

REHABILITATION & PROSTHETICS

DICK H. PLETTENBURG

Evolving Design WB3110



Rehabilitation = ?

Rehabilitation

From: **re·ha·bil·i·tate**

Etymology: Medieval Latin *rehabilitatus*, past participle of *rehabilitare*, from Latin *re-* + Late Latin *habilitare* to habilitate

1 a : to restore to a former capacity : **REINSTATE**

b : to restore to good repute : reestablish the good name of

2 a : to restore to a former state (as of efficiency, good management, or solvency) <*rehabilitate* slum areas>

b : to restore or bring to a condition of health or useful and constructive activity

Physical Medicine and Rehabilitation

=

branch of medicine that deals
with the functional restoration of
a person affected by a physical
disability

Physical Medicine and Rehabilitation

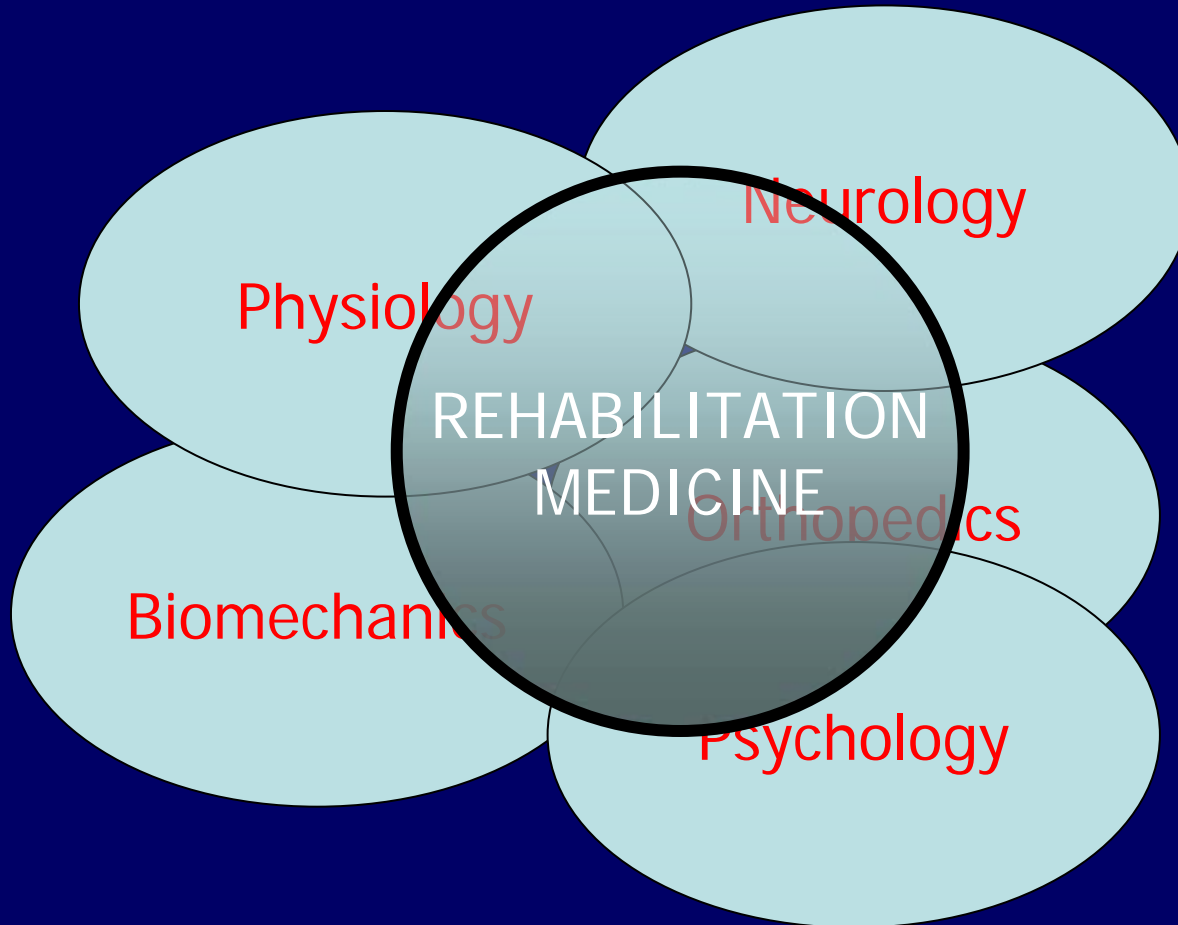
or

Physiatry, Physical Therapy, or
Rehabilitation Medicine

=

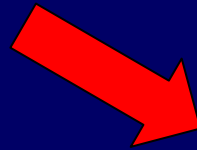
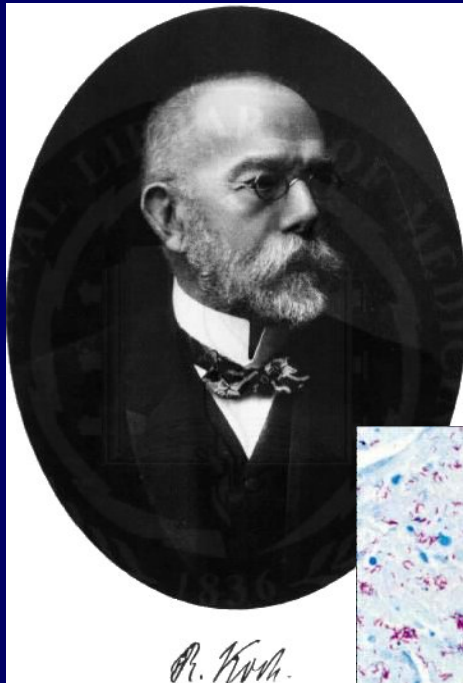
medical specialty concerned with the
treatment of chronic disabilities and with
the restoration of normal functioning to
the disabled

Rehabilitation Medicine

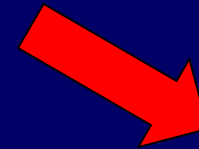
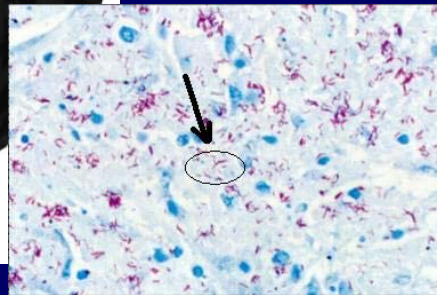


Classical model of disease

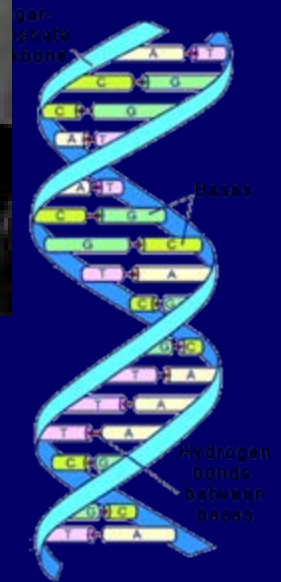
Etiology



Pathogenesis



Illness/disease



Rehabilitation: model

Disease



Impairment



Disability



Handicap

Rehabilitation: model

Disease



Impairment

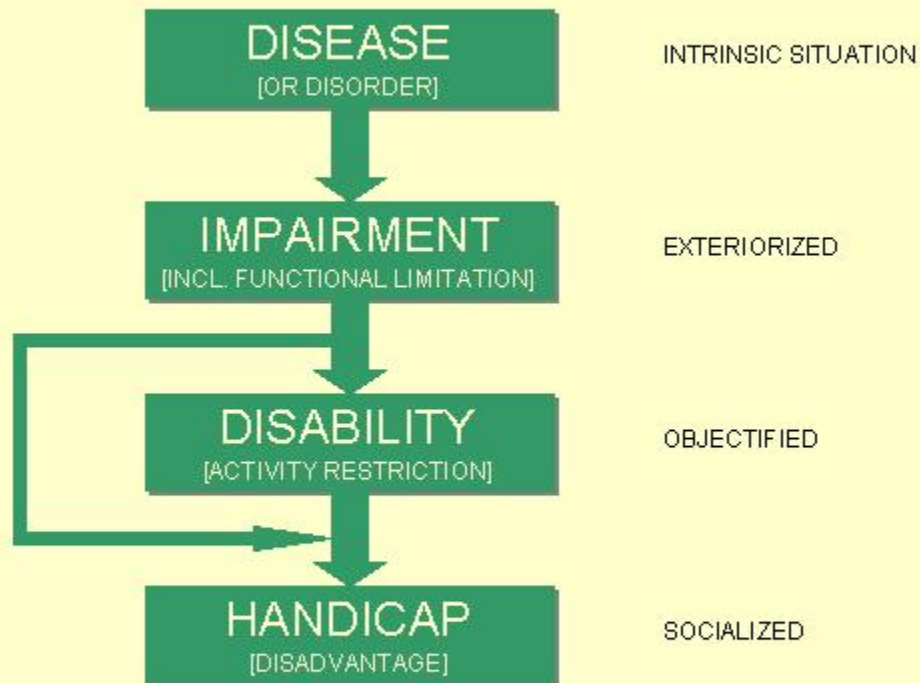


Disability



Handicap

*International
classification
of impairment,
disability
and handicap
(ICIDH)*



Rehabilitation: model

Disease



Impairment
(function)



Disability
(activity)



Handicap
(participation)

*International
classification
of impairment,
disability
and handicap
(ICIDH)*

Rehabilitation: model

Disease



Impairment
(function)



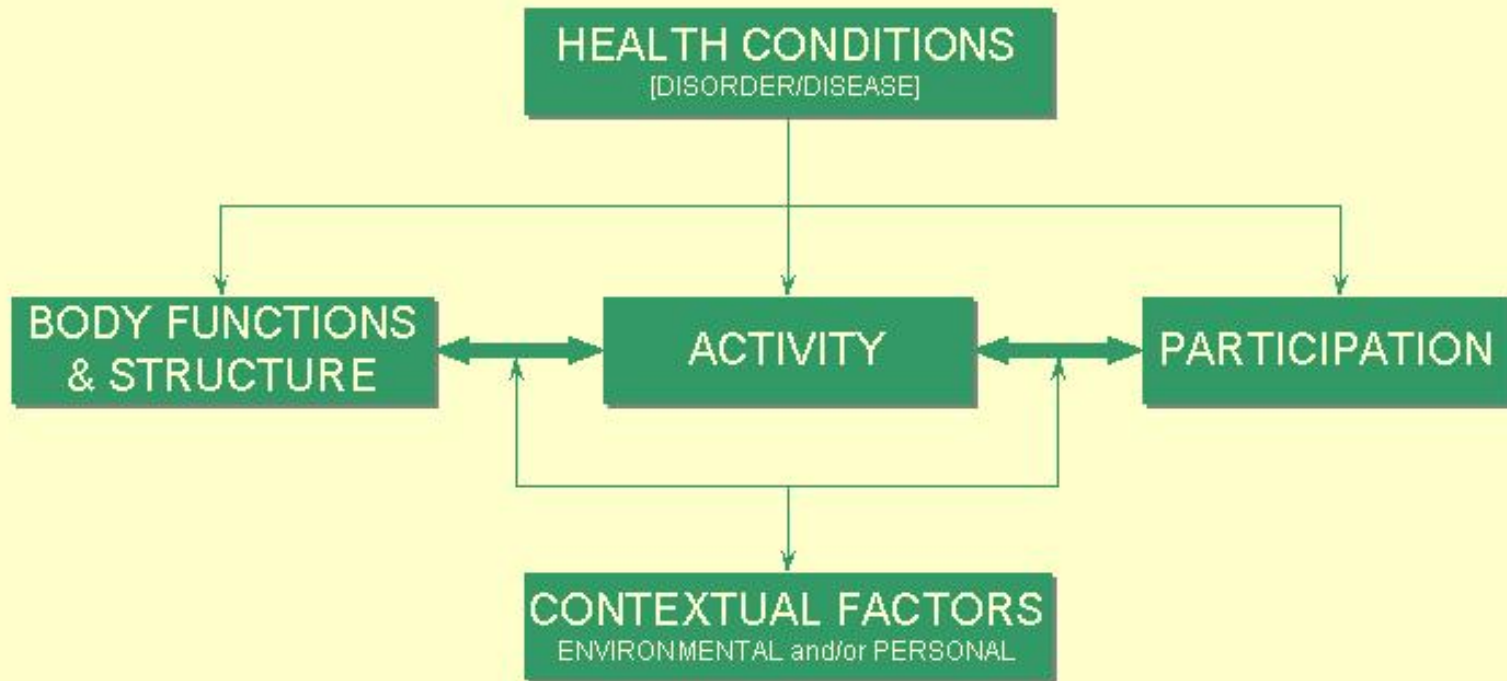
Disability
(activity)



