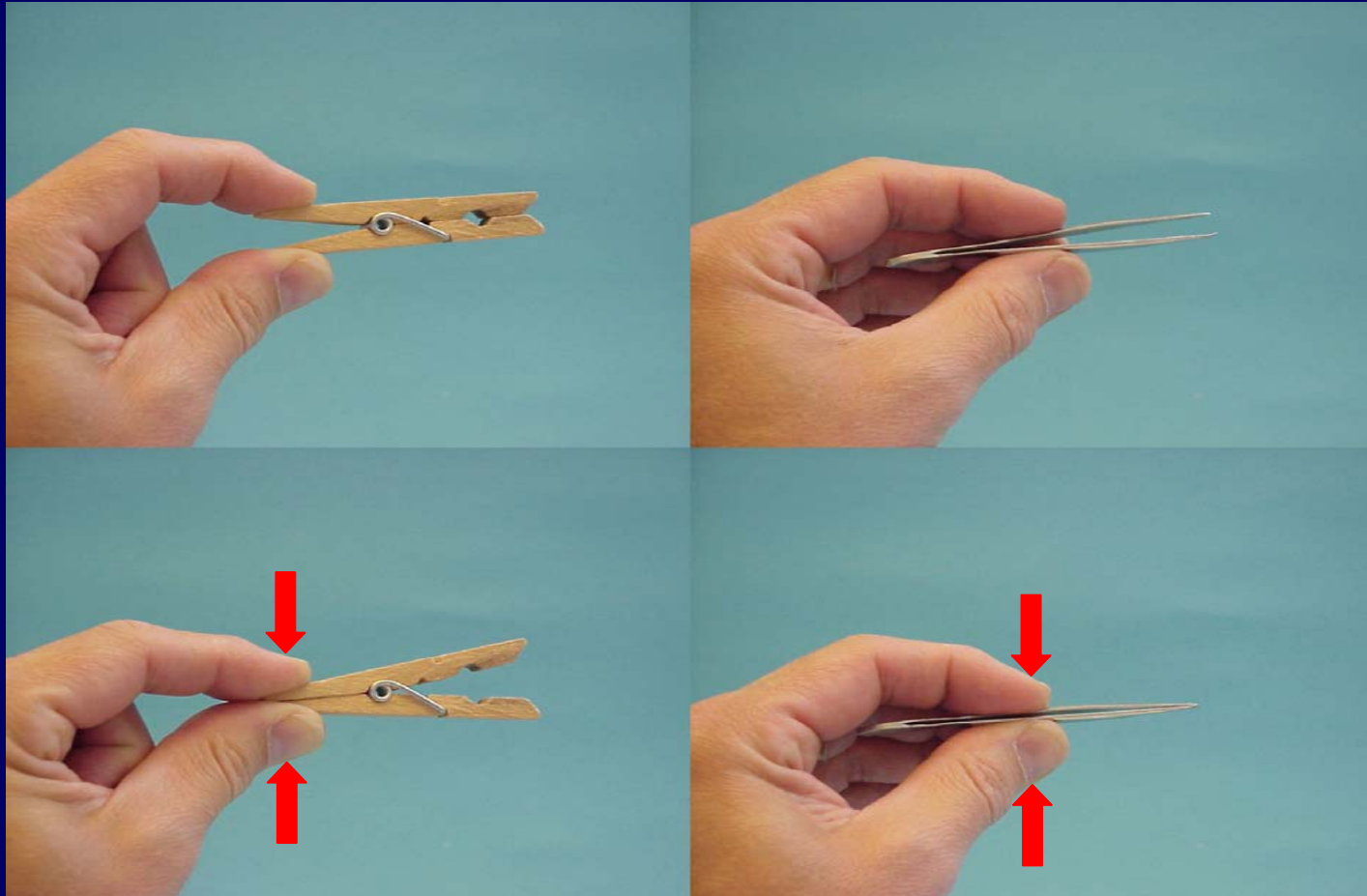


Hosmer Dorrance Co., USA



BELOW ELBOW PROSTHESES

- VOLUNTARY OPENING vs VOLUNTARY CLOSING



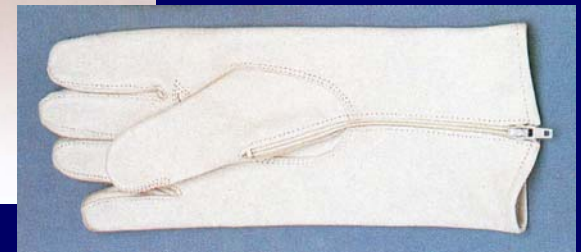
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BELOW ELBOW PROSTHESES

- COSMETIC GLOVES



RSL-Steeper, UK



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BELOW ELBOW PROSTHESES

- BODY POWERED TERMINAL DEVICES - HOOKS



Bowker & Michael, 1992

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- BODY POWERED TERMINAL DEVICES - HOOKS



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- BODY POWERED TERMINAL DEVICES - HOOKS



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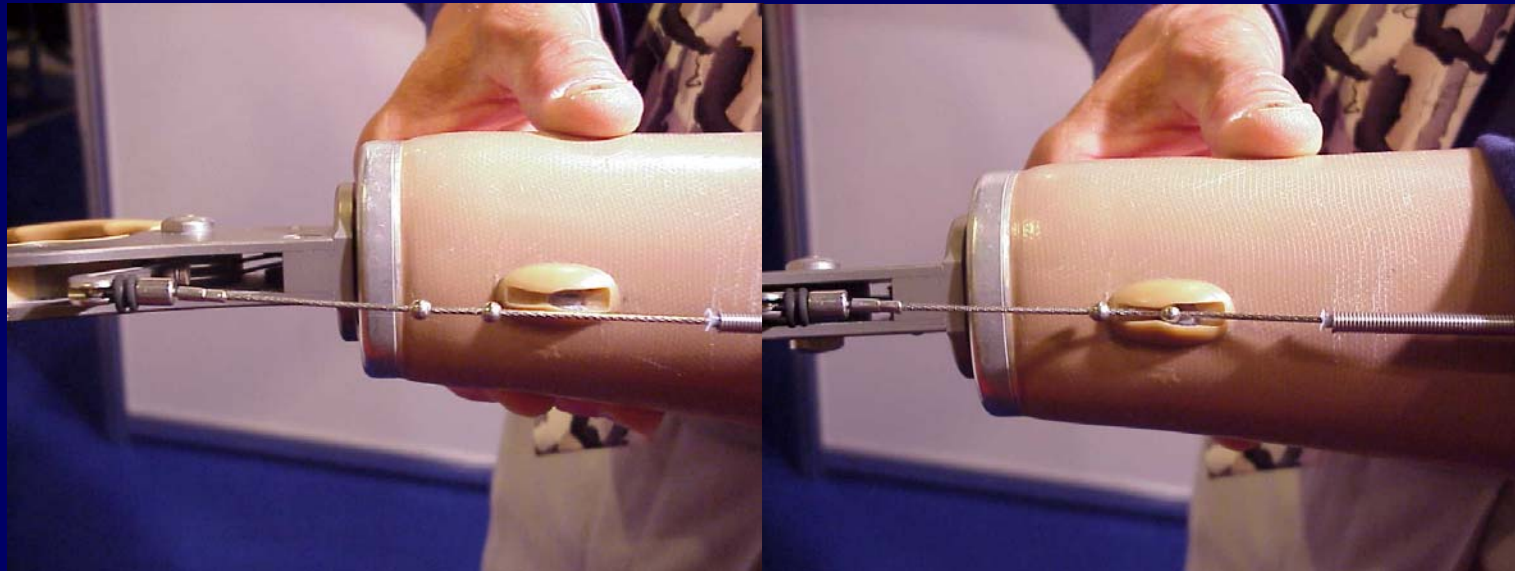


TRS Inc., USA

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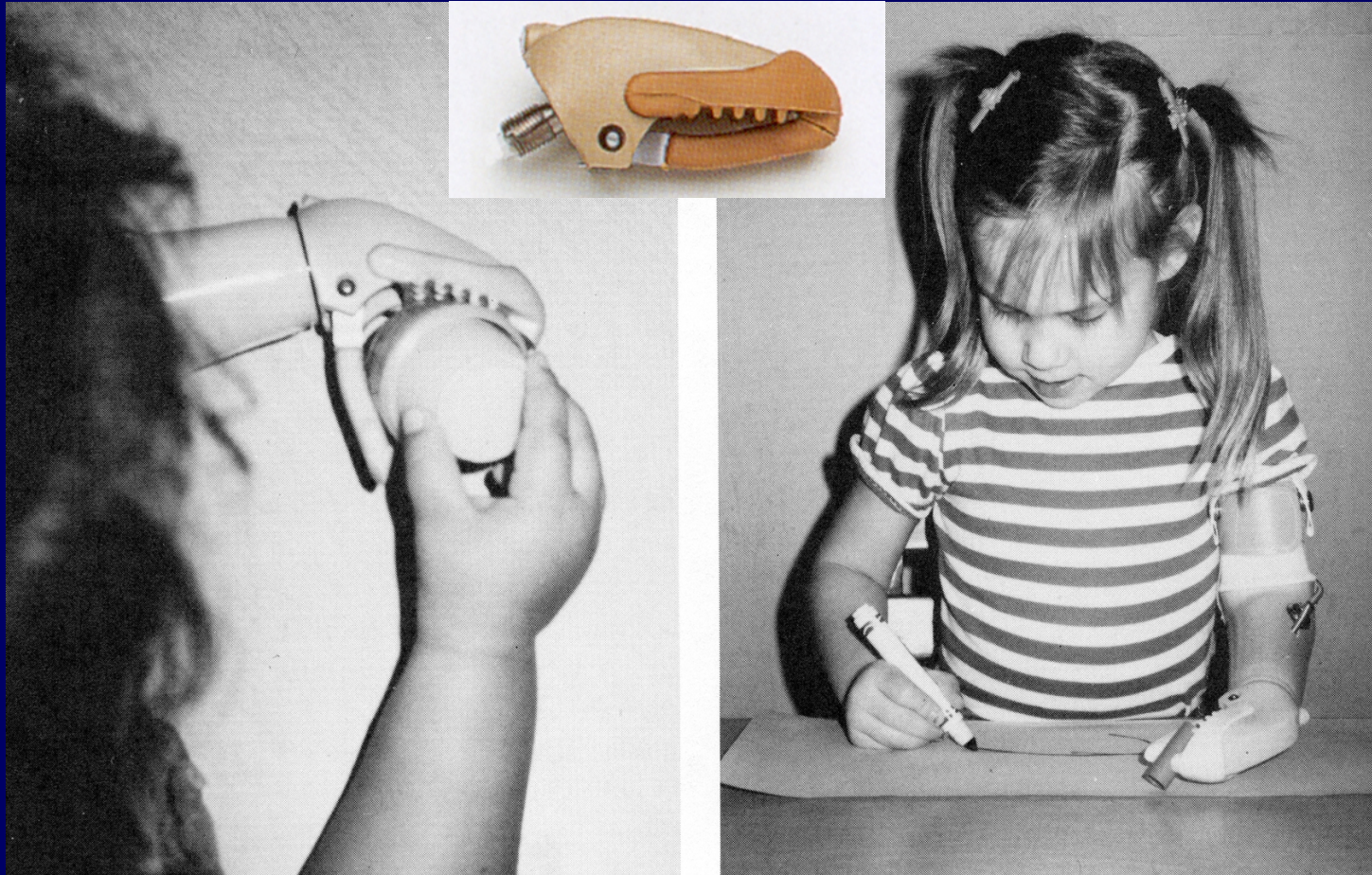
- BODY POWERED TERMINAL DEVICES - HOOKS