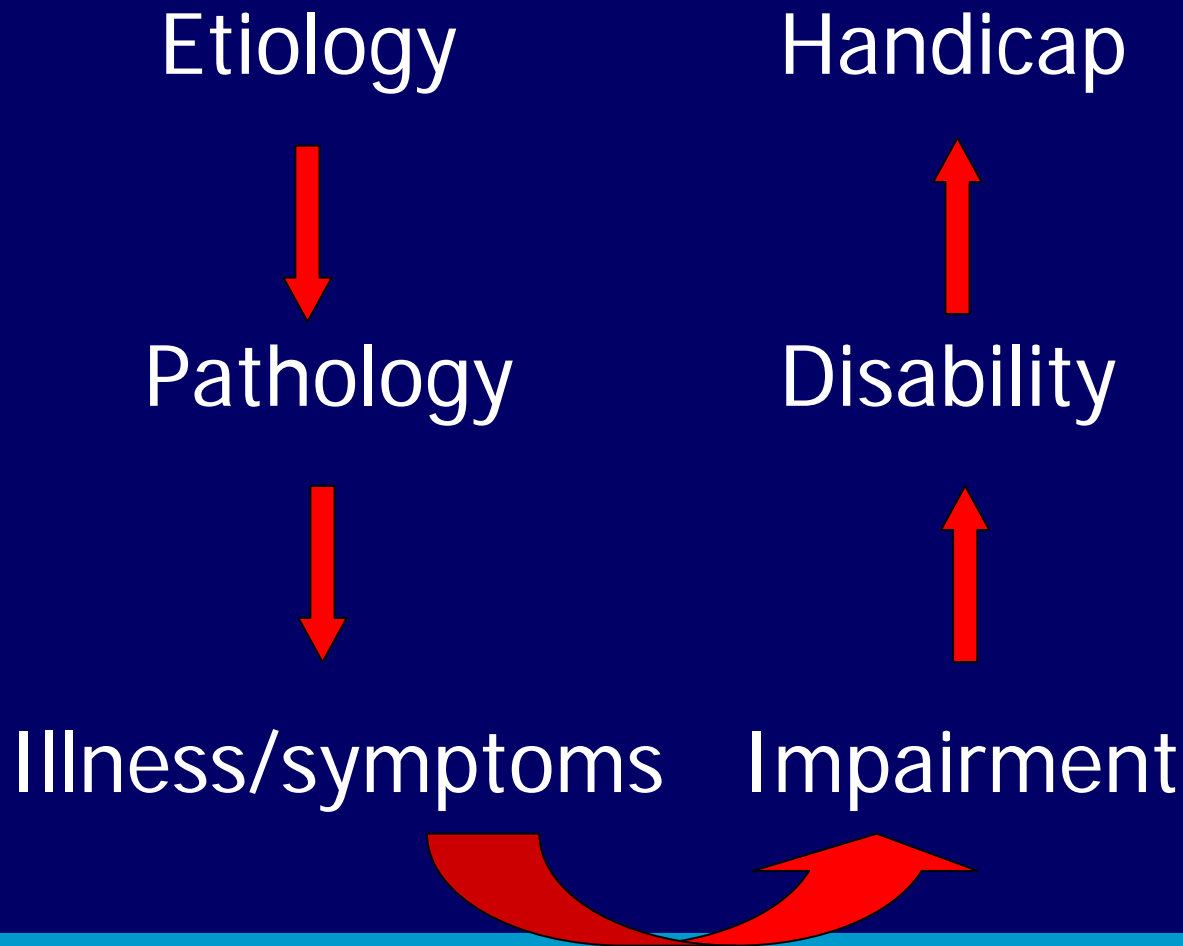
Handicap
(participation)

*International
classification
of impairment,
disability
and handicap
(ICIDH)*

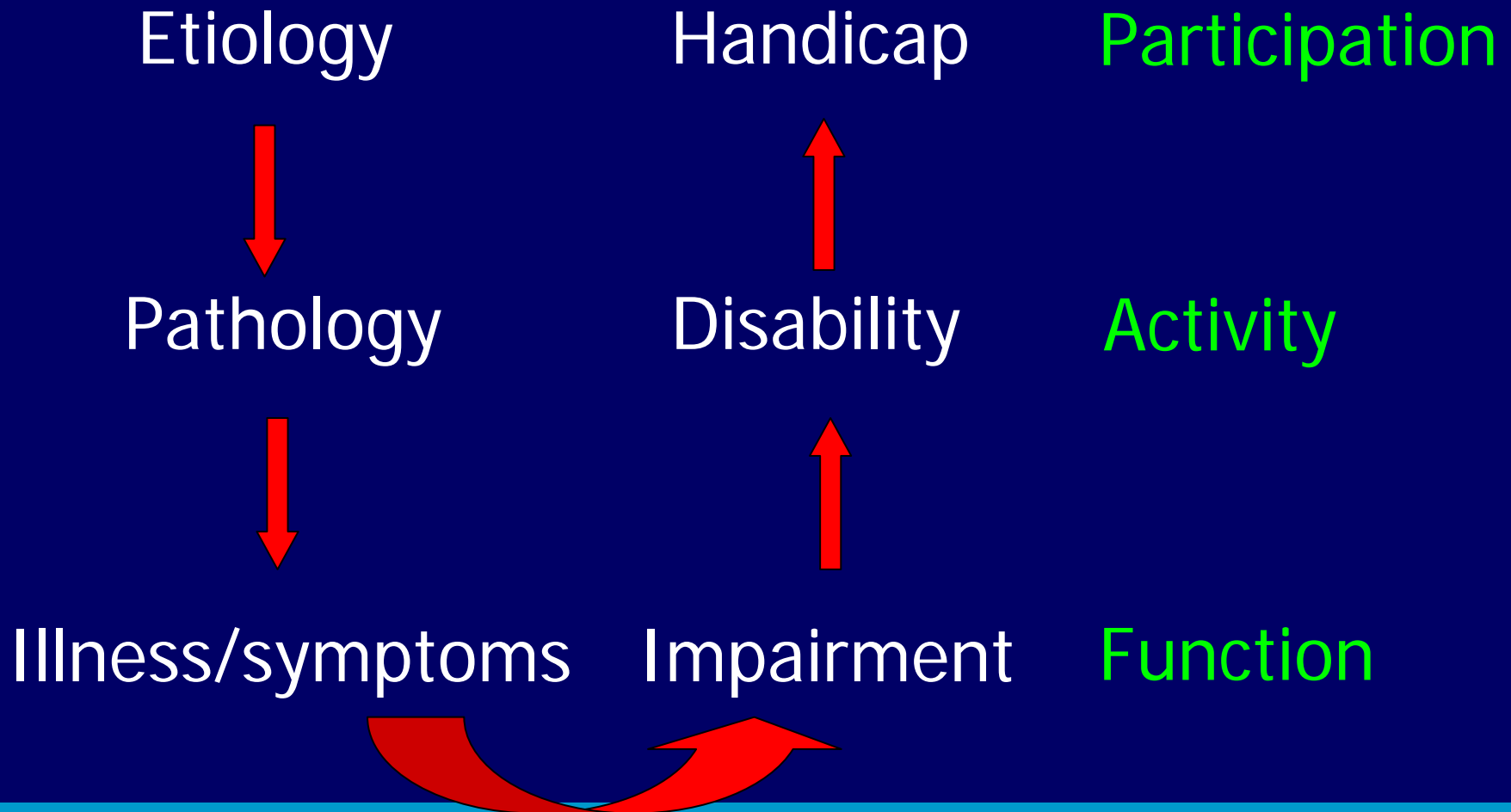
*International
classification
of function
(ICF)*



Classic meets rehabilitation



Classic meets rehabilitation



Rehabilitation topics today:

- Rehabilitation robotics
- Prostheses: lower limb prostheses
upper limb prostheses

Rehabilitation robots

Machines to assist humans / interact with humans

“**Rehabilitation robots** are robots which operate semi of fully autonomously to perform services useful to the well-being of disabled humans”

(Richard Q. van der Linde, 2003)

Rehabilitation robotics

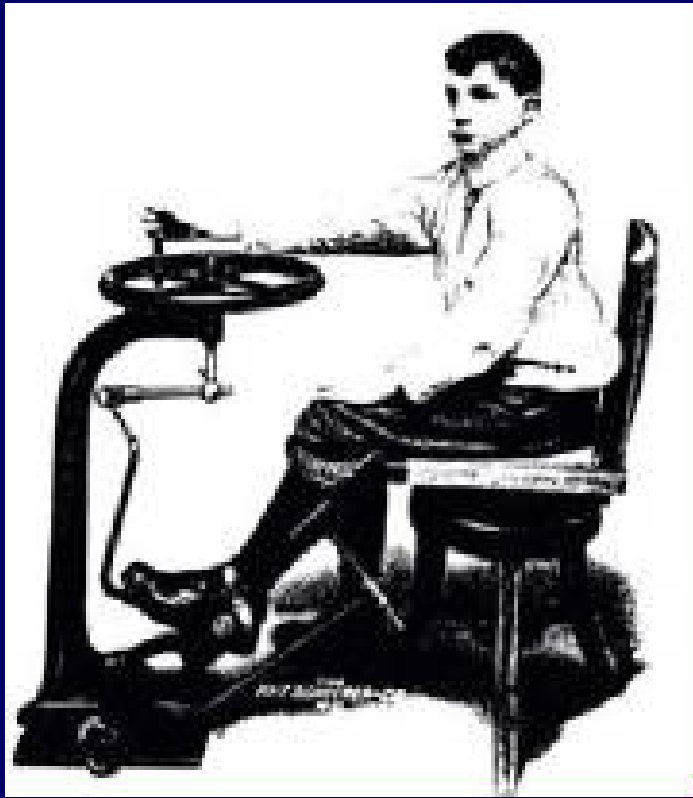
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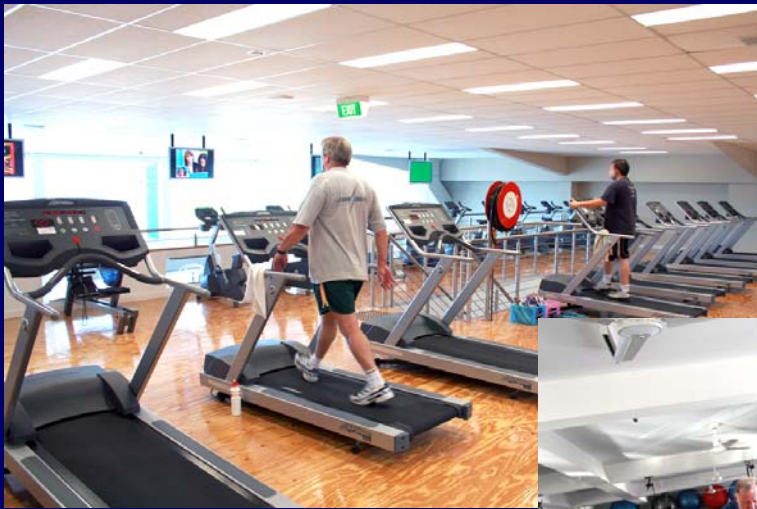
Gustav Zander
1835 – 1920
mechanotherapy











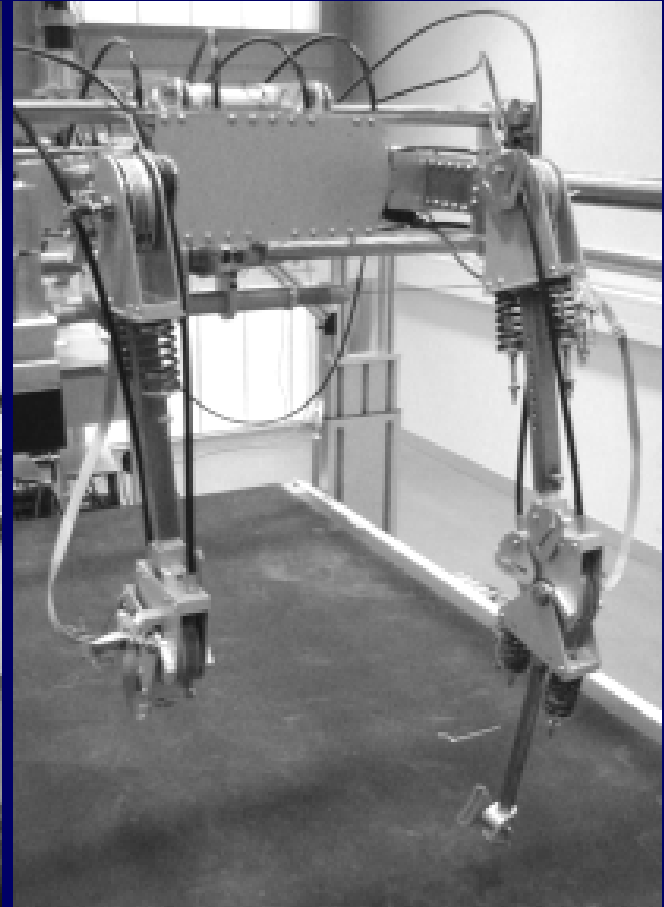
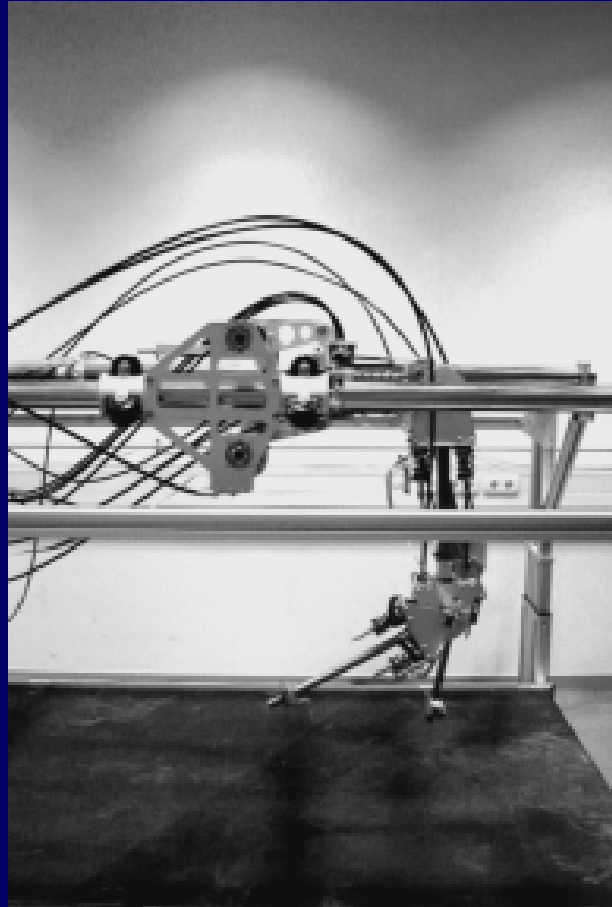
LOCOMAT - Hacoma, Zurich

- commercial device
- gait generation (no impedance, just position)
- spinal cord injuries
- mainly research applications



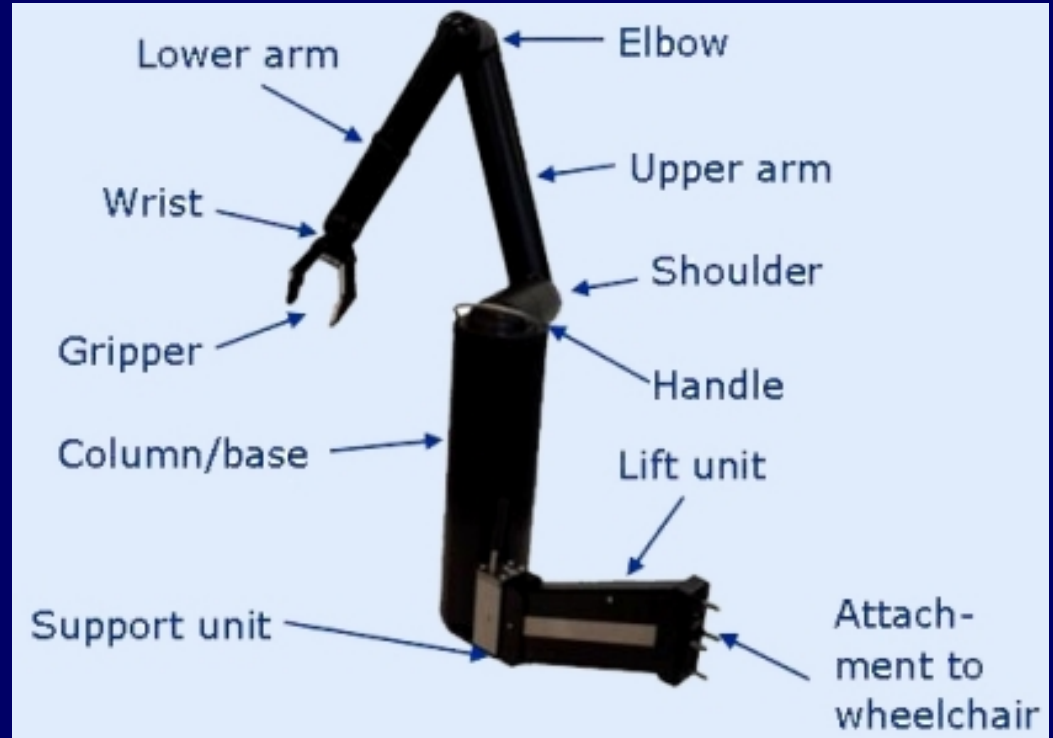
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LOPES – University Twente



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WHEELCHAIR ROBOTS - ARM

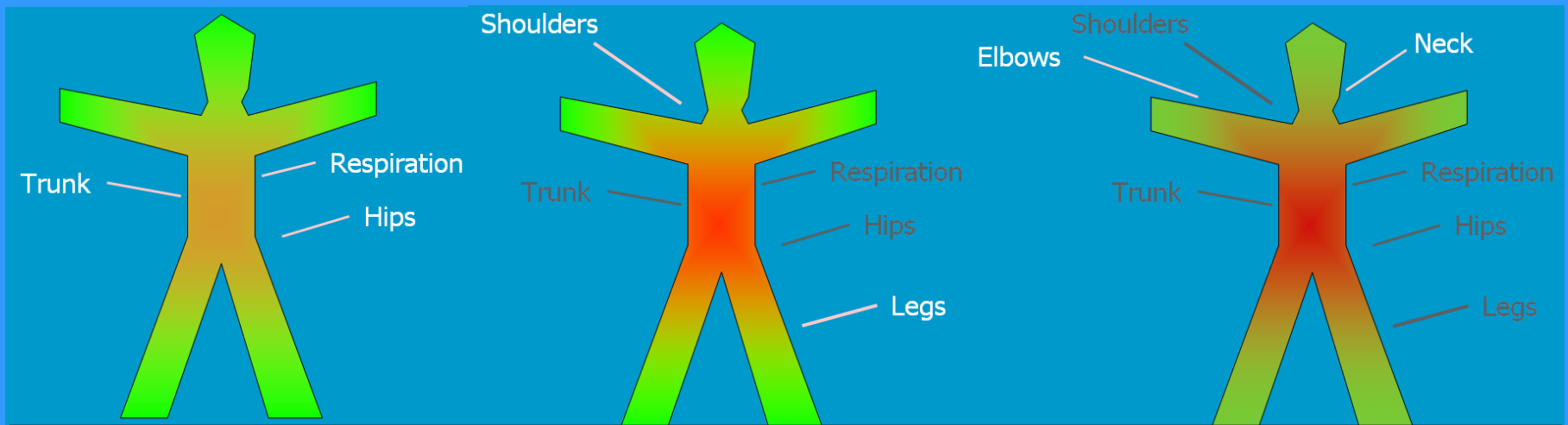


Spinal Muscular Atrophy (SMA)

Affects motor neurons voluntary muscles

Senses not affected, normal or above-average intellect

Inherited, Incurable, Progressive



Two of our volunteers!

A



Academic degree
Head support
Scoliosis, A had surgery, B not
Wheelchair bound
Arm on armrest
Good sense of touch
Slight deformations
in hands

B



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Different concepts

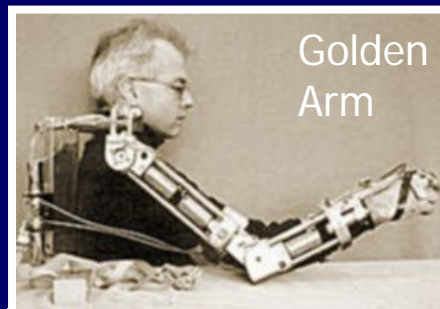
1: Separate Manipulators



Weston

Manus ARM

2: Powered Orthoses



Golden Arm



MULOS



WREX

3: Passive Orthoses



Universal Radial

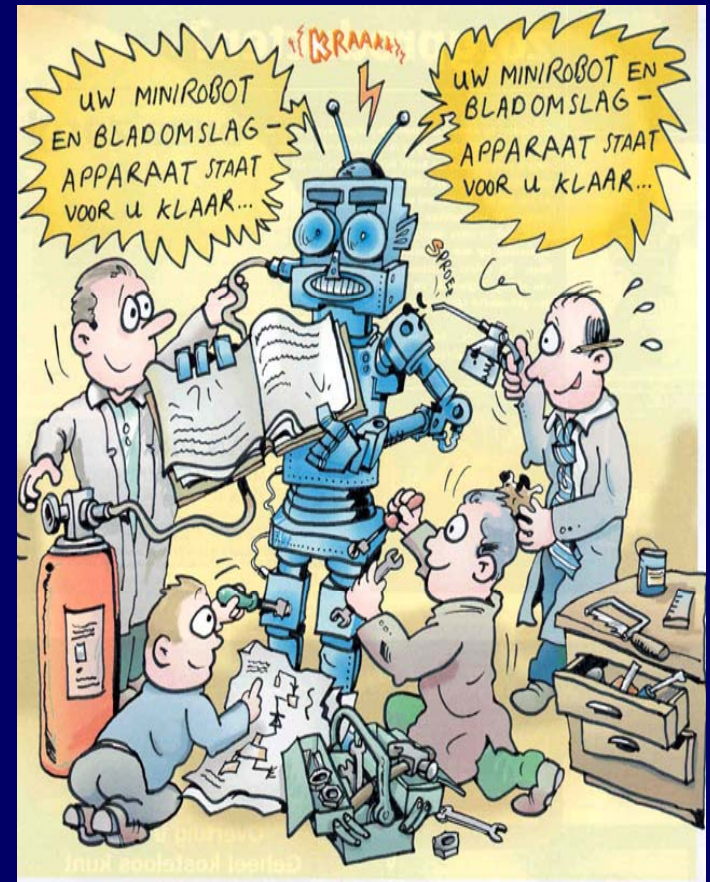


Focal TOP

Clinically driven approach

Home visits

- Independence
 - Personal Hygiene
 - Cooking, eating
 - Computer work
- Social activities
 - Have dinner
 - Shake hands
- Trunk balance
 - Arm rest essential
- Inconspicuous!

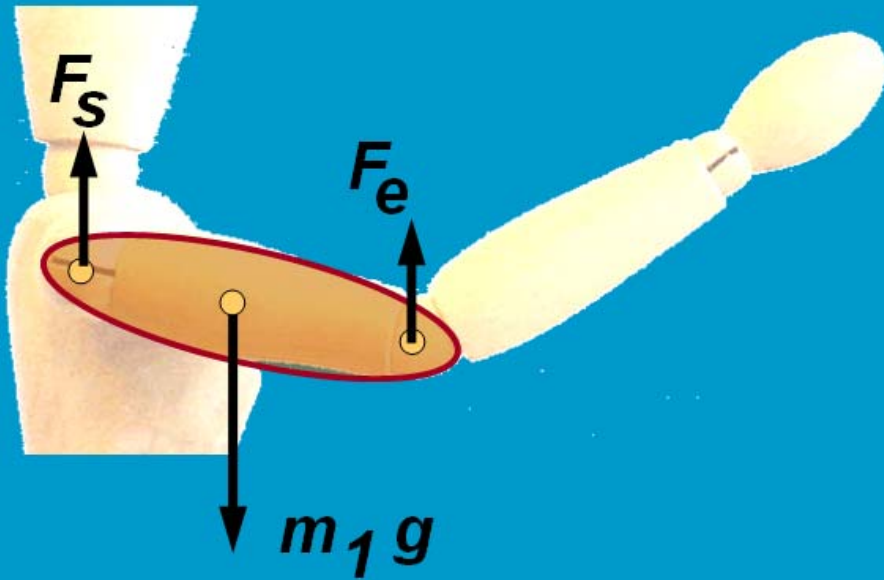


"Your page turner is ready..."

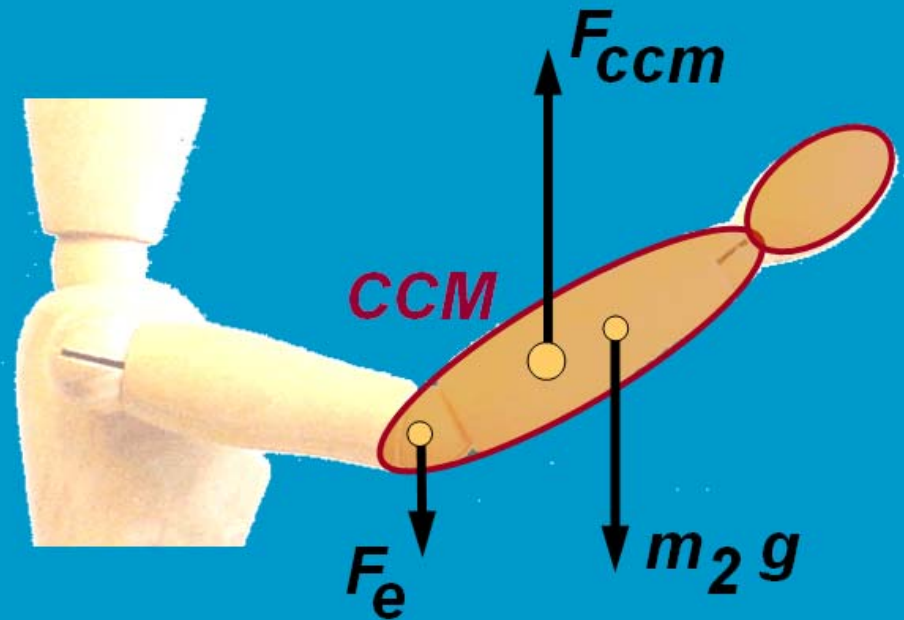
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Conceptual design