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BELOW ELBOW PROSTHESES

- BODY POWERED TERMINAL DEVICES



Atkins & Meier, 1989 Insert: Hosmer Dorrance Co., USA

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BELOW ELBOW PROSTHESES

- BODY POWERED TERMINAL DEVICES - HANDS

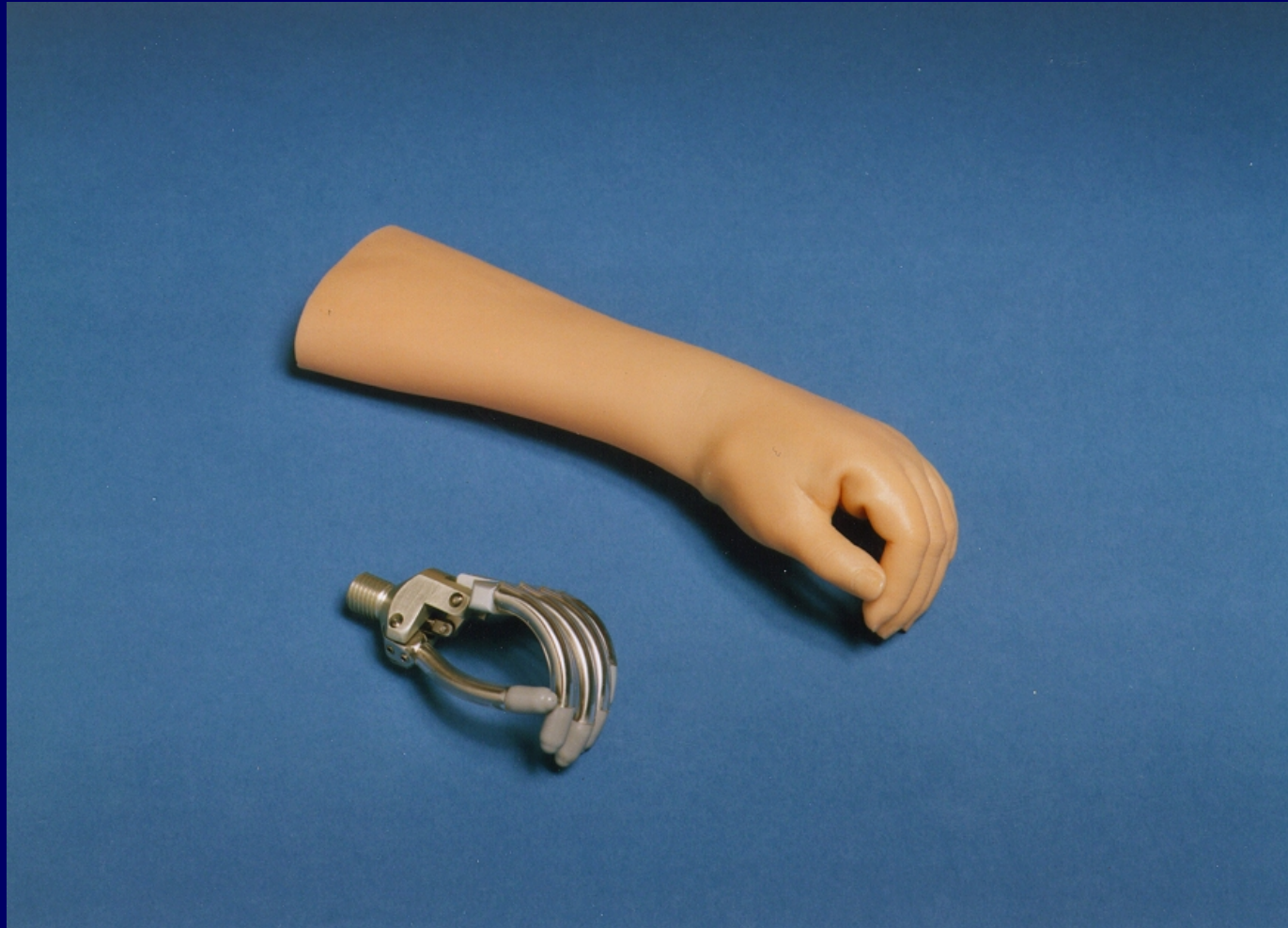


Näder, 1990

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- BODY POWERED TERMINAL DEVICES - HANDS

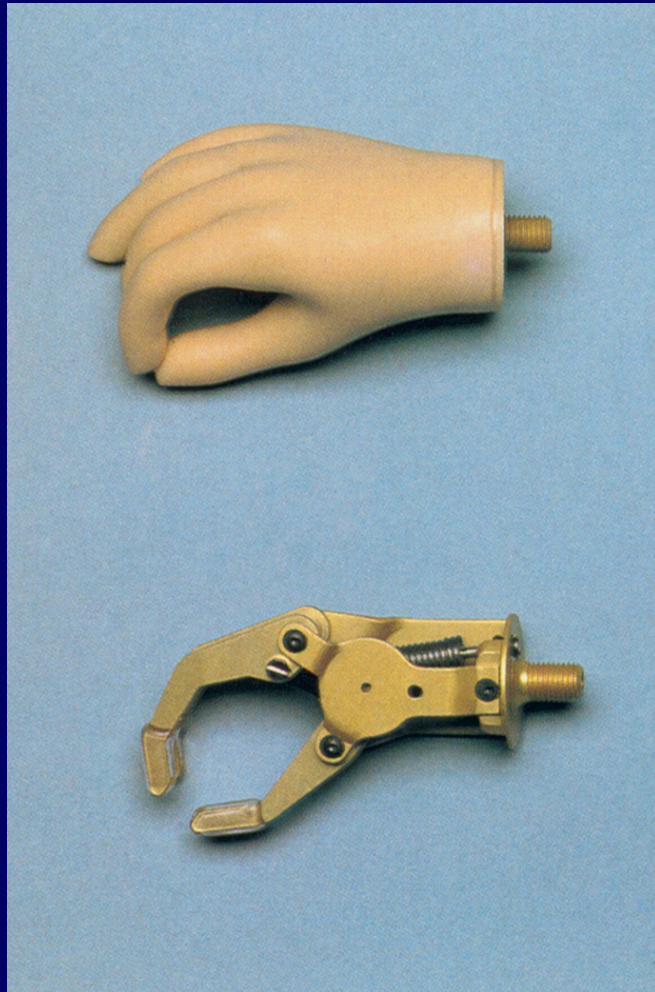


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- BODY POWERED TERMINAL DEVICES - HANDS

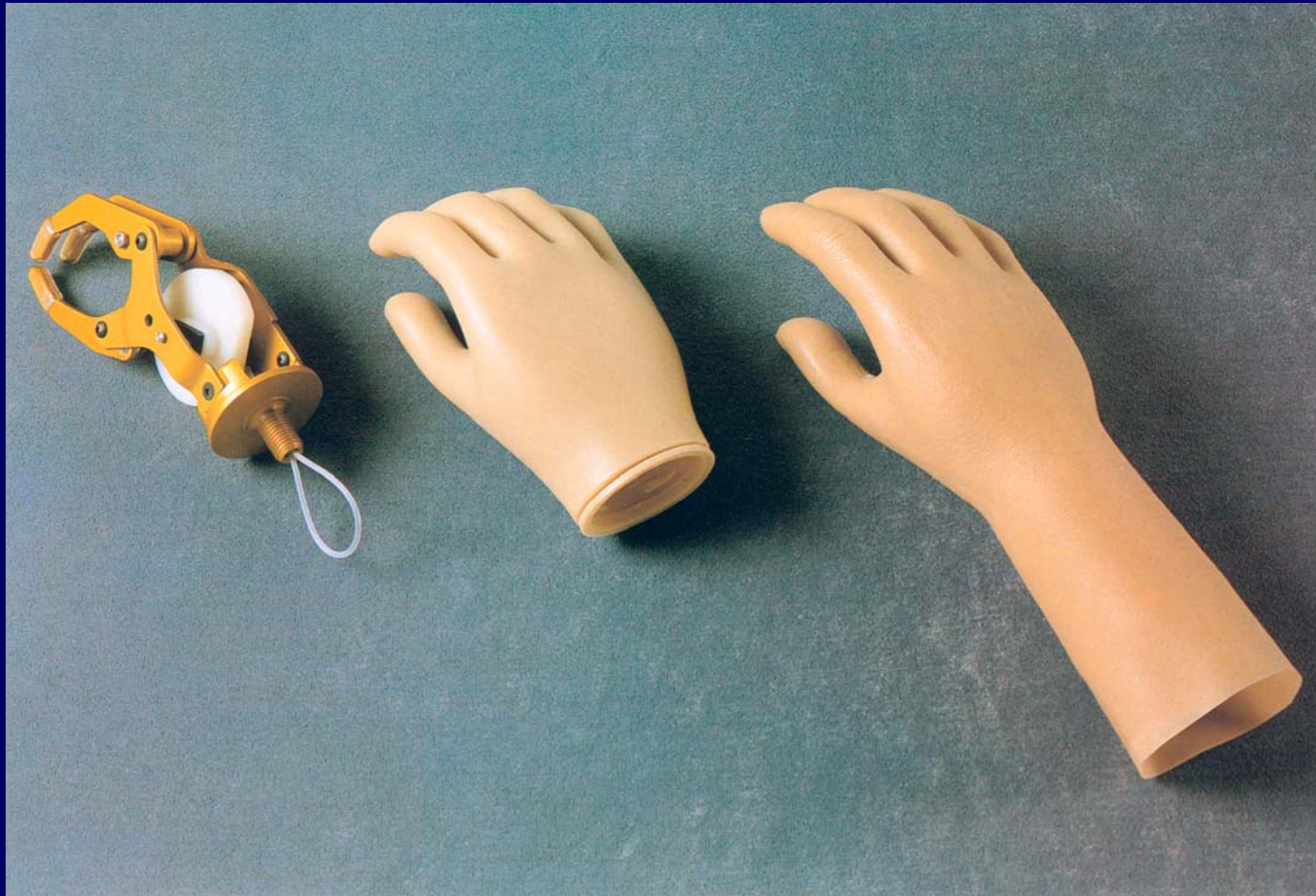


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- BODY POWERED TERMINAL DEVICES - HANDS