Force analysis revisited



F_e and F_s constant
 F_s by shoulder

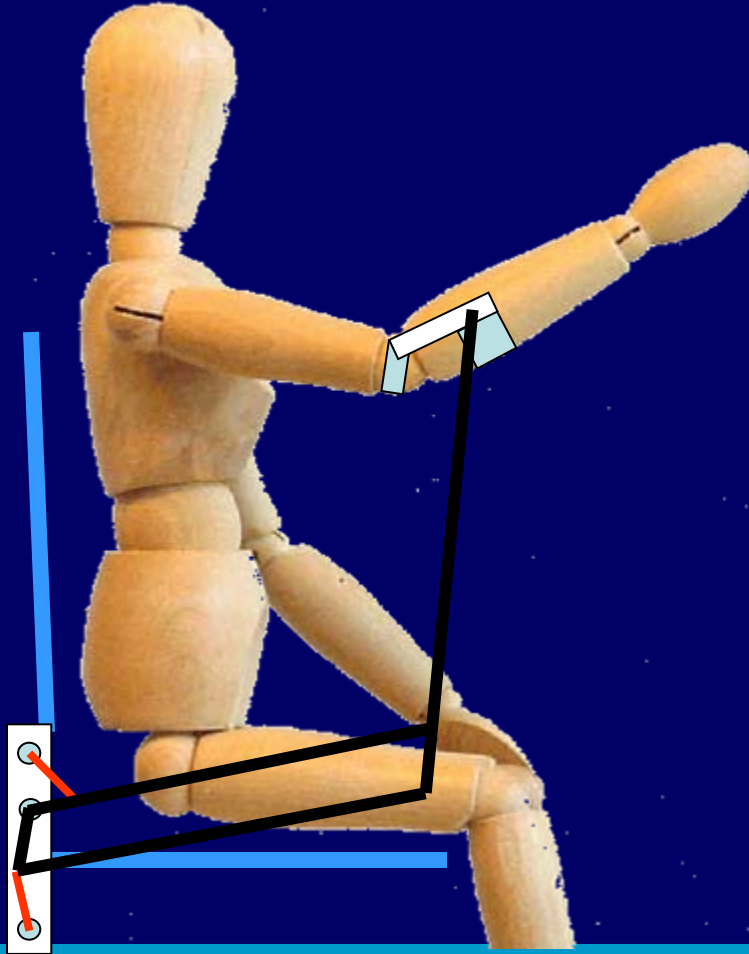


F_e and $m_2 g$ constant
 F_{ccm} for complete arm

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Conceptual design

Working principle

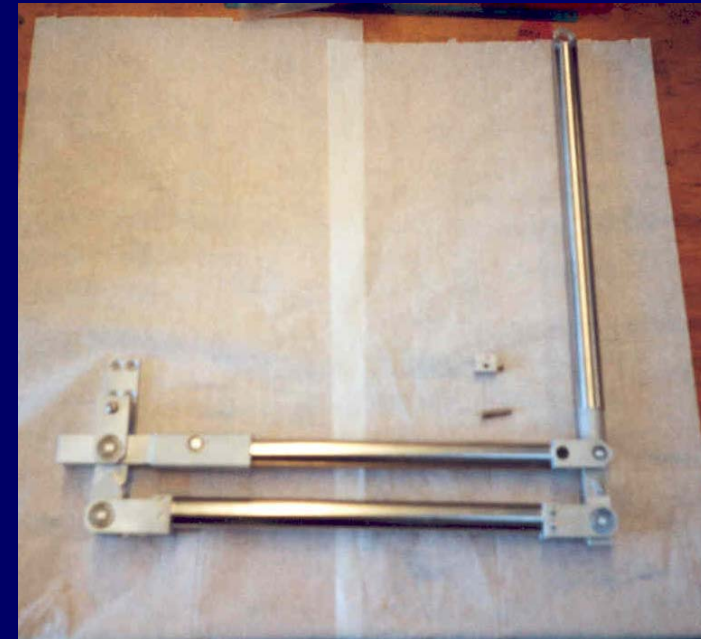
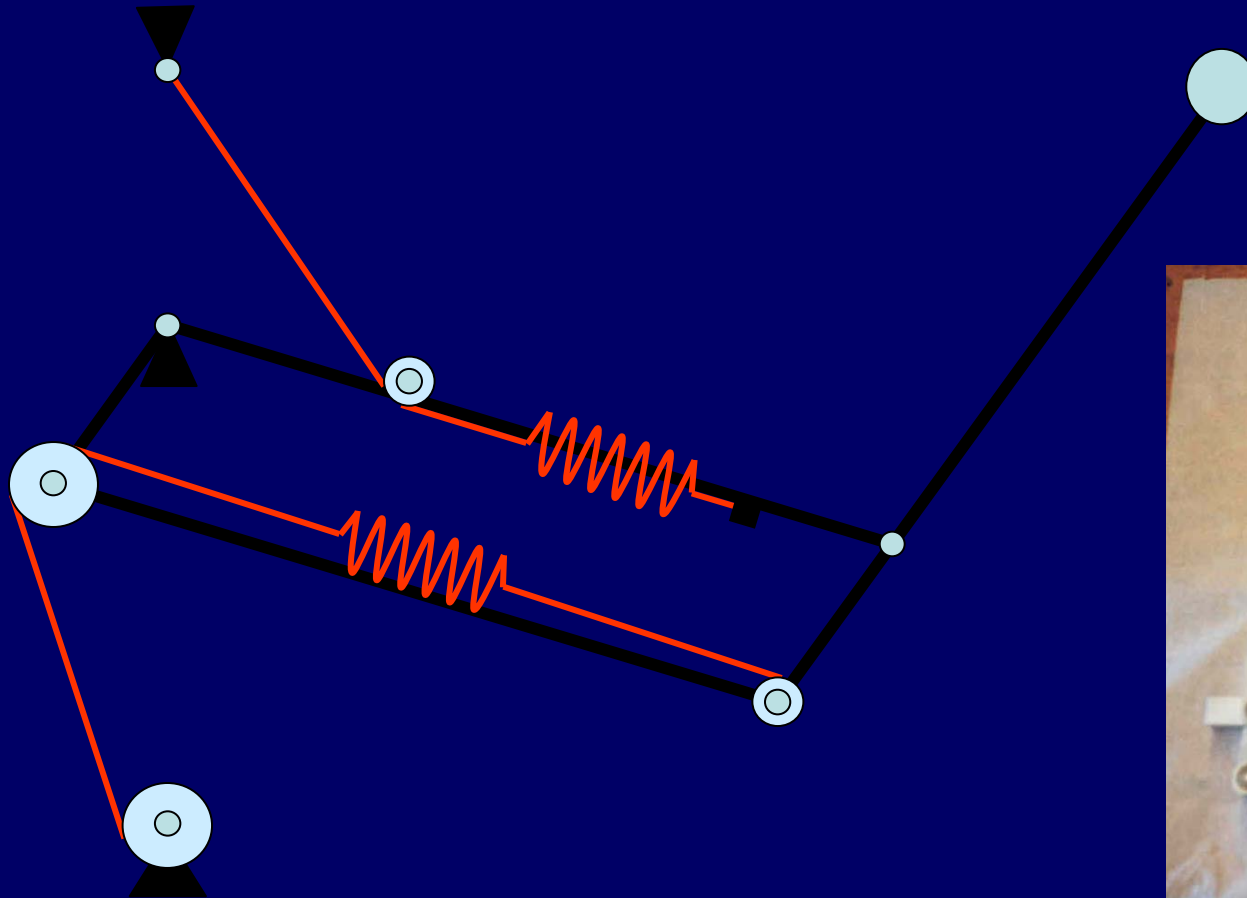


No longer alongside arm
Arm rest maintained
Inconspicuous

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Conceptual design

Working principle



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Preliminary clinical testing

Moving arm up



Herder, Tomazio, Cardoso, Gil and Koopman, 2002

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Patent pending

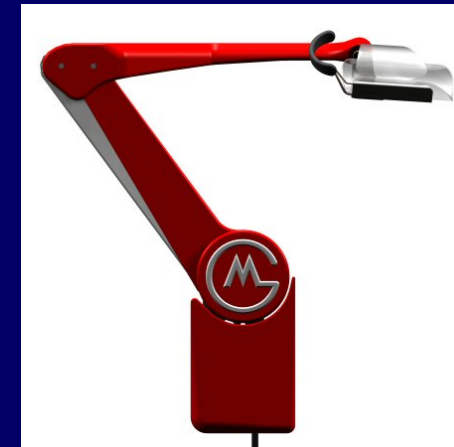
ARMON (Mark II) Patients with the device



Herder, Stralen, Lucieer, Gal and Antonides, 2004

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ARMON (Mark III) First commercial product



Herder, Vrijlandt, Antonides, Cloosterman, Mastenbroek, 2006

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Patent pending

www.microgravityproducts.com

TU Delft

ARMON (Mark III)

Patients with the product



Herder, Vrijlandt, Antonides, Cloosterman, Mastenbroek, 2006

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Patent pending

www.microgravityproducts.com

TU Delft

Protheseses

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PROSTHESIS

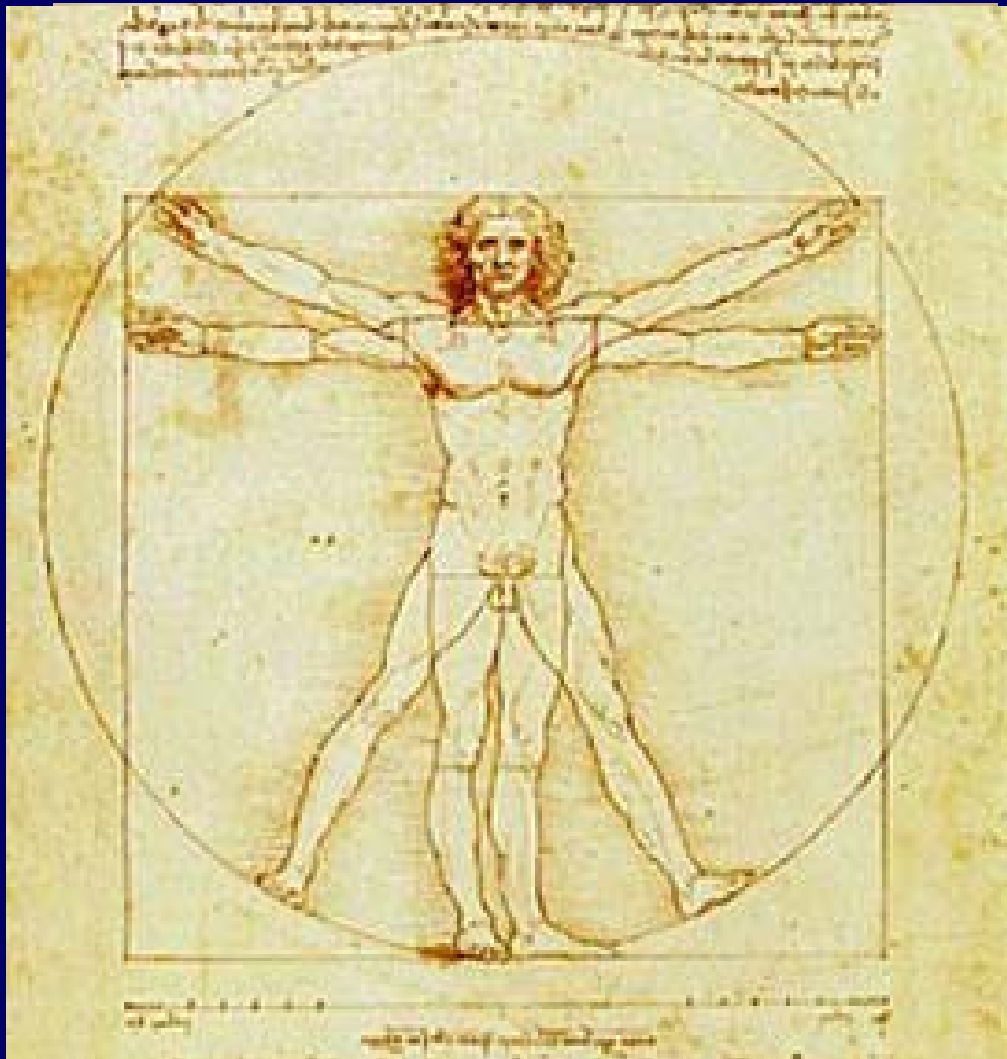
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ARTIFICIAL SUBSTITUTE OF A MISSING
PART OF THE BODY

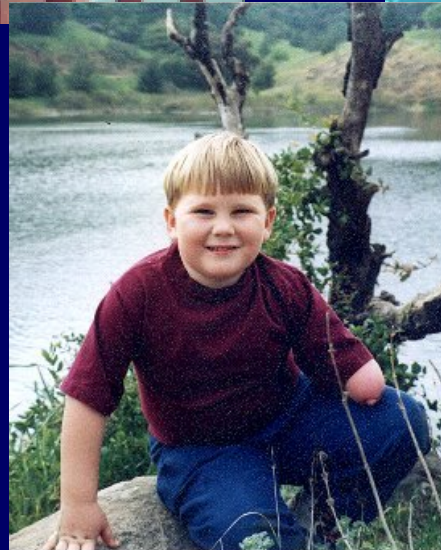
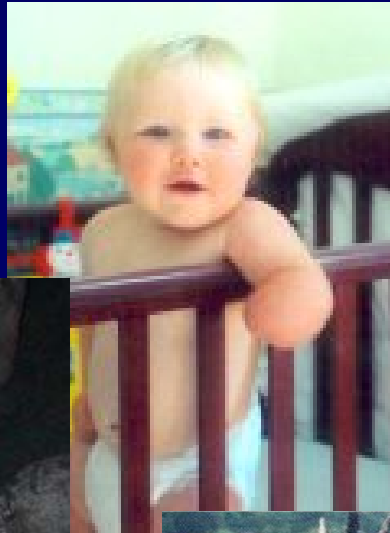
Prosthesis

Ethyology: from Greek: *pros* = to
tithenai = to place

Prosthesis = to place something to or against



congenital



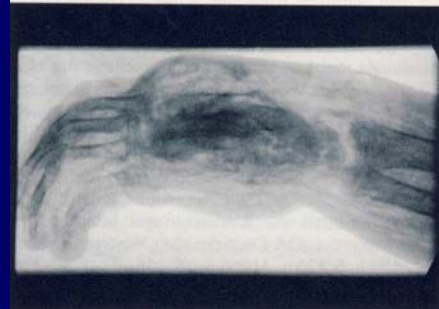
THALIDOMIDE



Issued in 1956 by Chemie Grünenthal to fight nausea and sleeping problems in pregnant women.

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acquired

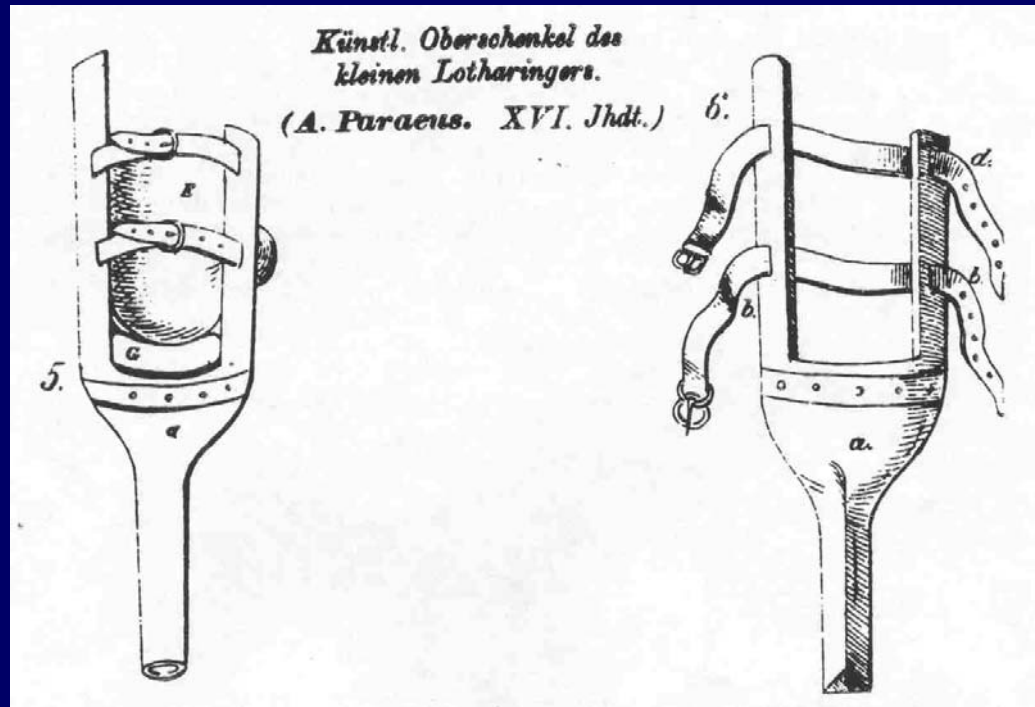


Prostheses – lower limb

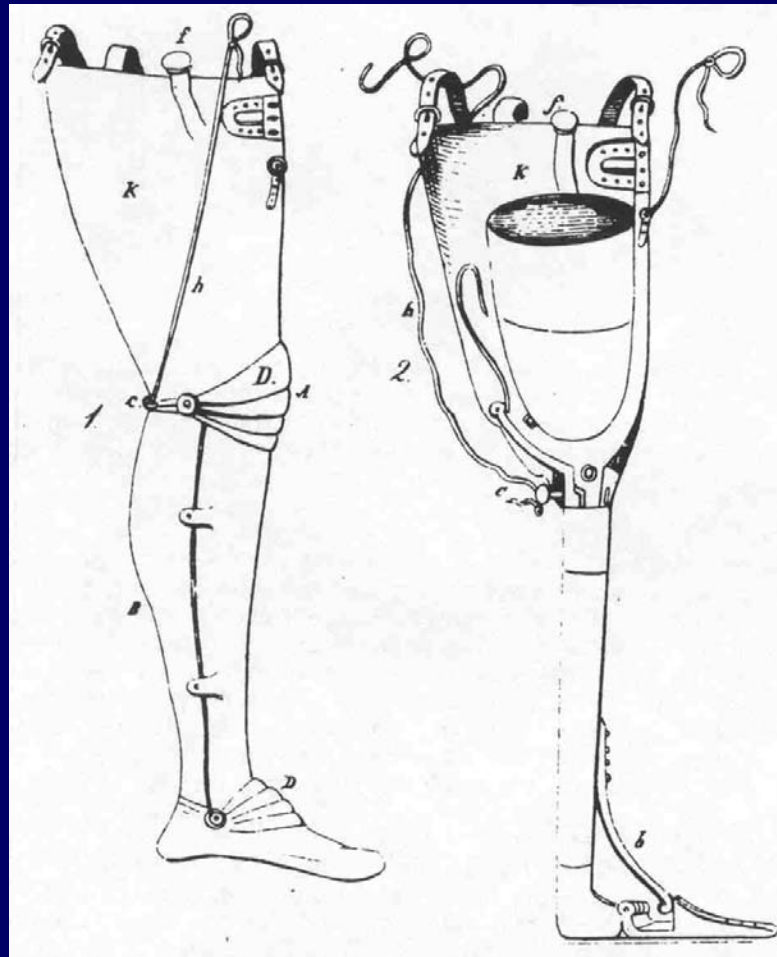
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Ambroise Paré (1510-1590)



Prosthesis of Paré



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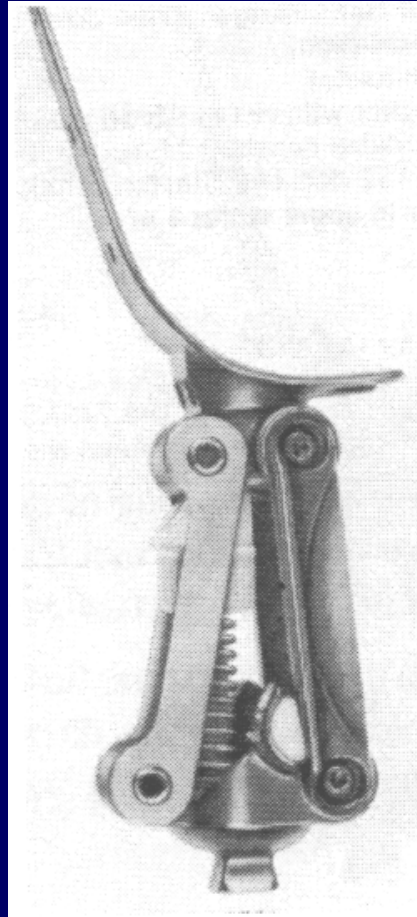
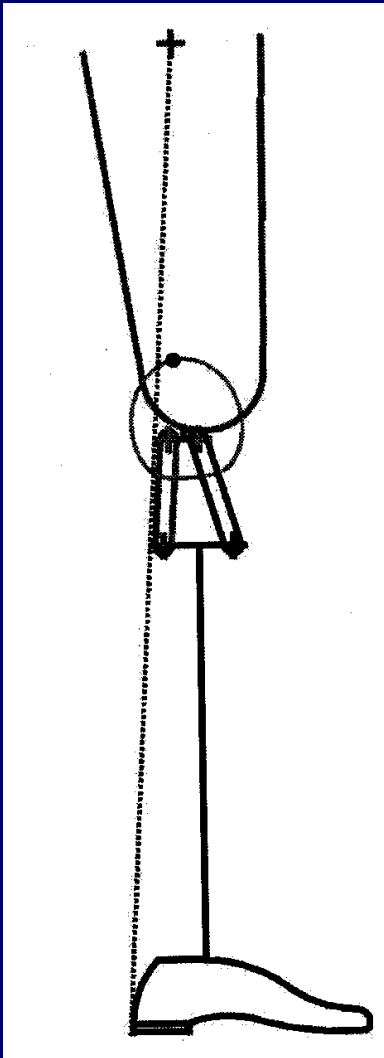
Peter Stuyvesant

1612 - 1672



Peg leg Pete





4-axial knee:

- Improve local stability
- Improve controllability
- No actuation!

Otto Bock[®]

QUALITY FOR LIFE

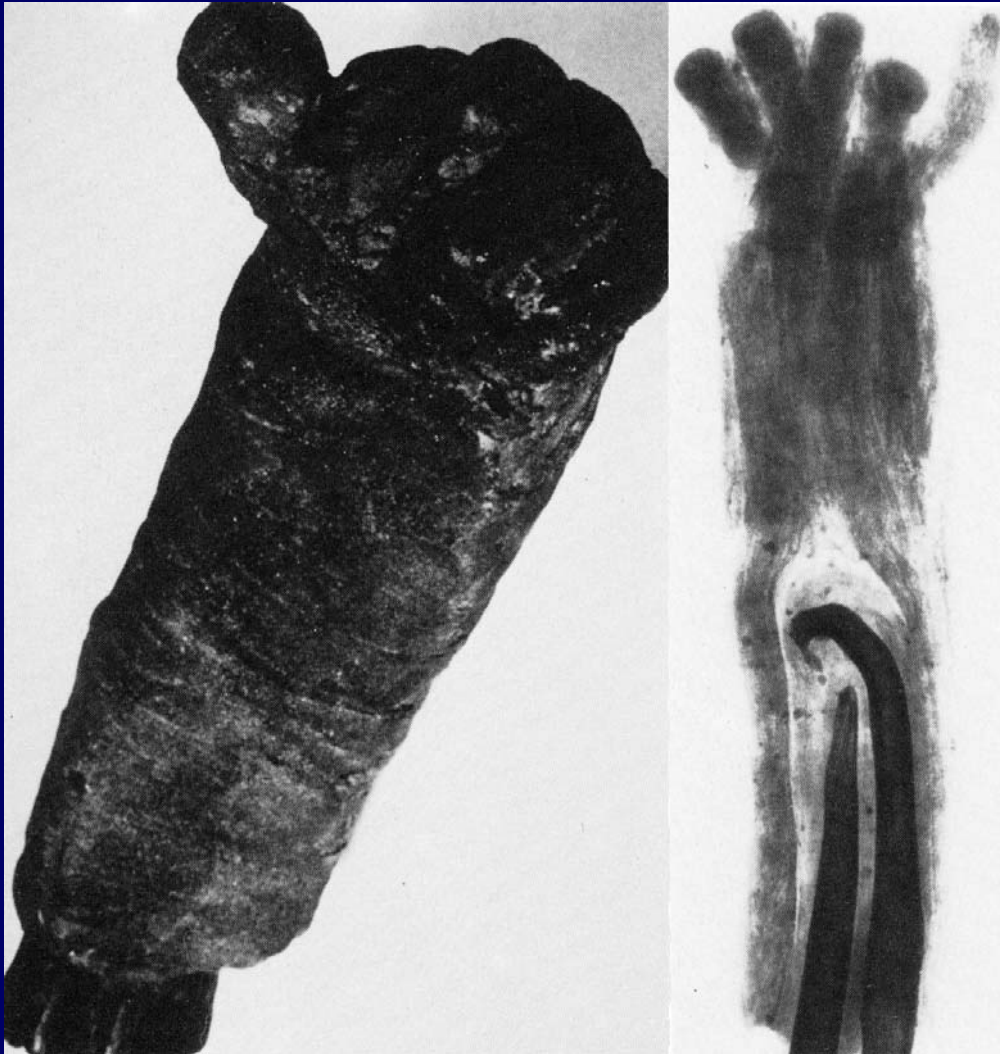
C-leg



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Prostheses – upper limb

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Egypt, 330 BC [Löffler, 1984]

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Florence, 15th century [Löffler, 1984]

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Götz von Berlichingen

1480 - 1562



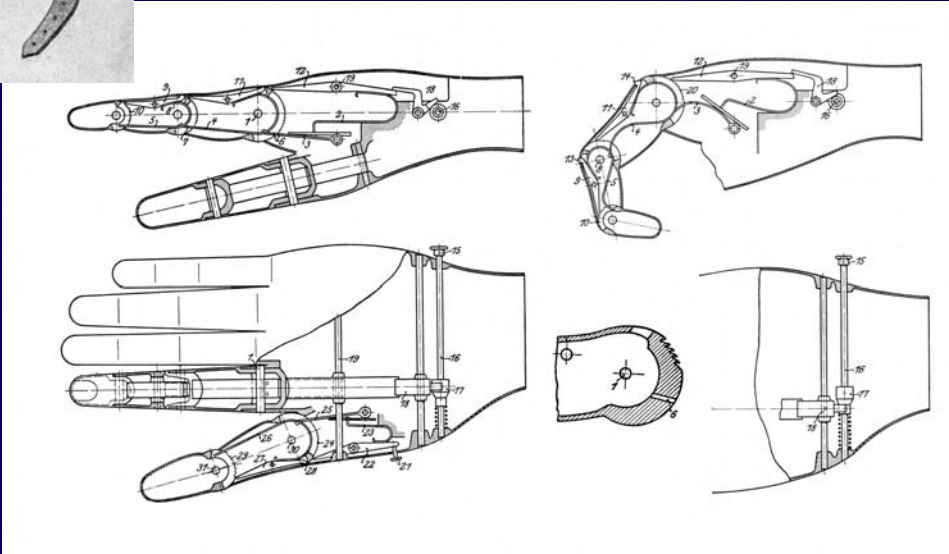
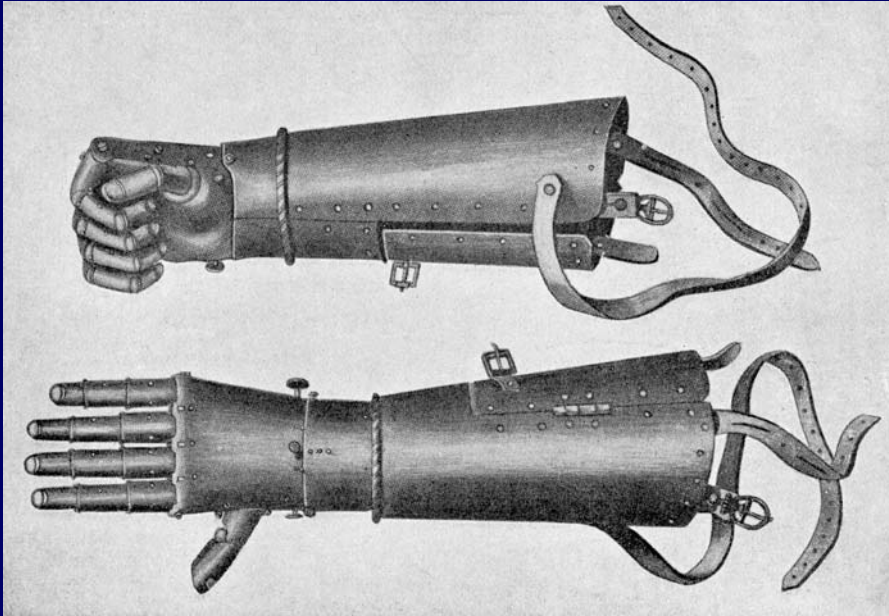
Götz von Berlichingen, ± 1504 [Löffler, 1984]