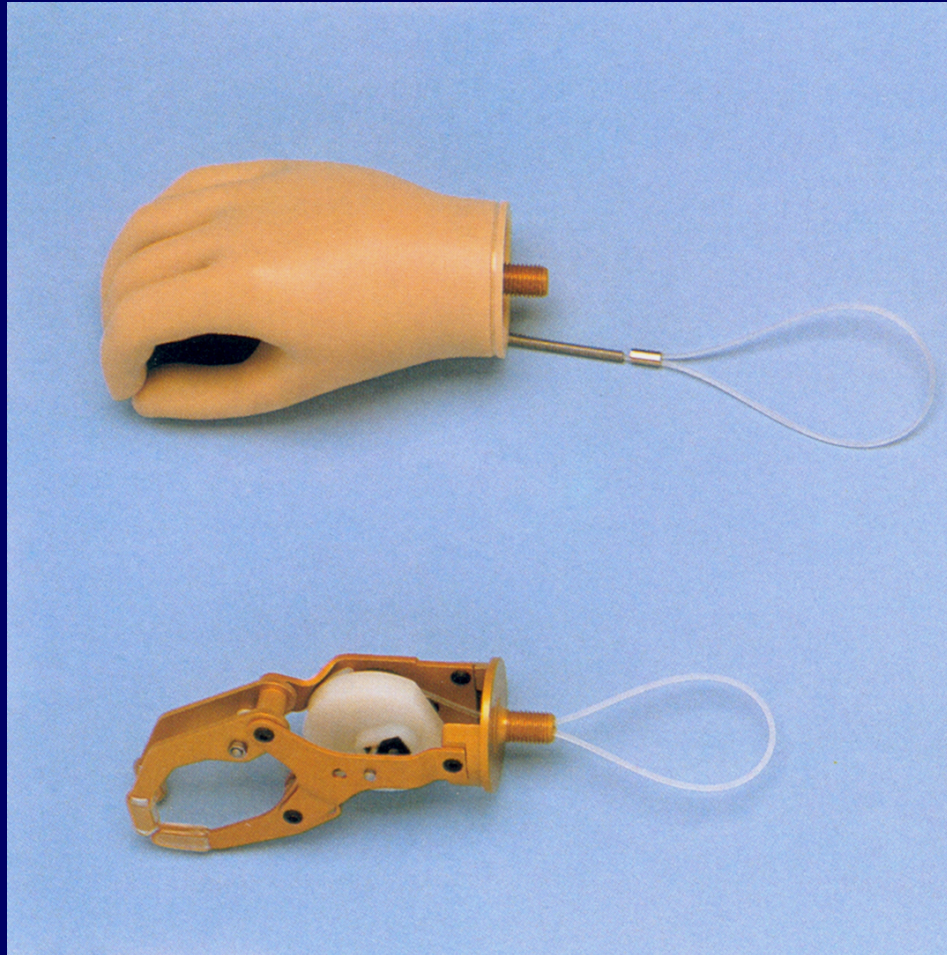


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- BODY POWERED TERMINAL DEVICES - HANDS

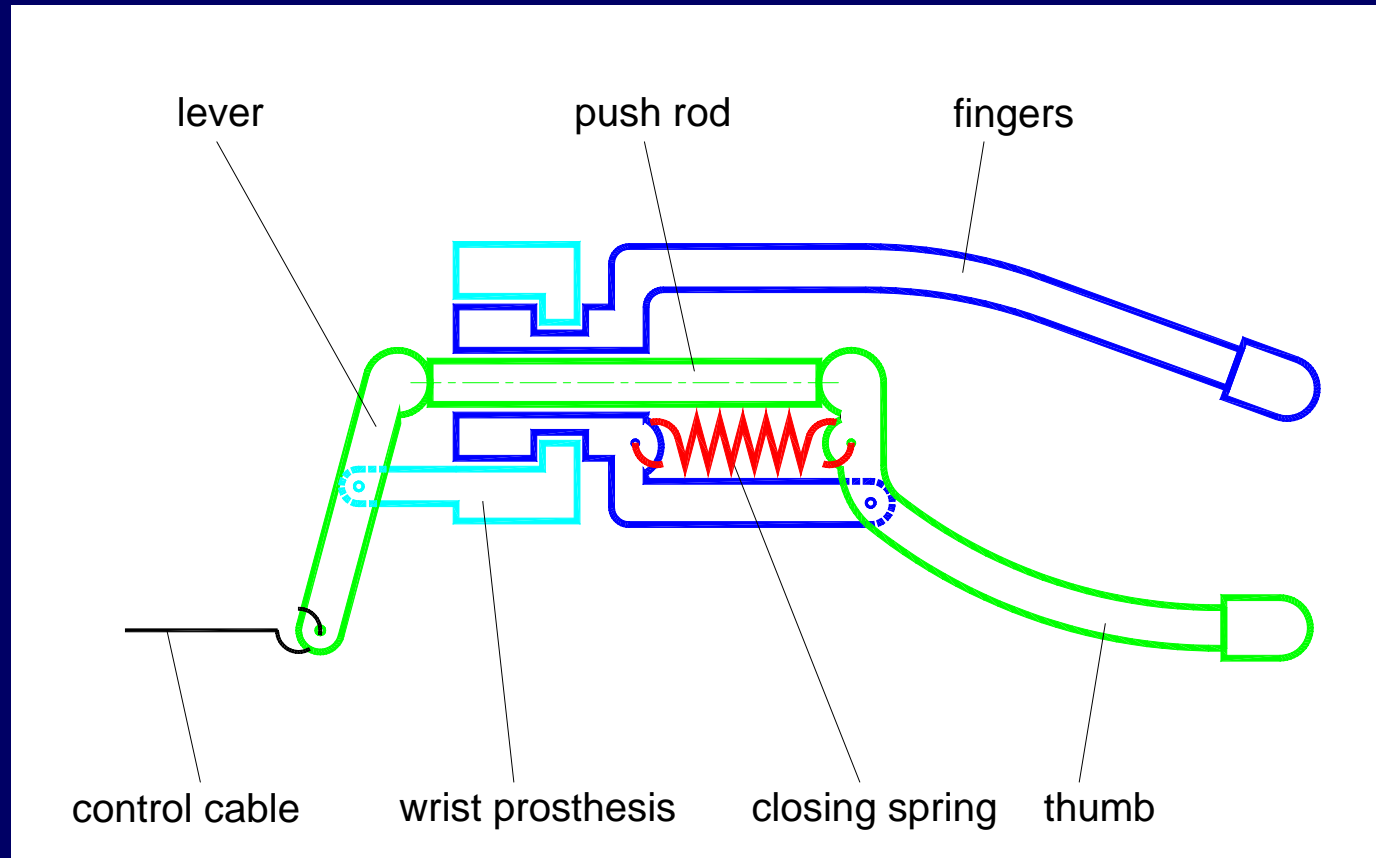


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- BODY POWERED TERMINAL DEVICES - HANDS



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BELOW ELBOW PROSTHESES

- BODY POWERED TERMINAL DEVICES - TOOLS



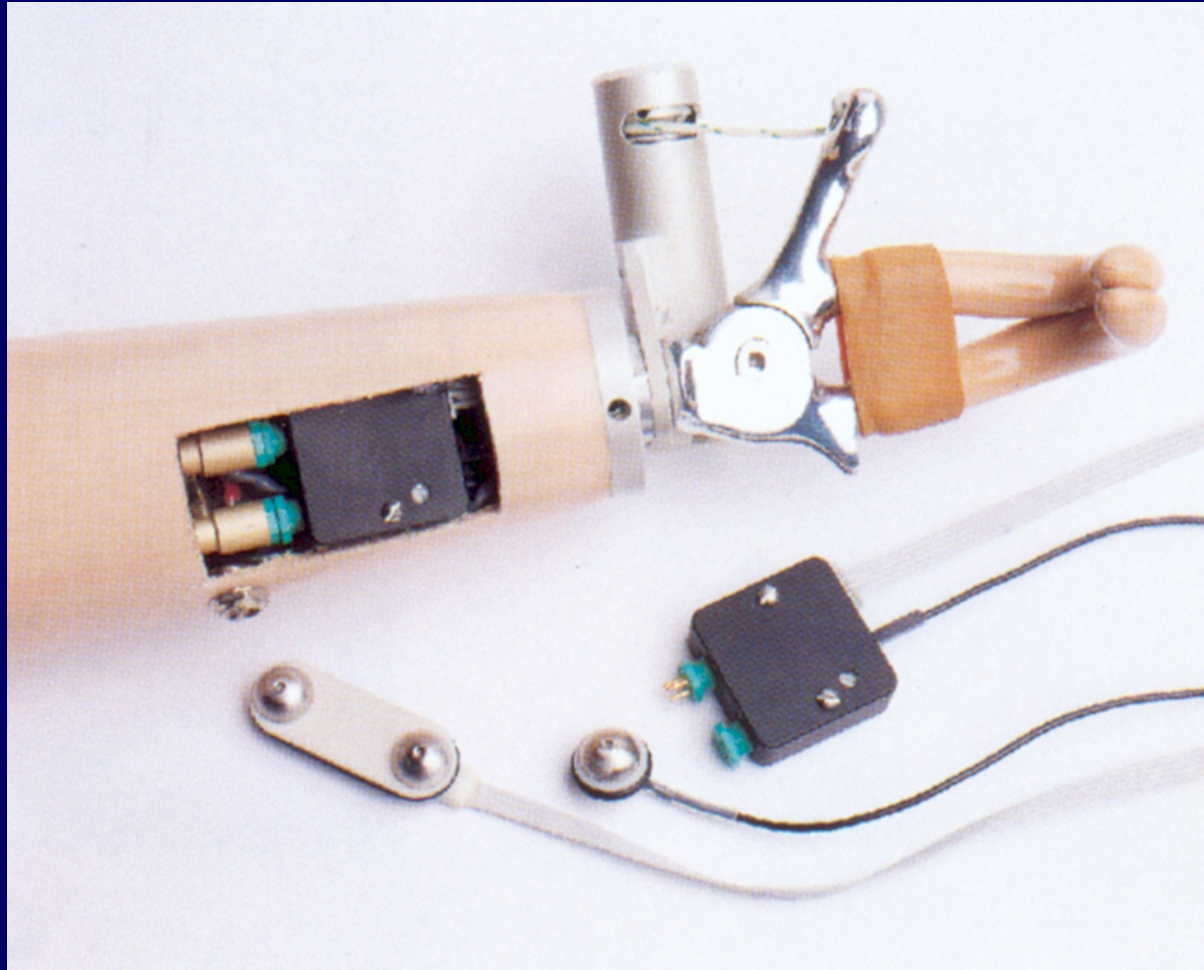
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RSL-Steeper, UK