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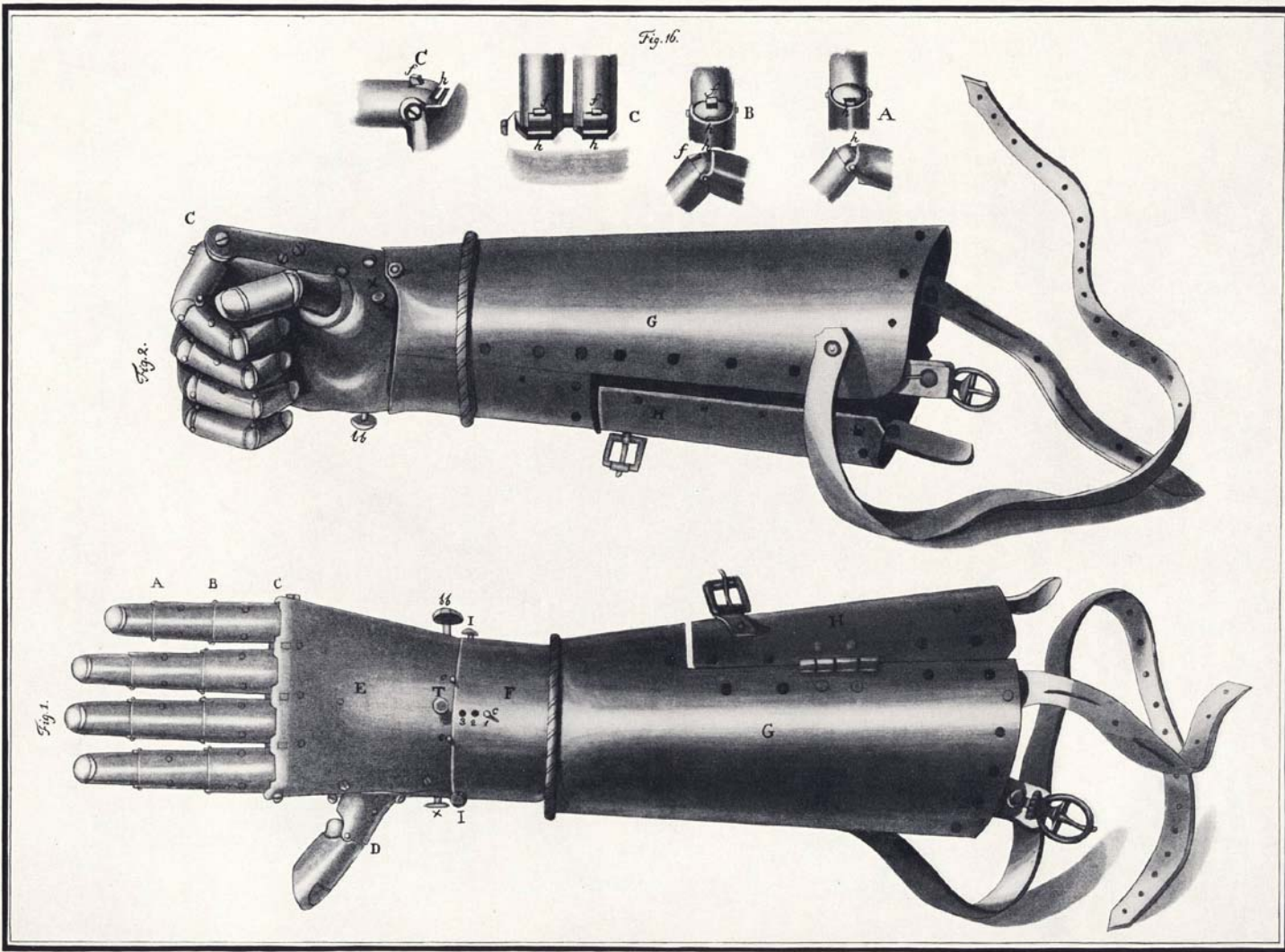
Johann Wolfgang Goethe, 1773

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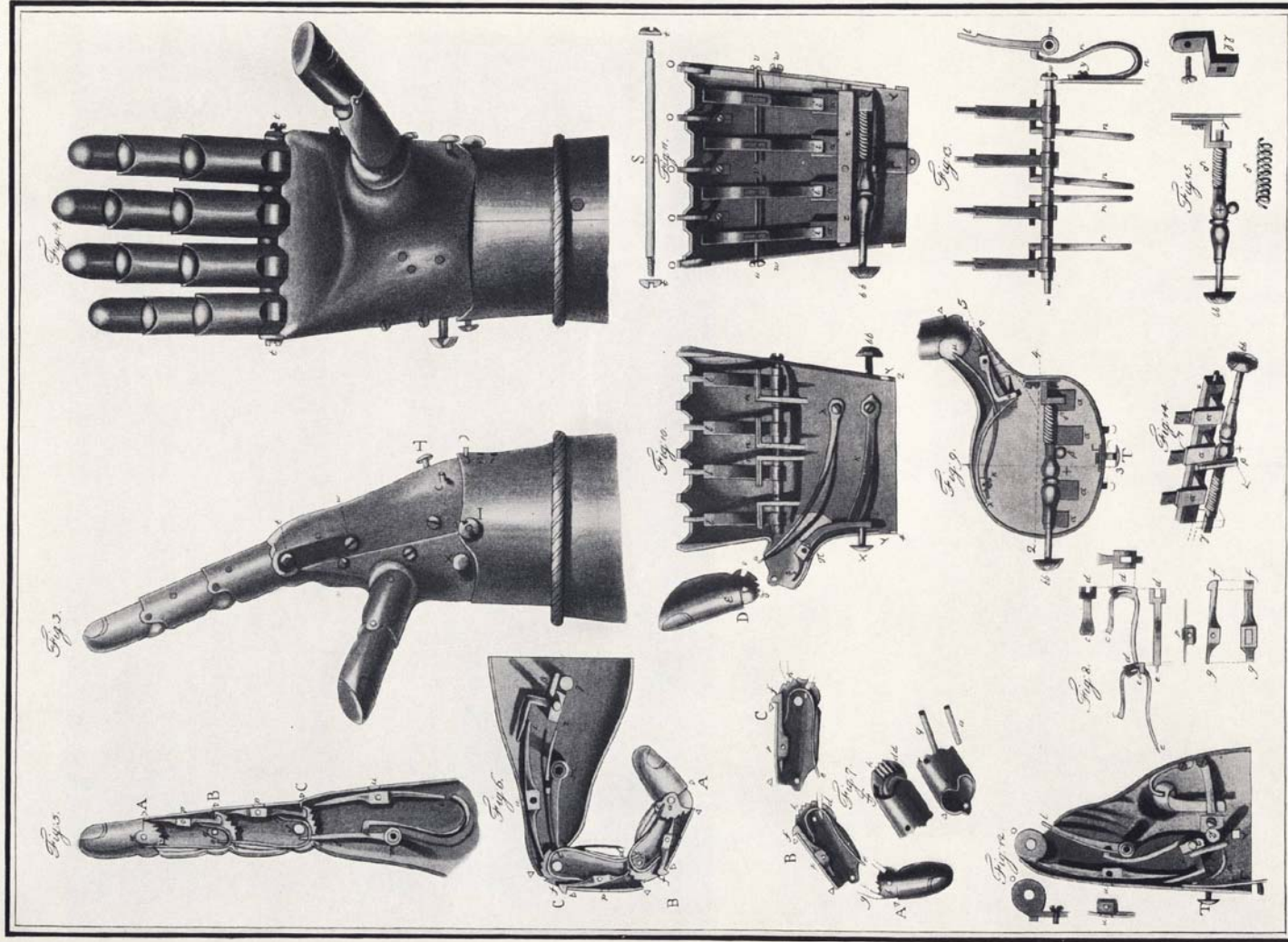
Götz von Berlichingen, 1509 [Borchardt et.al., 1919]

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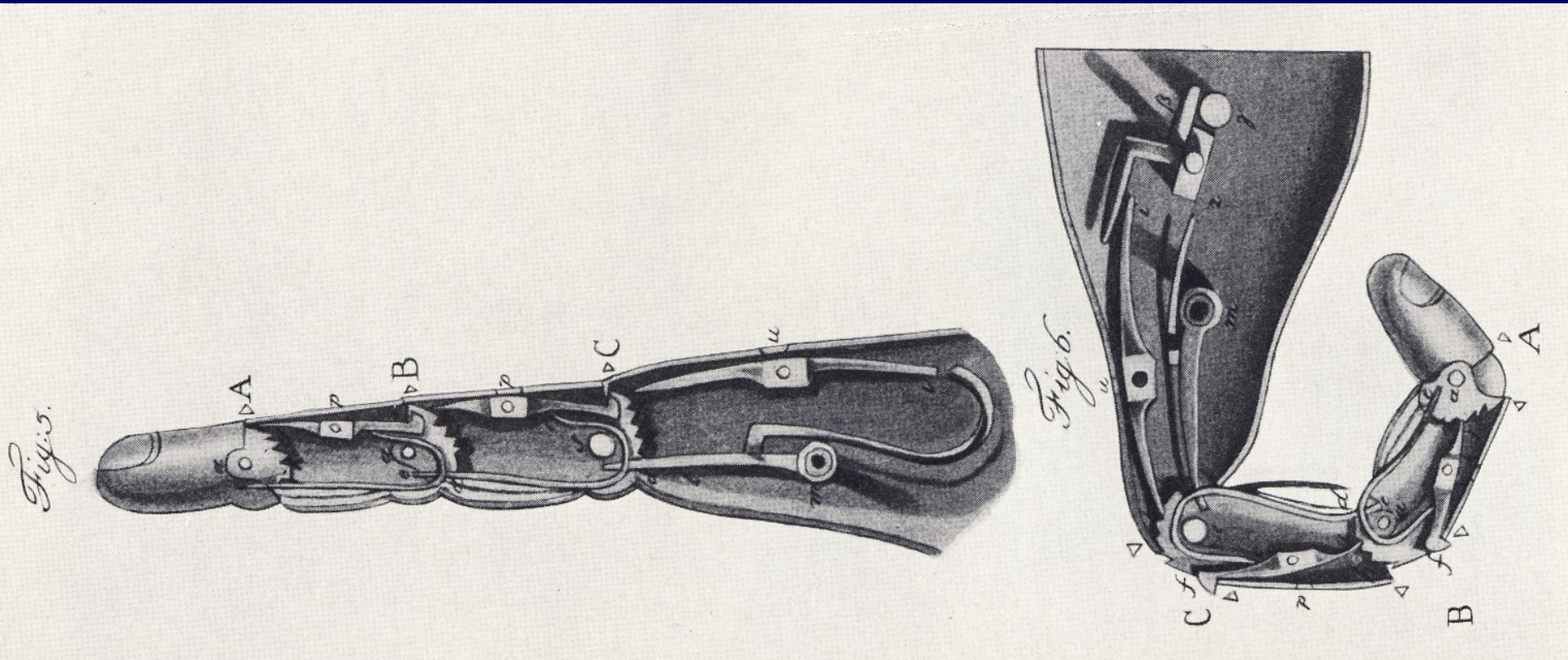


*Die handhoute eiserne Hand des Ritters Götz von Berlichingen.
nach dem bey seiner Familie in Francken aufbewahrten Original abgebildet von Ch. von Mechel*

TAB. II



Gez. von Bestehingens eisene Hand, nach ihrem inneren Kunstweisen Mechanismus,
und allen zu demselben gehörenden einzelnen Theilen richtig abgez. sieben

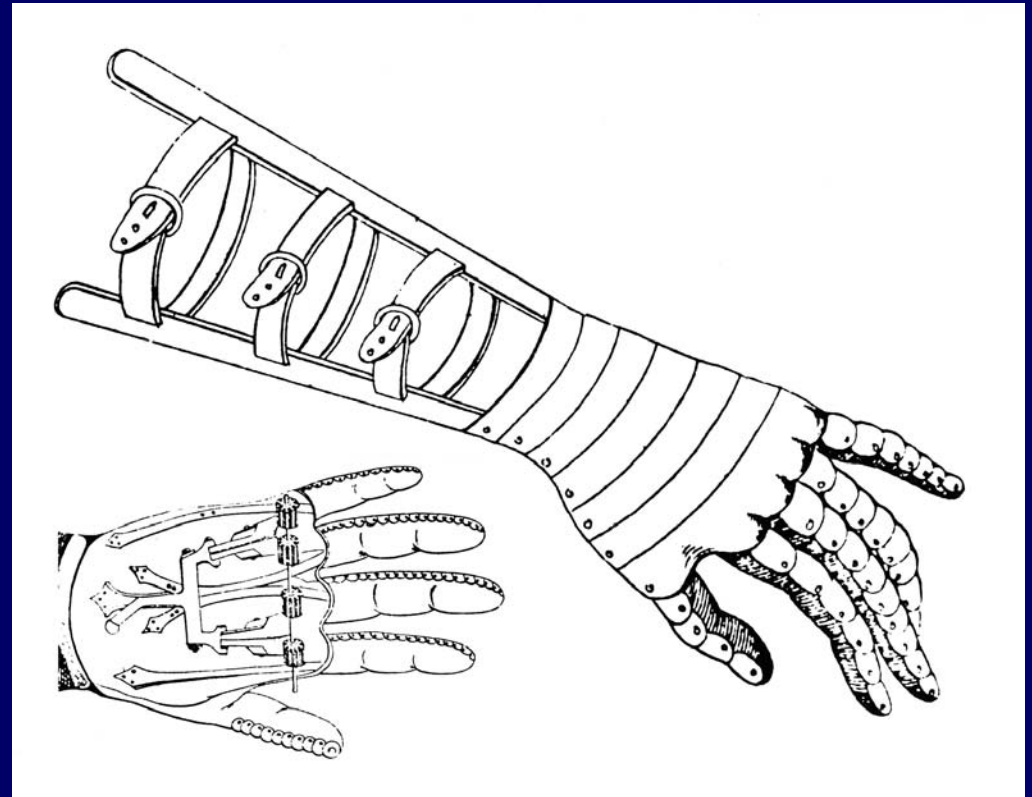


Christian von Mechel, 1815

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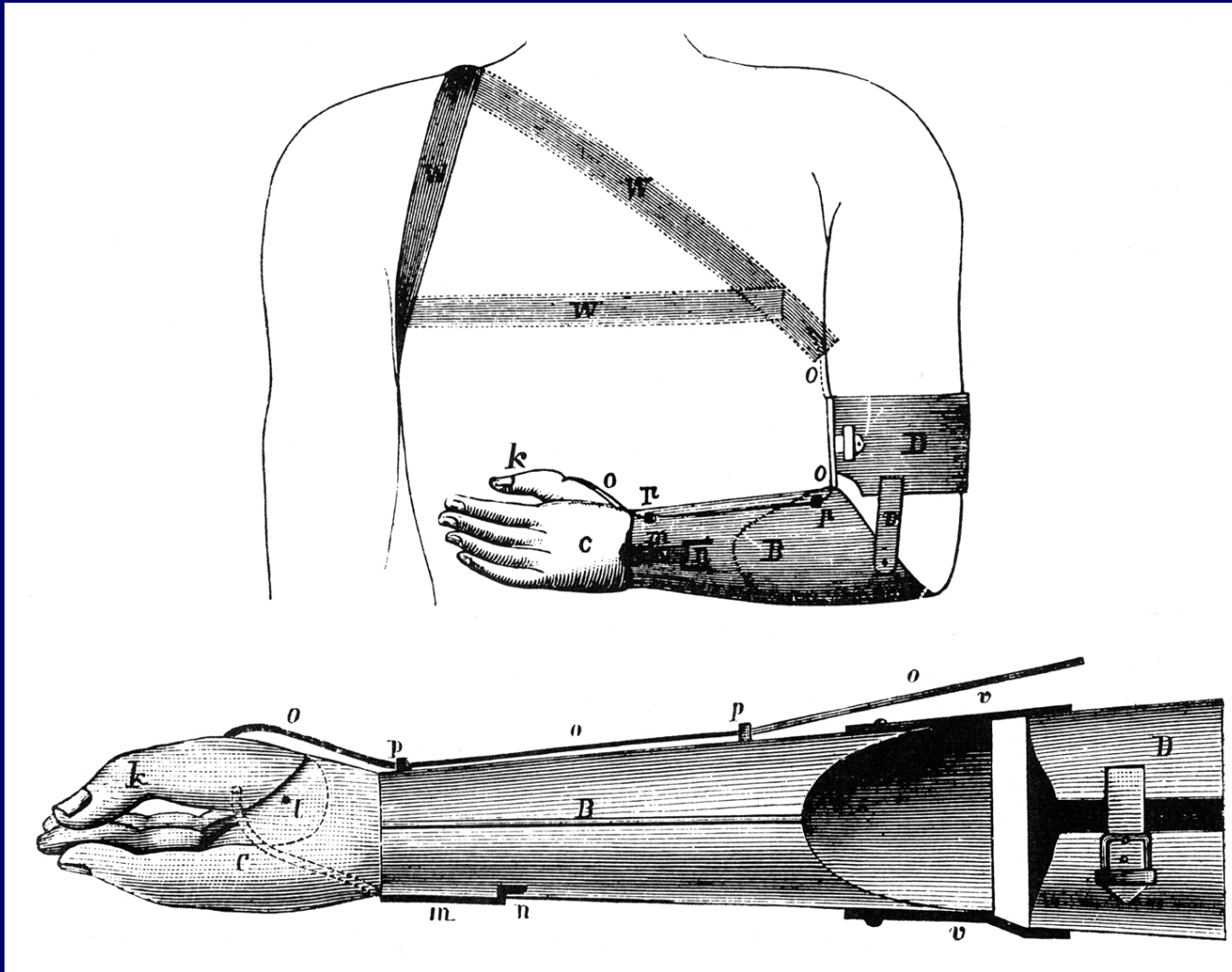
Ambroise Paré

1510 - 1590



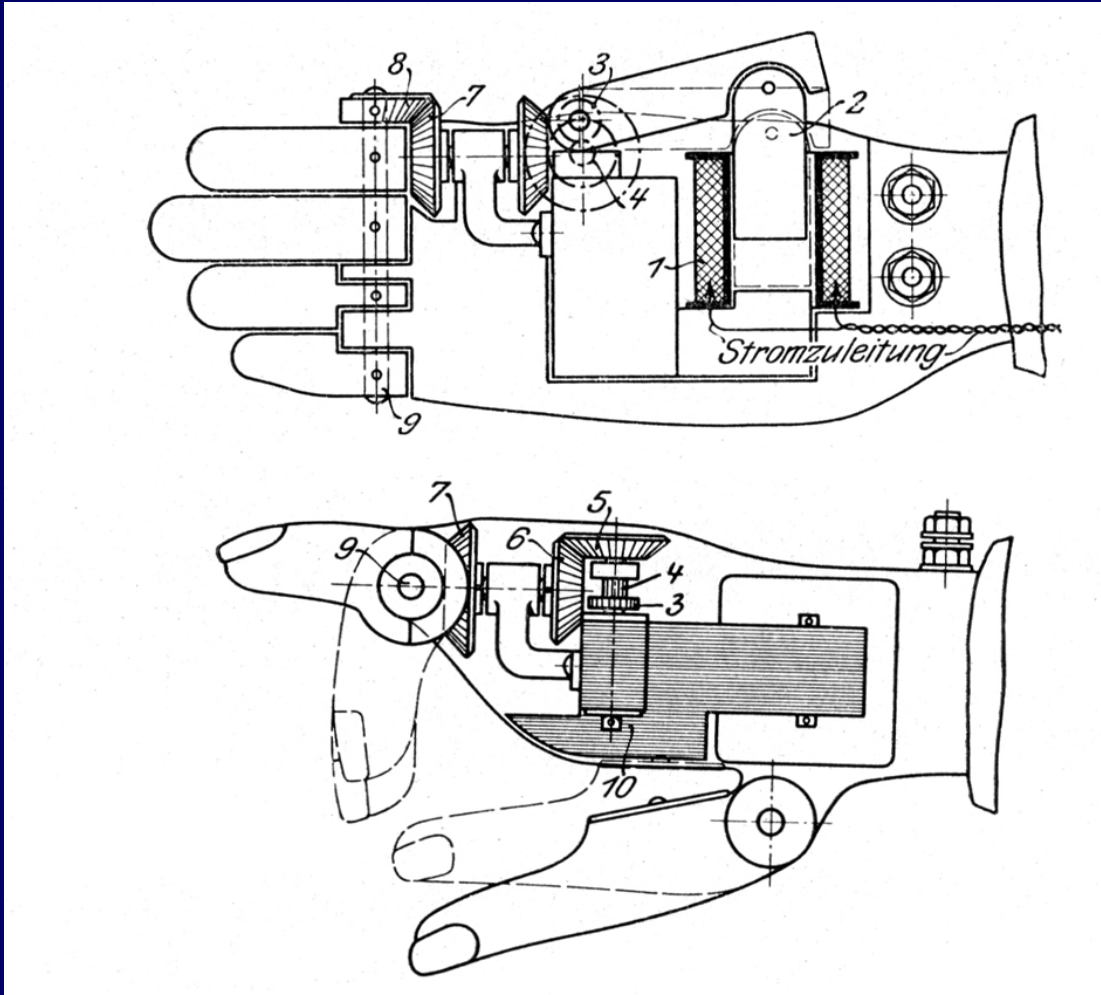
Ambroise Paré, 16th century [Löffler, 1984]

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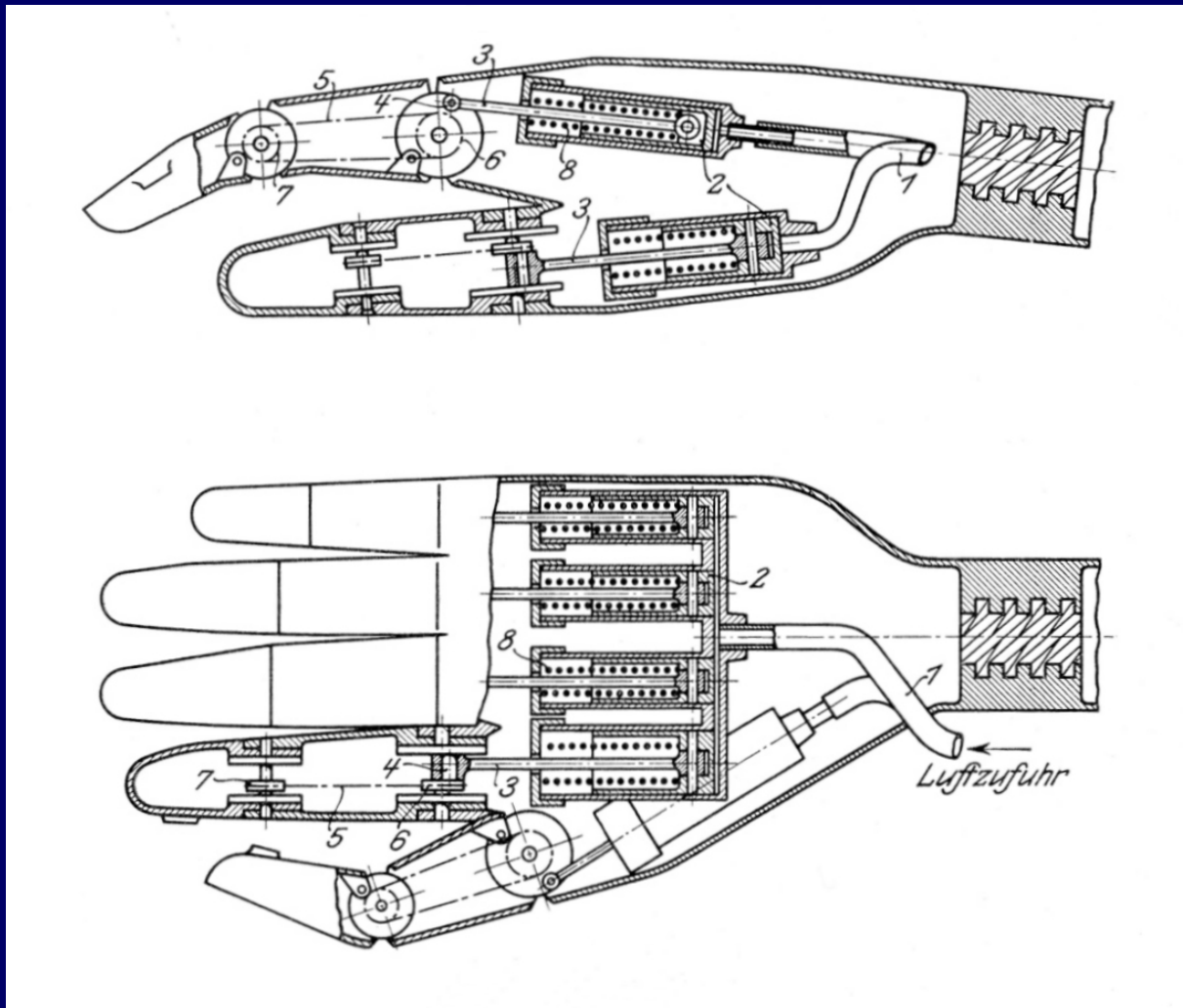


Count of Beaufort, 1860
 [Löffler, 1984]