BELOW ELBOW PROSTHESES

- EXTERNALLY POWERED TERMINAL DEVICES - HOOKS

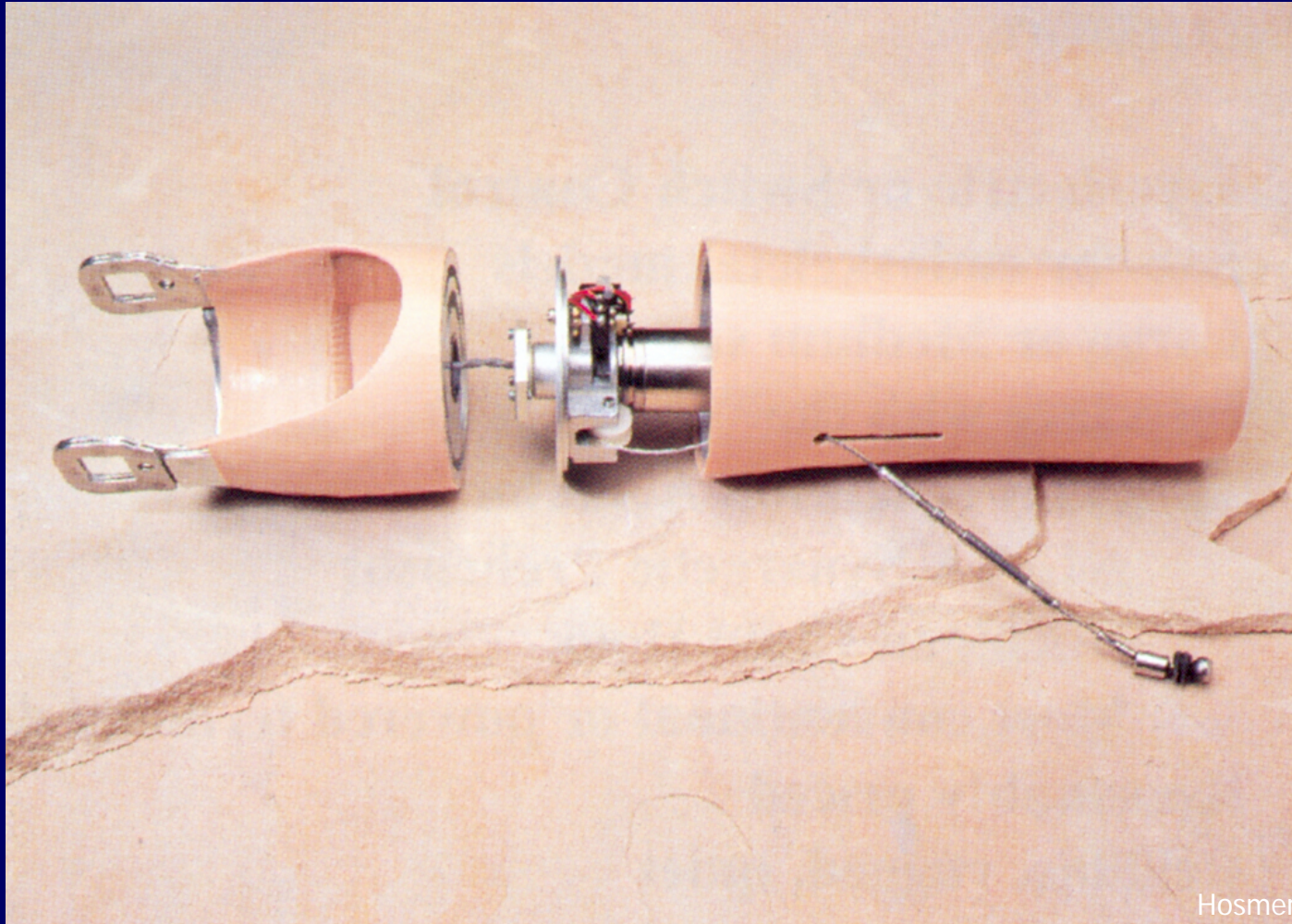


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BELOW ELBOW PROSTHESES

- EXTERNALLY POWERED TERMINAL DEVICES - HOOKS

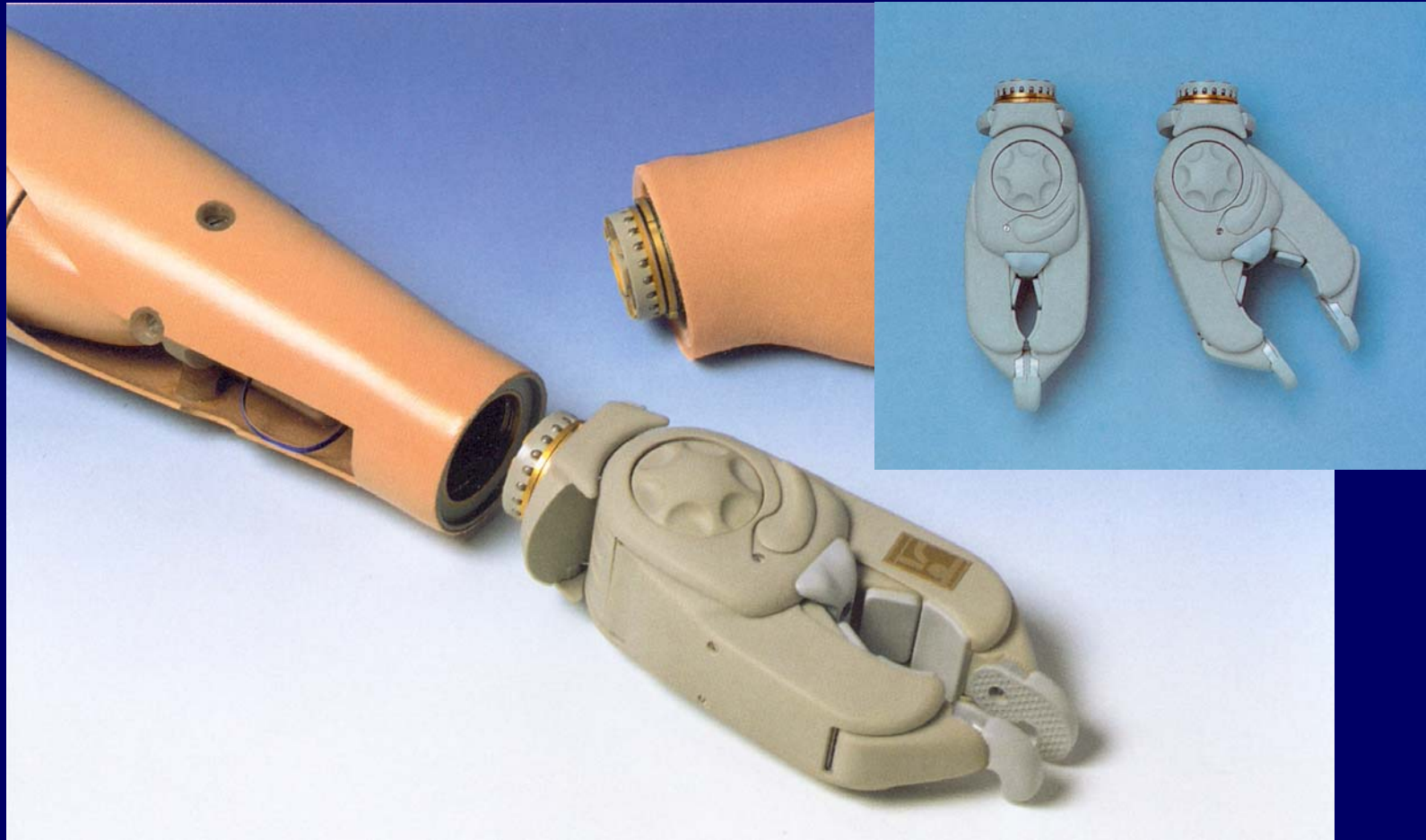


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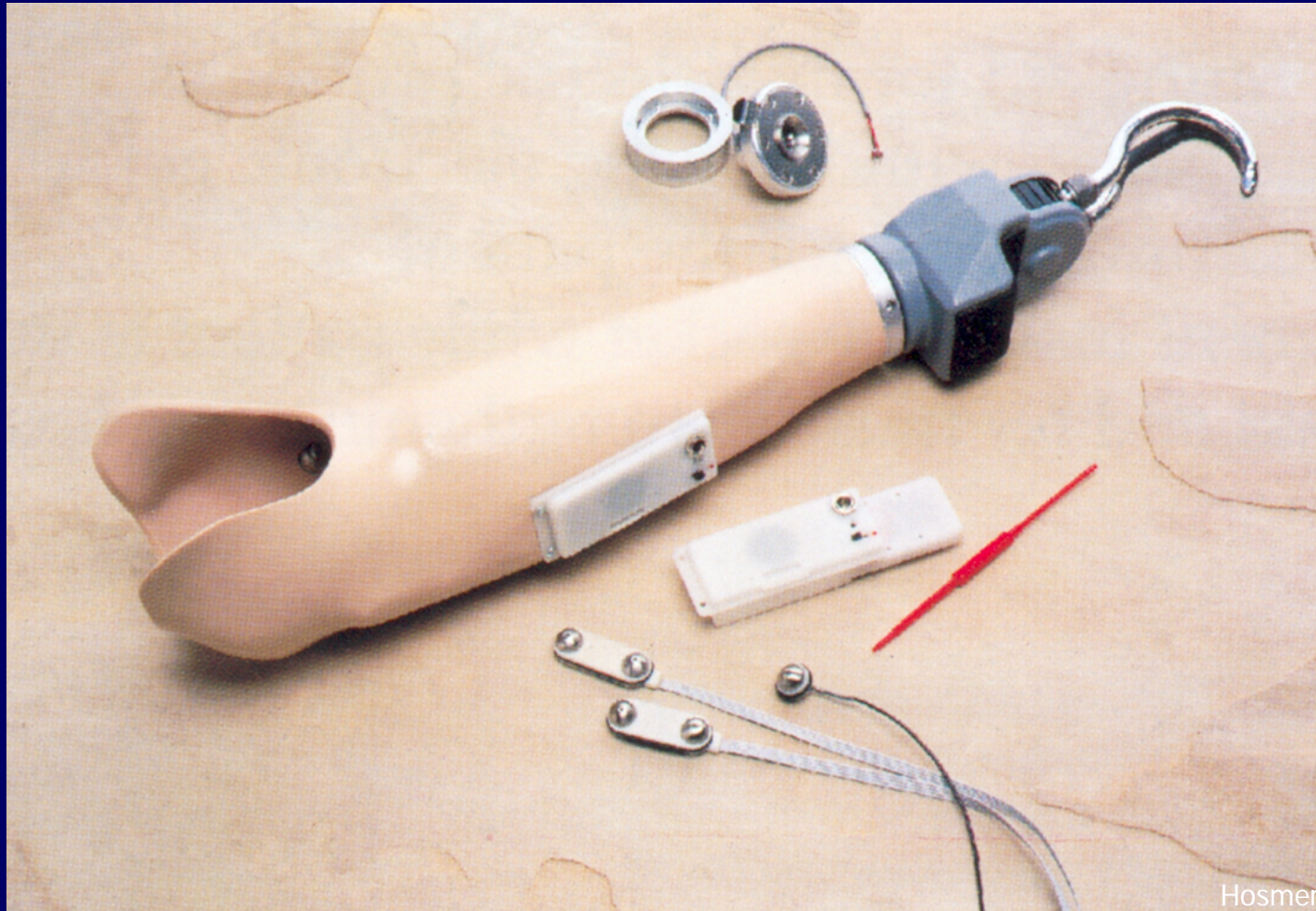


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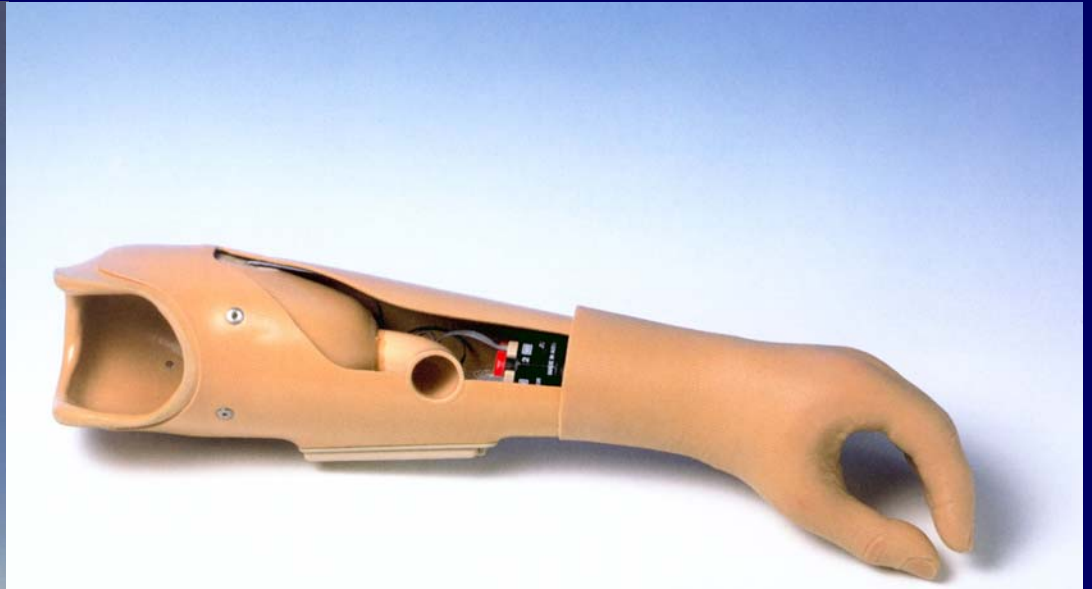


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BELOW ELBOW PROSTHESES

- EXTERNALLY POWERED TERMINAL DEVICES - HANDS

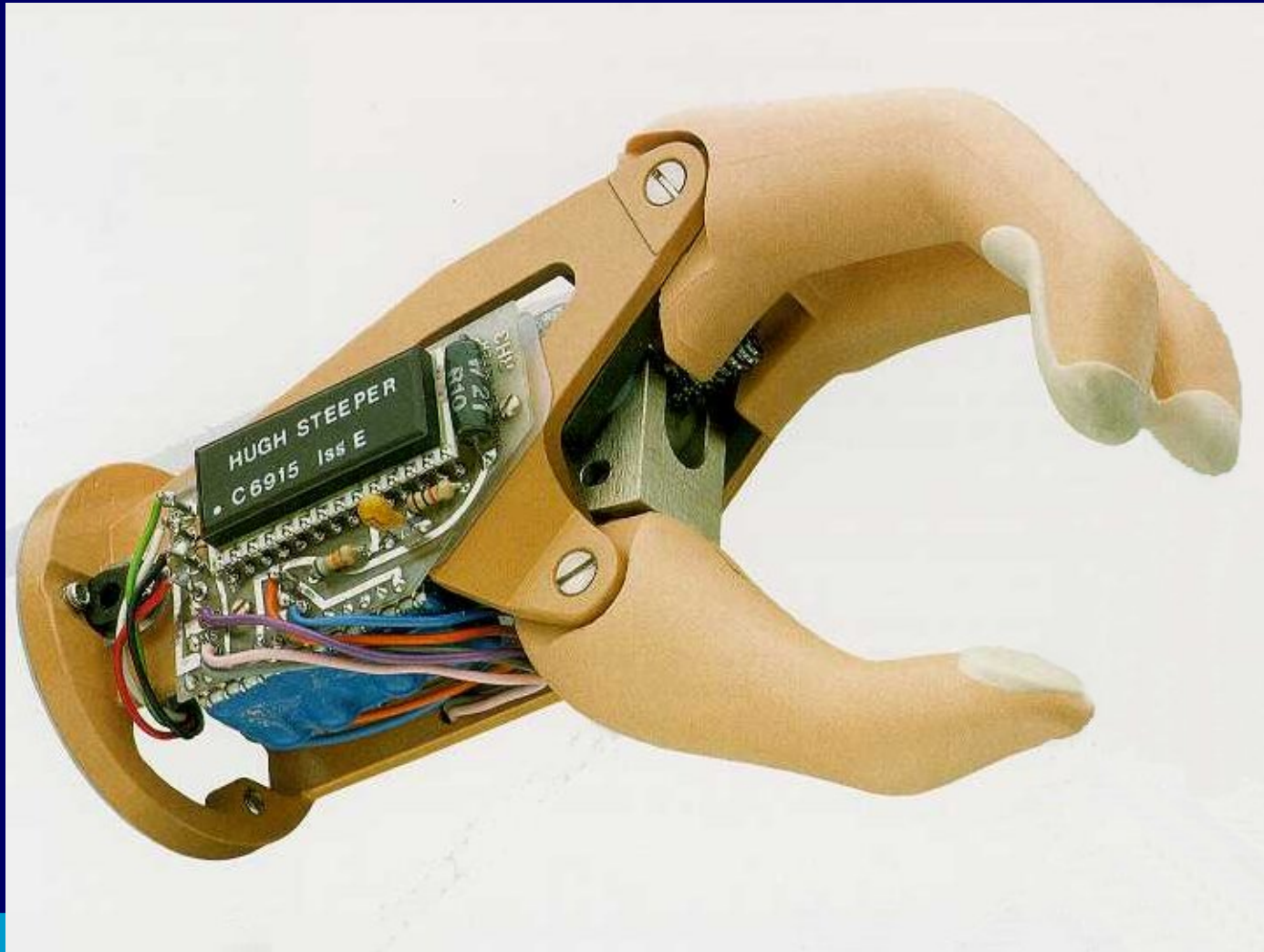


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- EXTERNALLY POWERED TERMINAL DEVICES - HANDS

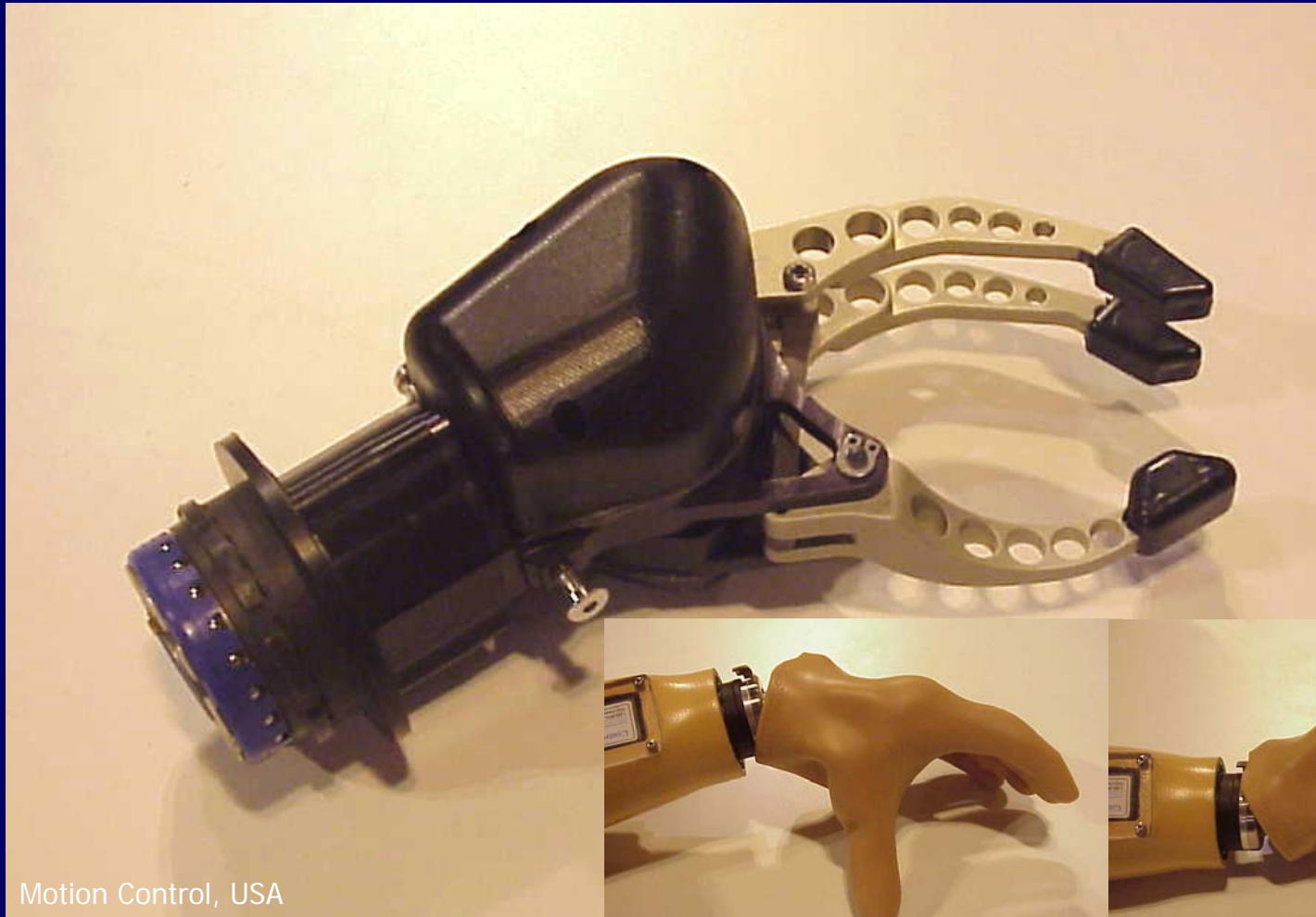


RSL-Steeper, UK

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BELOW ELBOW PROSTHESES

- EXTERNALLY POWERED TERMINAL DEVICES - HANDS



BELOW ELBOW PROSTHESES

- EXTERNALLY POWERED TERMINAL DEVICES - HANDS

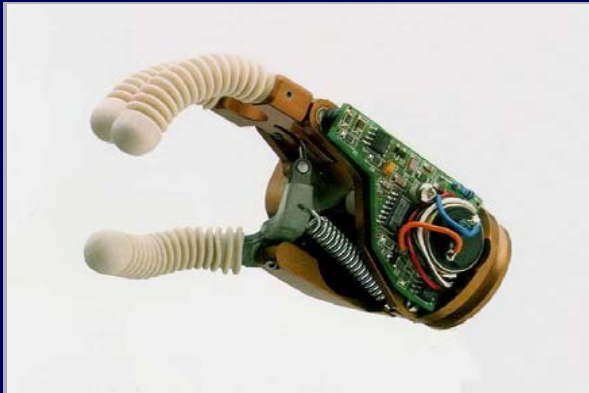


RSL-Stepper, UK

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BELOW ELBOW PROSTHESES

- EXTERNALLY POWERED TERMINAL DEVICES - HANDS



RSL-Steepier, UK

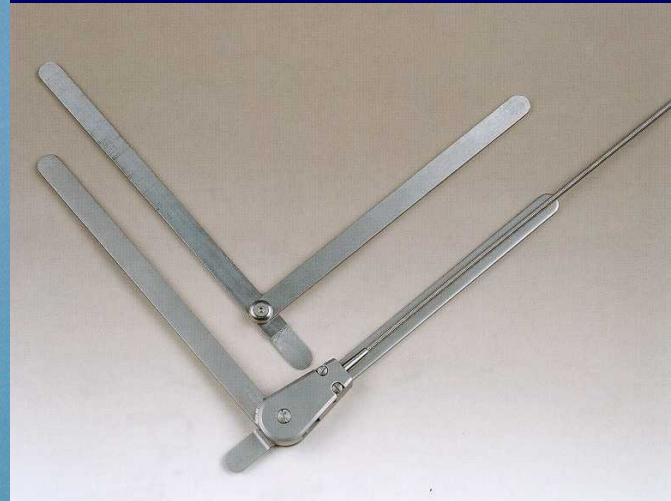
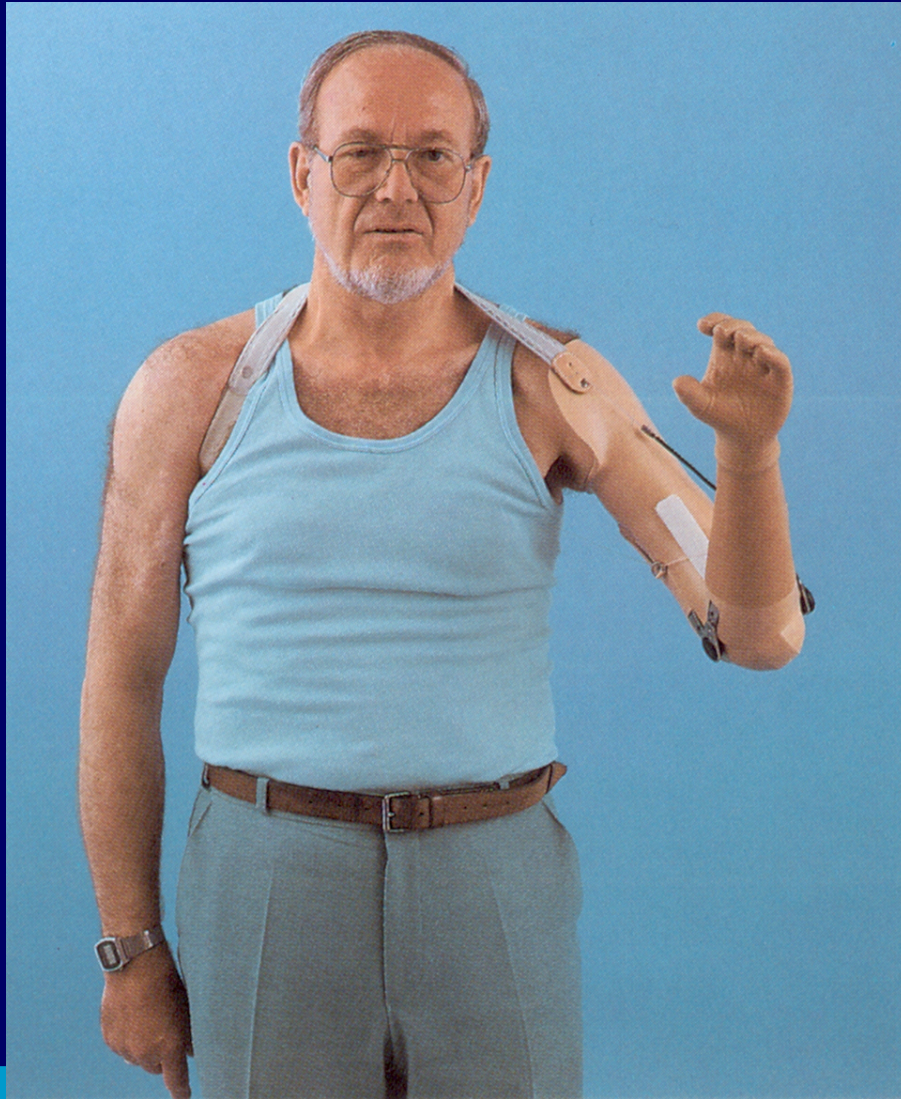
Centri AG, Sweden

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ELBOW DISARTICULATION PROSTHESES



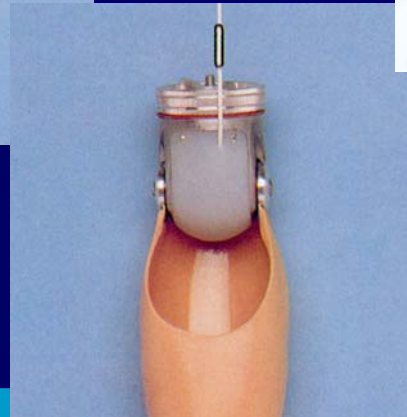
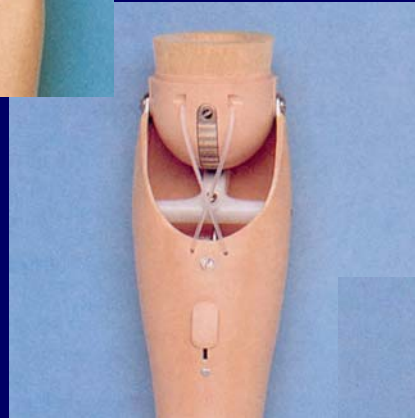
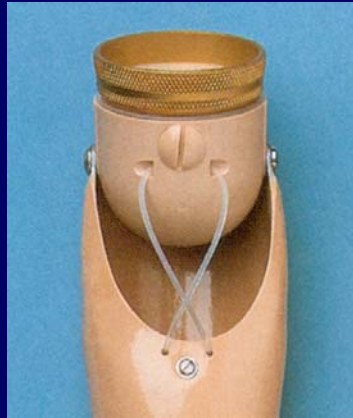
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Näder, 1990