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Borchardt et.al., 1919



Borchardt et al., 1919

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arm prostheses

passive

active

cosmetic

tools

body power

external power

hybrid prostheses

cosmetic hand prosthesis



Näder, 1990

passive hand prosthesis



WILMER®

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tools

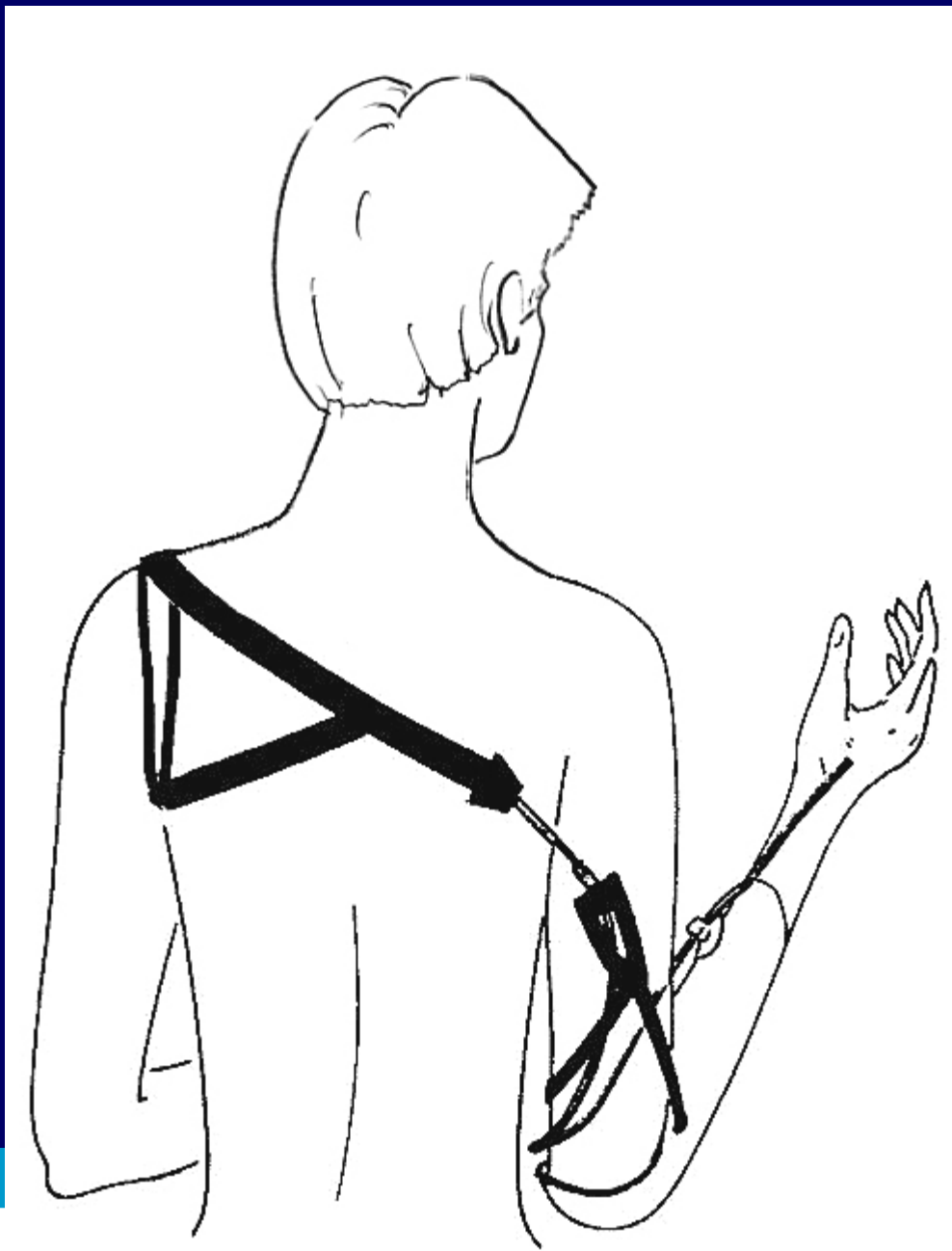


Otto Bock Healthcare GmbH

RSL-Steeper, UK

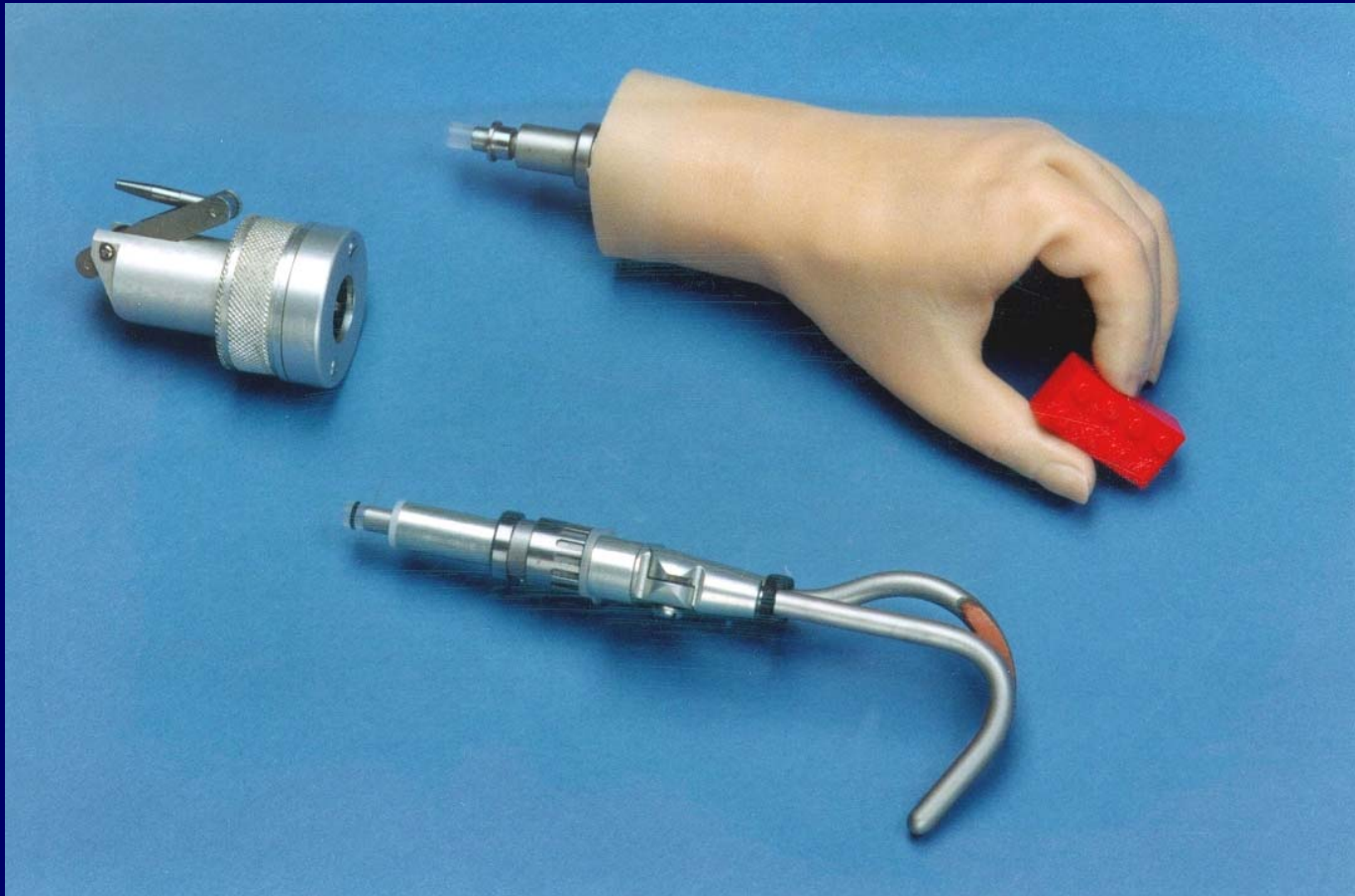


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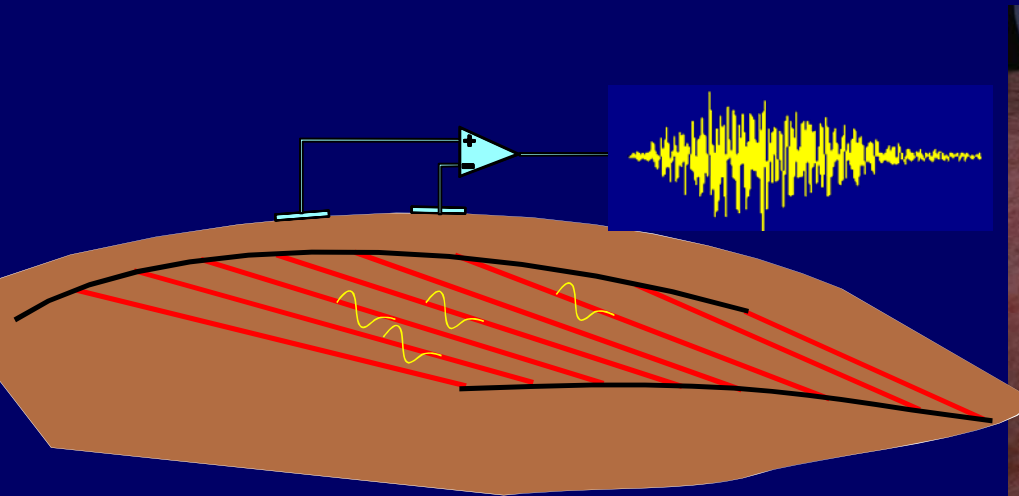
BODY POWERED TERMINAL DEVICES



WILMER®

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muscle activation signal: Electro Myo Gram (EMG)



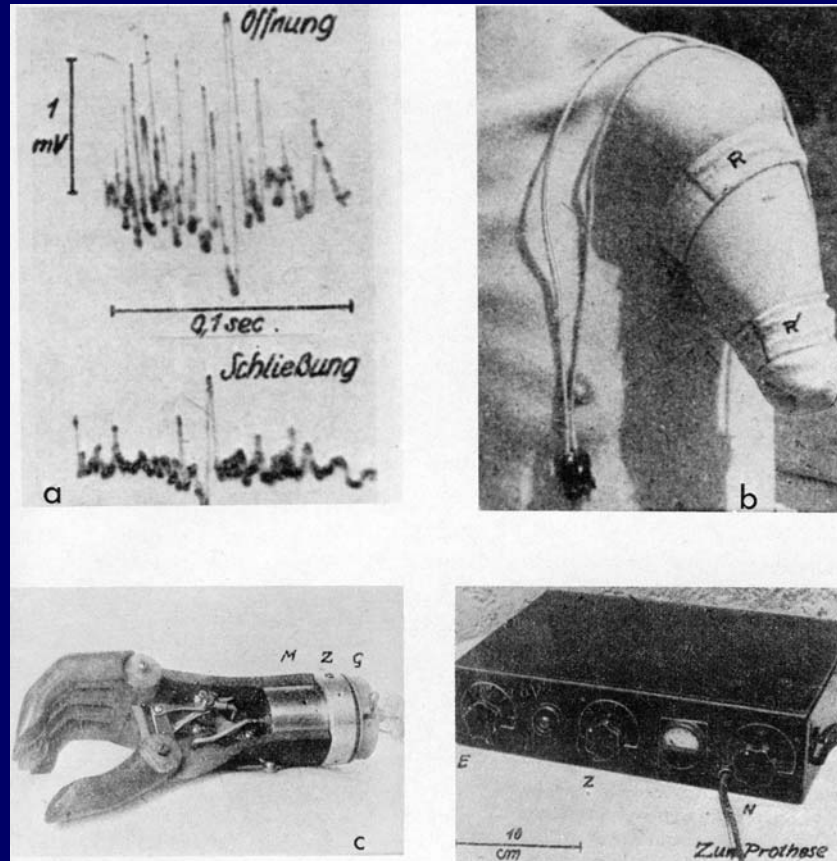
EMG is the summation of many **asynchronous** Motor Unit Action Potentials



Electrode mounted amplifier
differential lead-off

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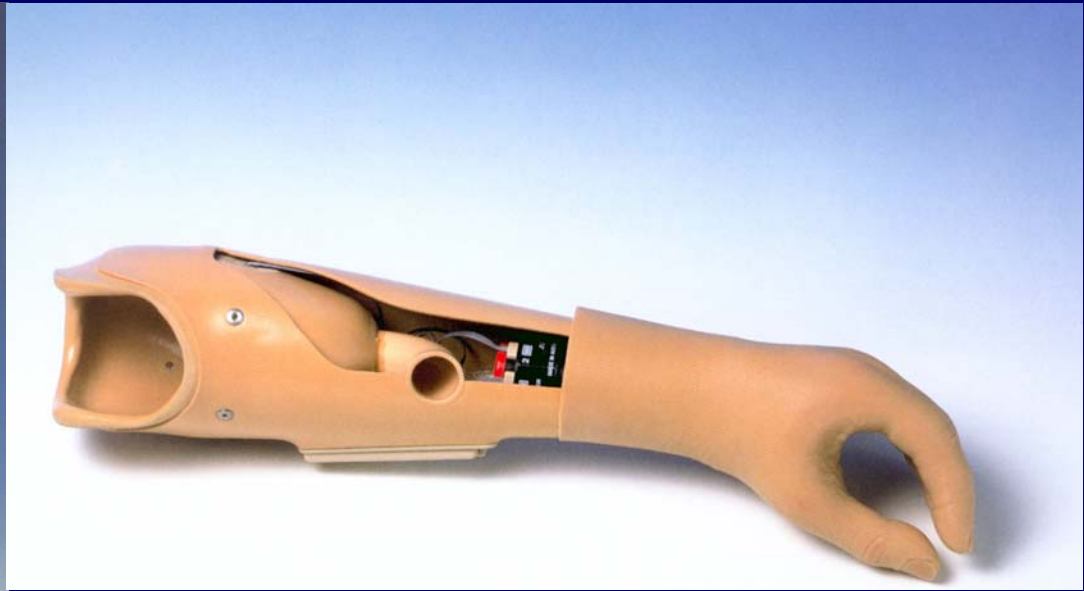
REITER, 1948



[Childress & Billock, 1970]

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- EXTERNALLY POWERED TERMINAL DEVICES



Otto Bock Healthcare GmbH



HANDIG

Vaardigheden van kinderen met een reductiedefect van de onderarm

UOPO

innovative upper extremity prostheses and orthoses



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Partners

- Ambroise bv

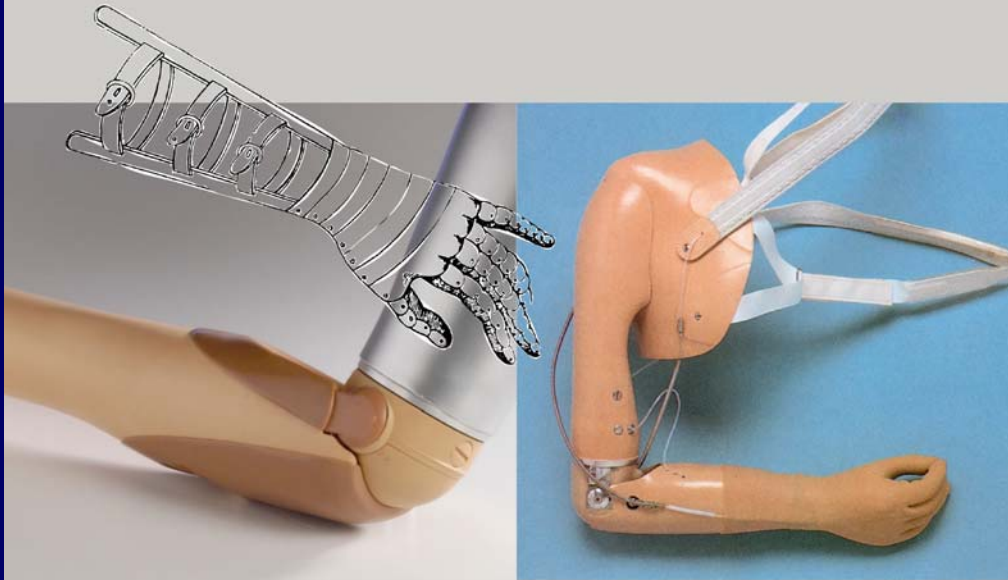
Ambroise

- Delft Prosthetics bv

DELFT PROSTHETICS

UPPER EXTREMITY PROSTHETICS

CURRENT STATUS & EVALUATION



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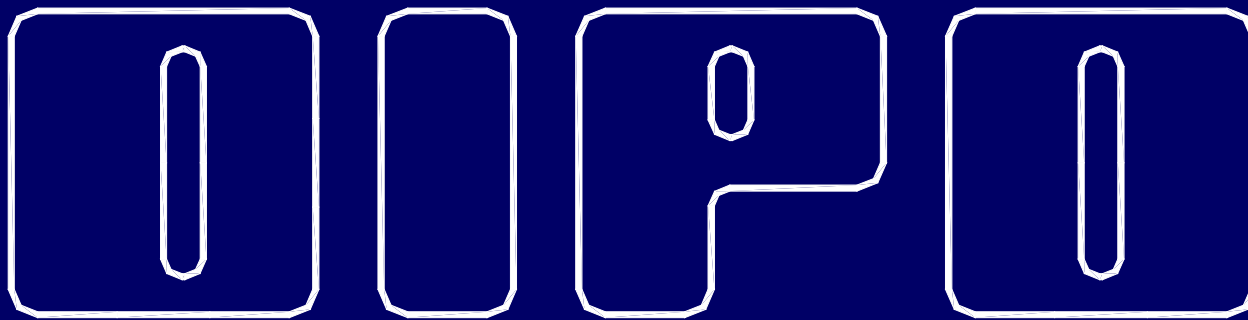
Publisher: VSSD – Delft
www.vssd.nl/hlf/m011.htm

ISBN 978-90-71301-75-9

Euro 21.50

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Delft Institute of Prosthetics and Orthotics



innovative upper extremity prostheses and orthoses

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www.dipo.3me.tudelft.nl