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ABOVE ELBOW PROSTHESES

- BODY POWERED ELBOW PROSTHESES



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ABOVE ELBOW PROSTHESES

- BODY POWERED ELBOW PROSTHESES

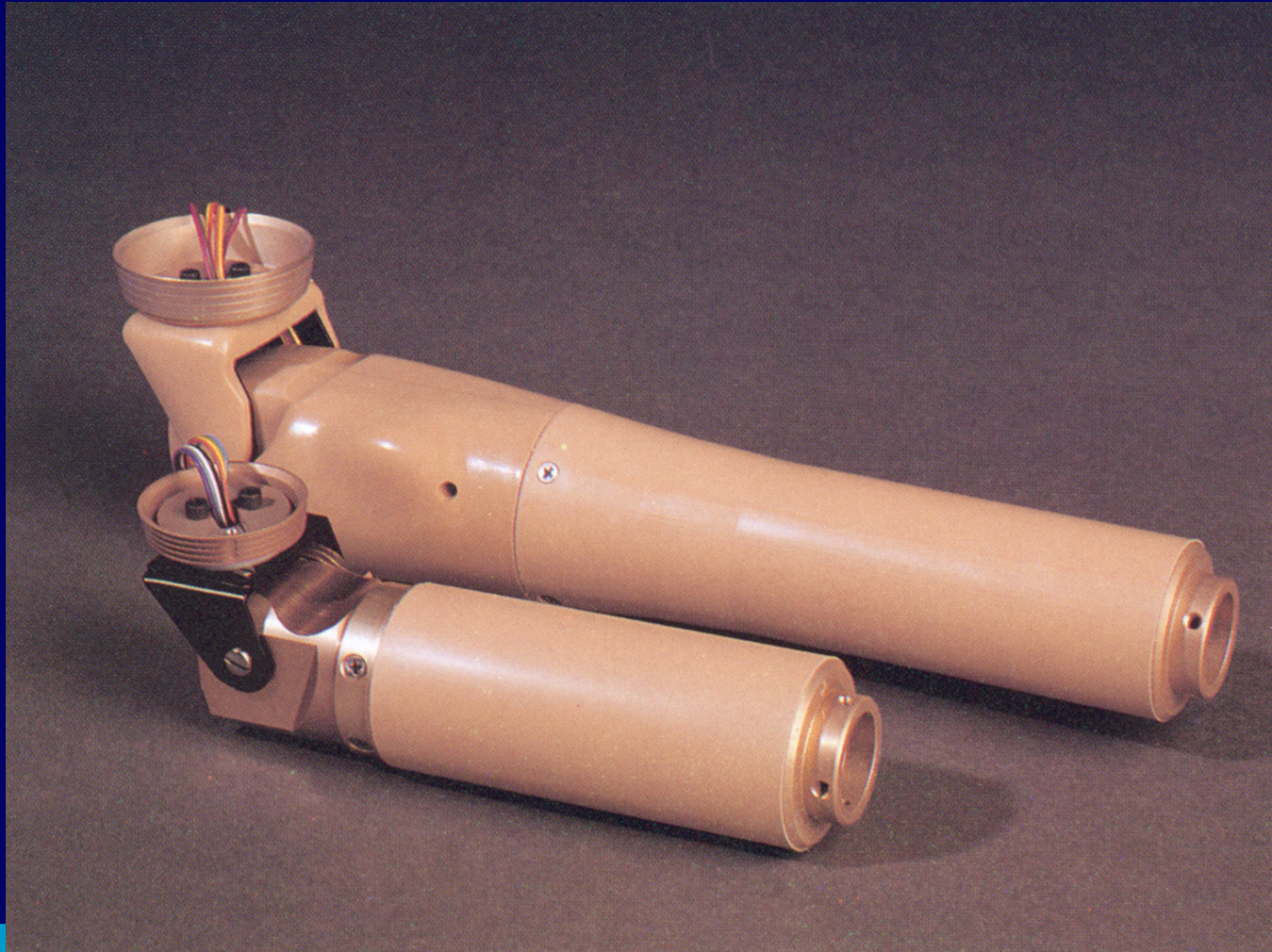


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ABOVE ELBOW PROSTHESES

- EXTERNALLY POWERED ELBOW PROSTHESES

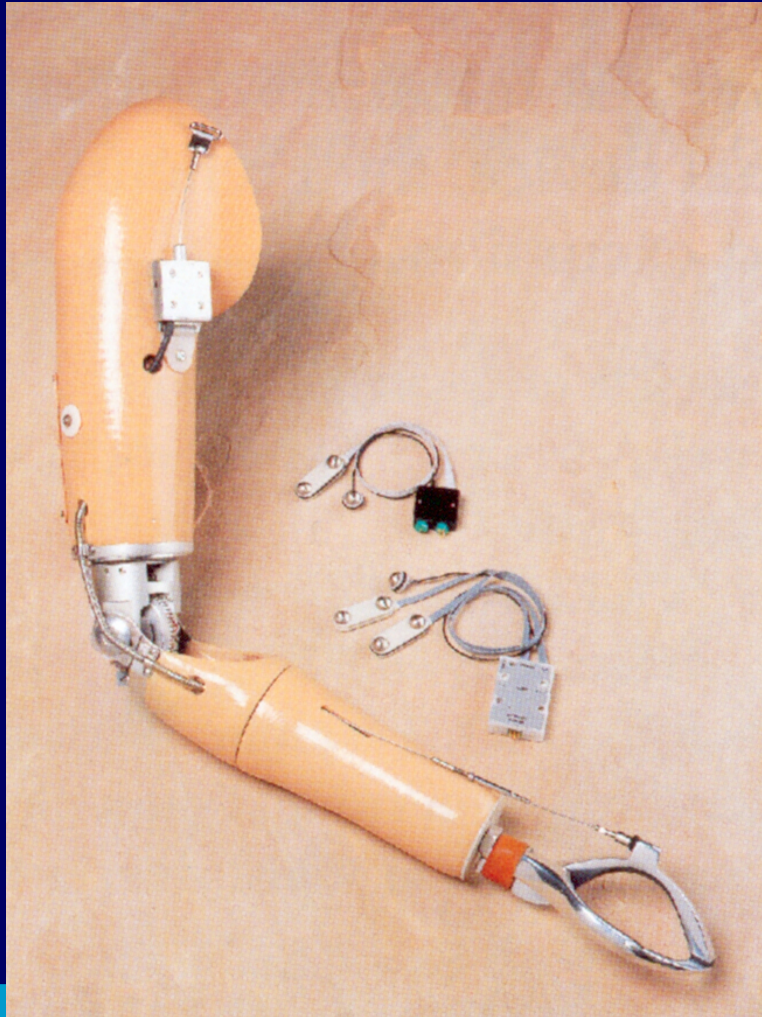


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ABOVE ELBOW PROSTHESES

- EXTERNALLY POWERED ELBOW PROSTHESES

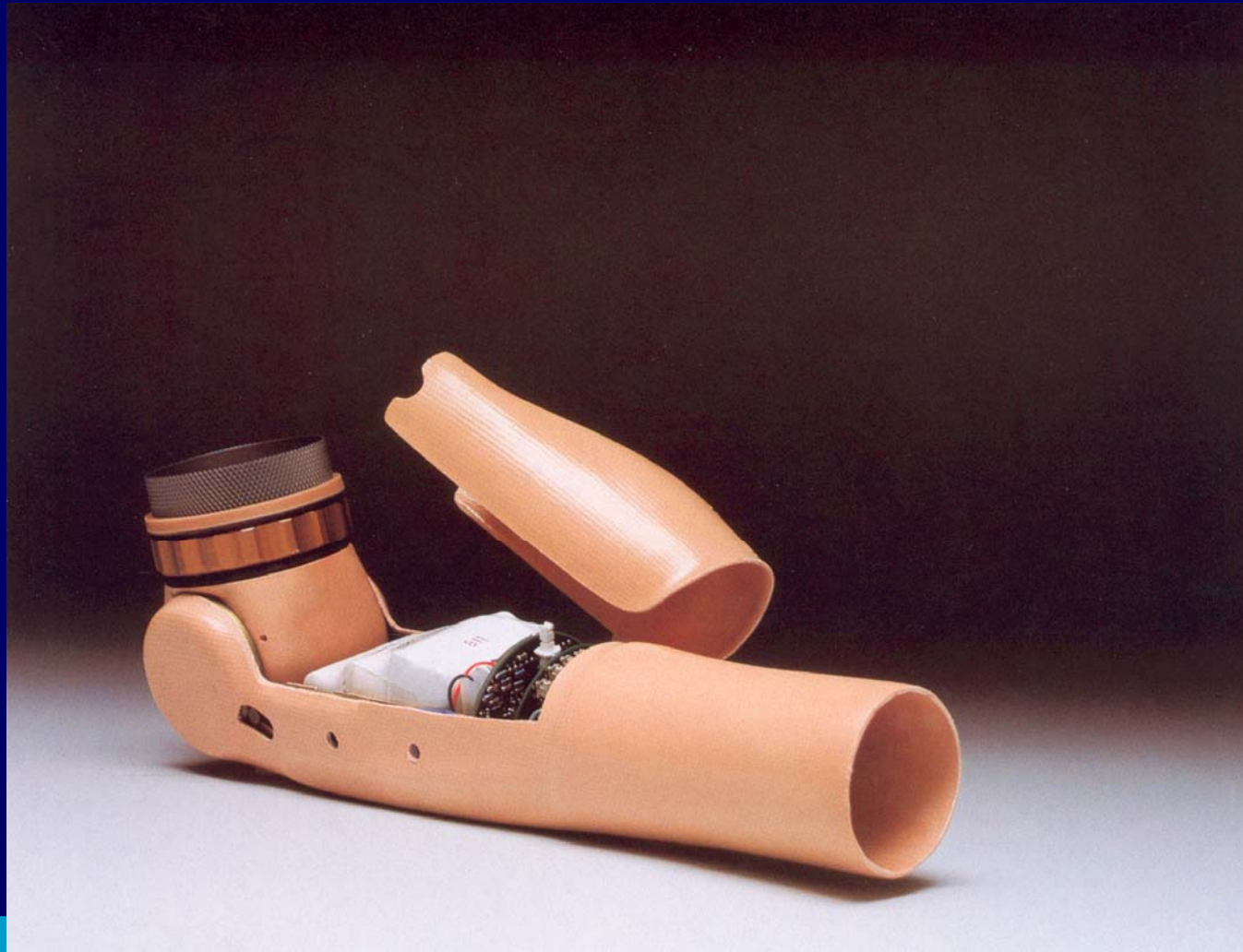


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ABOVE ELBOW PROSTHESES

- EXTERNALLY POWERED ELBOW PROSTHESES

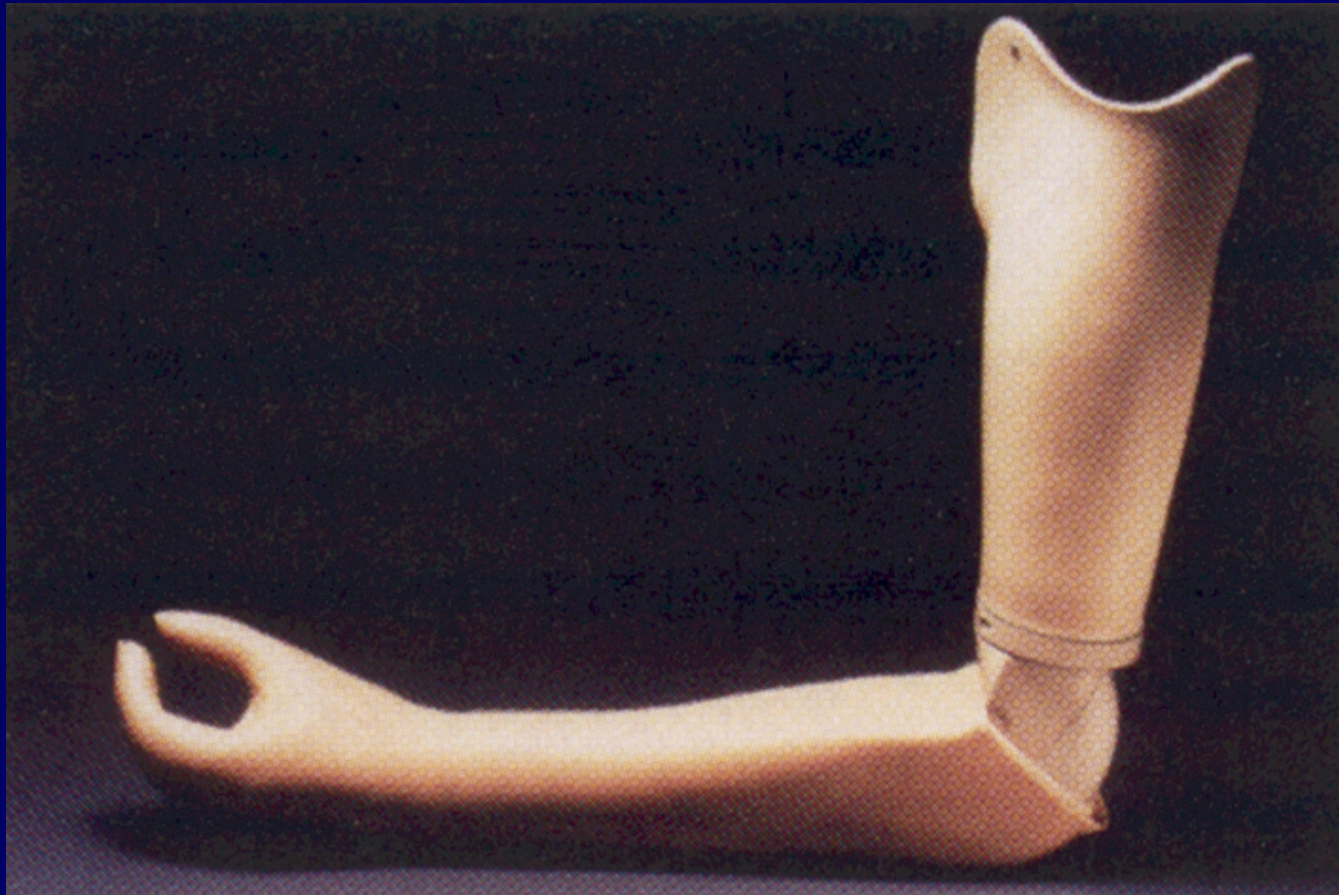


LTI, USA

Steffen Plettenburg, 2007

ABOVE ELBOW PROSTHESES

- EXTERNALLY POWERED ELBOW PROSTHESES



Motion Control, USA

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ABOVE ELBOW PROSTHESES

- EXTERNALLY POWERED ELBOW PROSTHESES

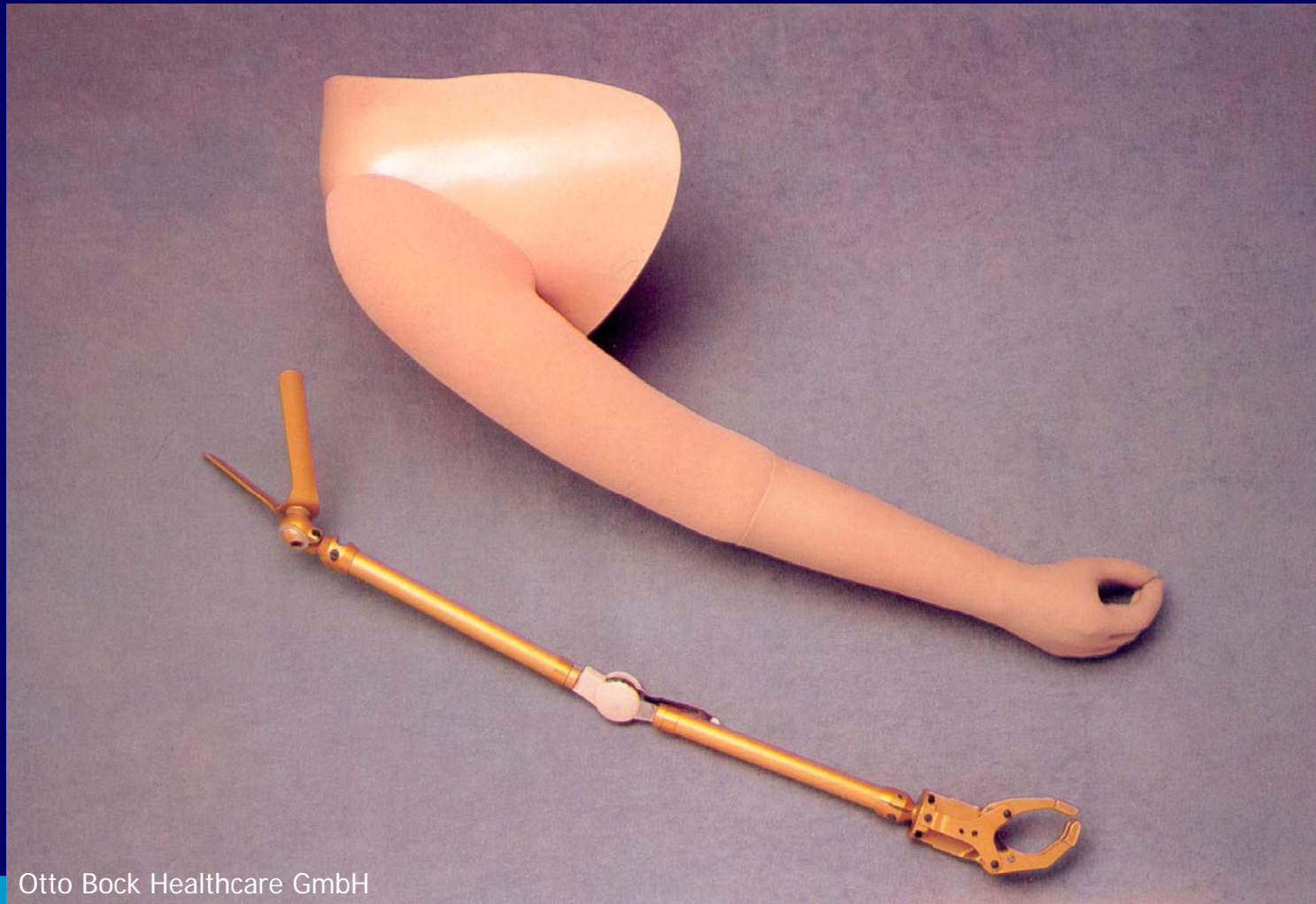


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SHOULDER DISARTICULATION PROSTHESES

- BODY POWERED

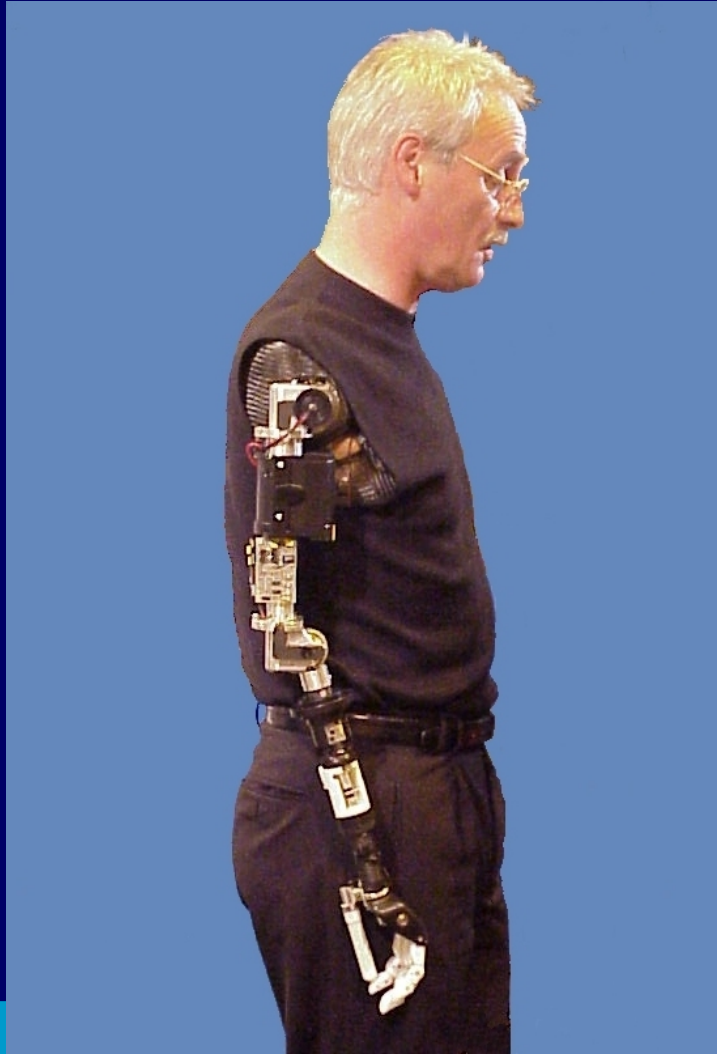


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SHOULDER DISARTICULATION PROSTHESES

- EXTERNALLY POWERED



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SUMMARY

- PROSTHESIS DEFINITION
- PROSTHETIC SUSPENSION
- CONTROL vs ACTUATION
- BODY POWERED PROSTHESES
- EXTERNALLY POWERED PROSTHESES

Concluding remarks

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PROSTHESES:

- Many different types available
- Many end up not being used:
 - 40% non-wearers
 - 60% non-users
- Worldwide research efforts to improve prosthetic performance
- Focus of most research is wrong!

I miss

my left hand!



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I want a prosthesis!



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I want a prosthesis that:

- is beautiful
- is easy to wear
- is easy to operate



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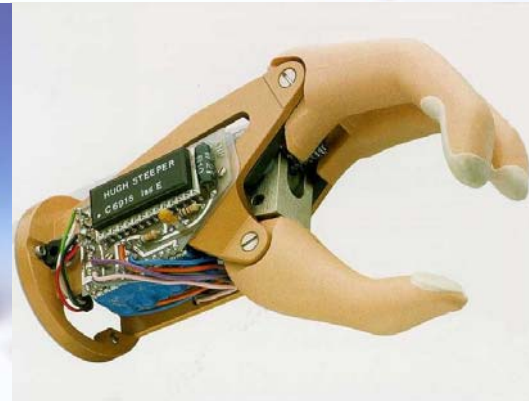
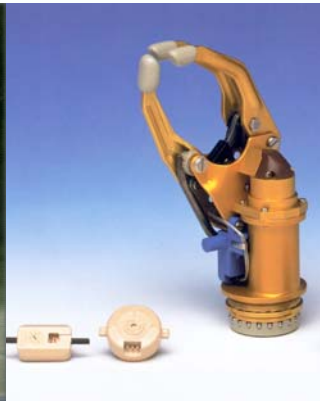
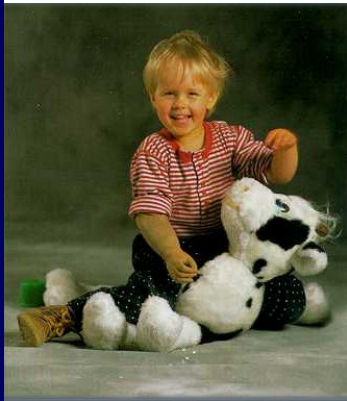
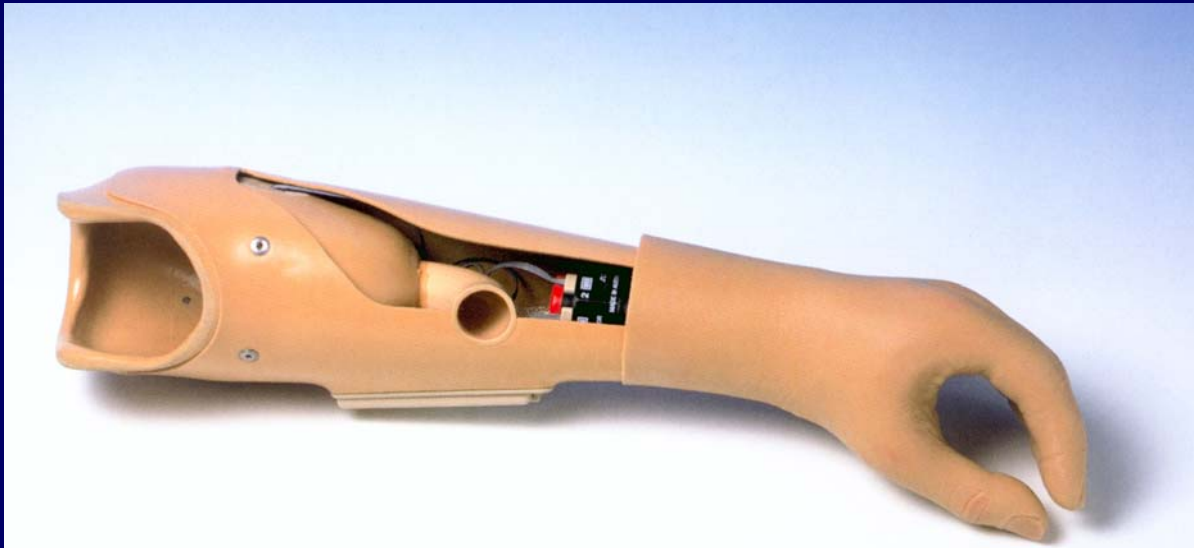


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Oh no! So ugly!

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Otto Bock Healthcare GmbH,
RSL-Stepper, UK



Hmm ... , nice. But very heavy!

DELFT INSTITUTE
of
PROSTHETICS and ORTHOTICS
home of WILMER



DIPO, part of BioMechanical Engineering, develops prostheses that are:

- beautiful = Cosmesis
- easy to wear = Comfort
- easy to operate = Control

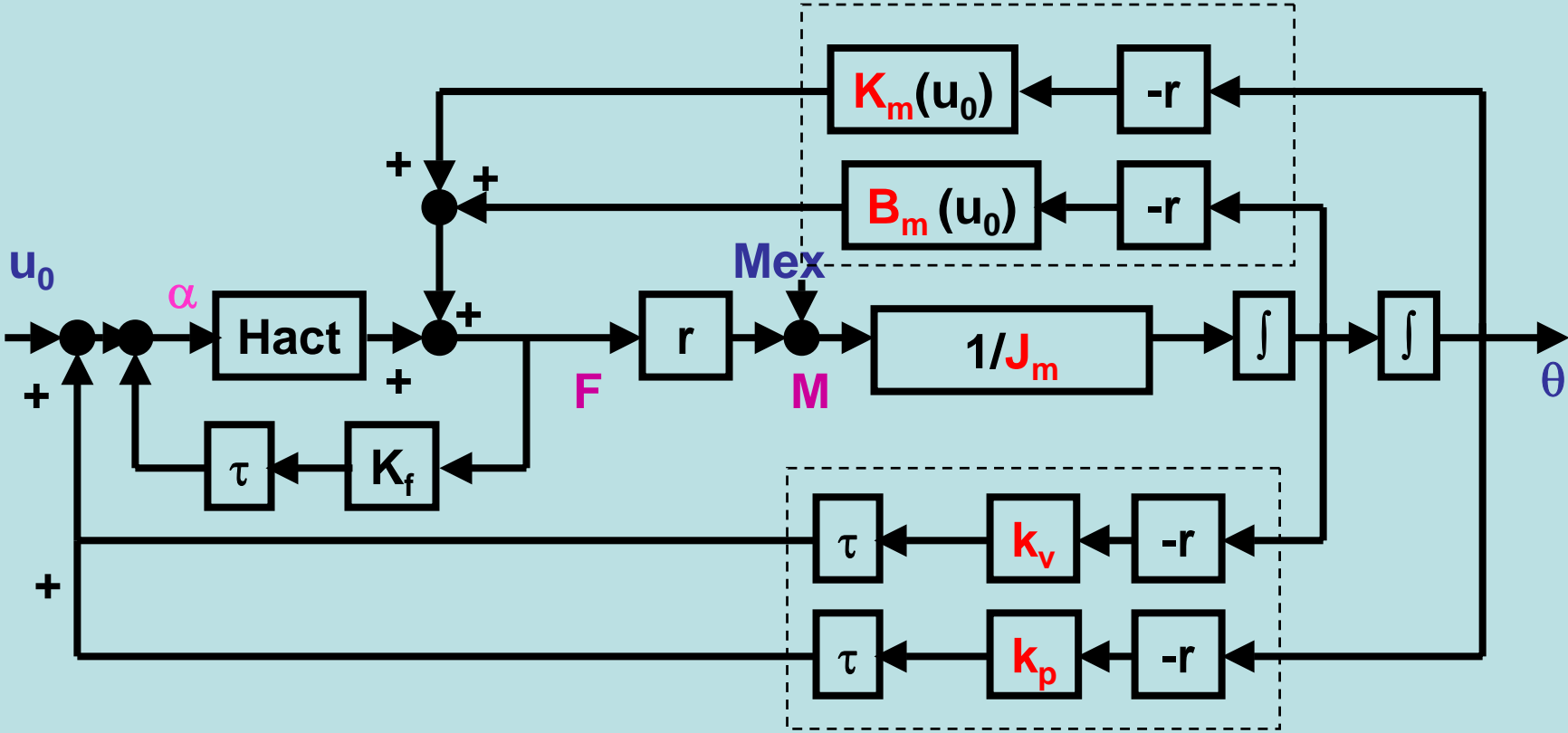
The three C's

Cosmesis: outward appearance

Comfort: low mass

Control: feedback important,
therefore mechanical prostheses

Muscle stiffness & viscosity



Muscle spindle

Collaborations:

Rehabilitation Center
De Hoogstraat, Utrecht



Rehabilitation Center
Sint Maartenskliniek, Nijmegen

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2007-03-07 STATE OF THE ART IN UE PROSTHETICS

2007-03-14 CONTROL

2007-03-21 ACTUATION