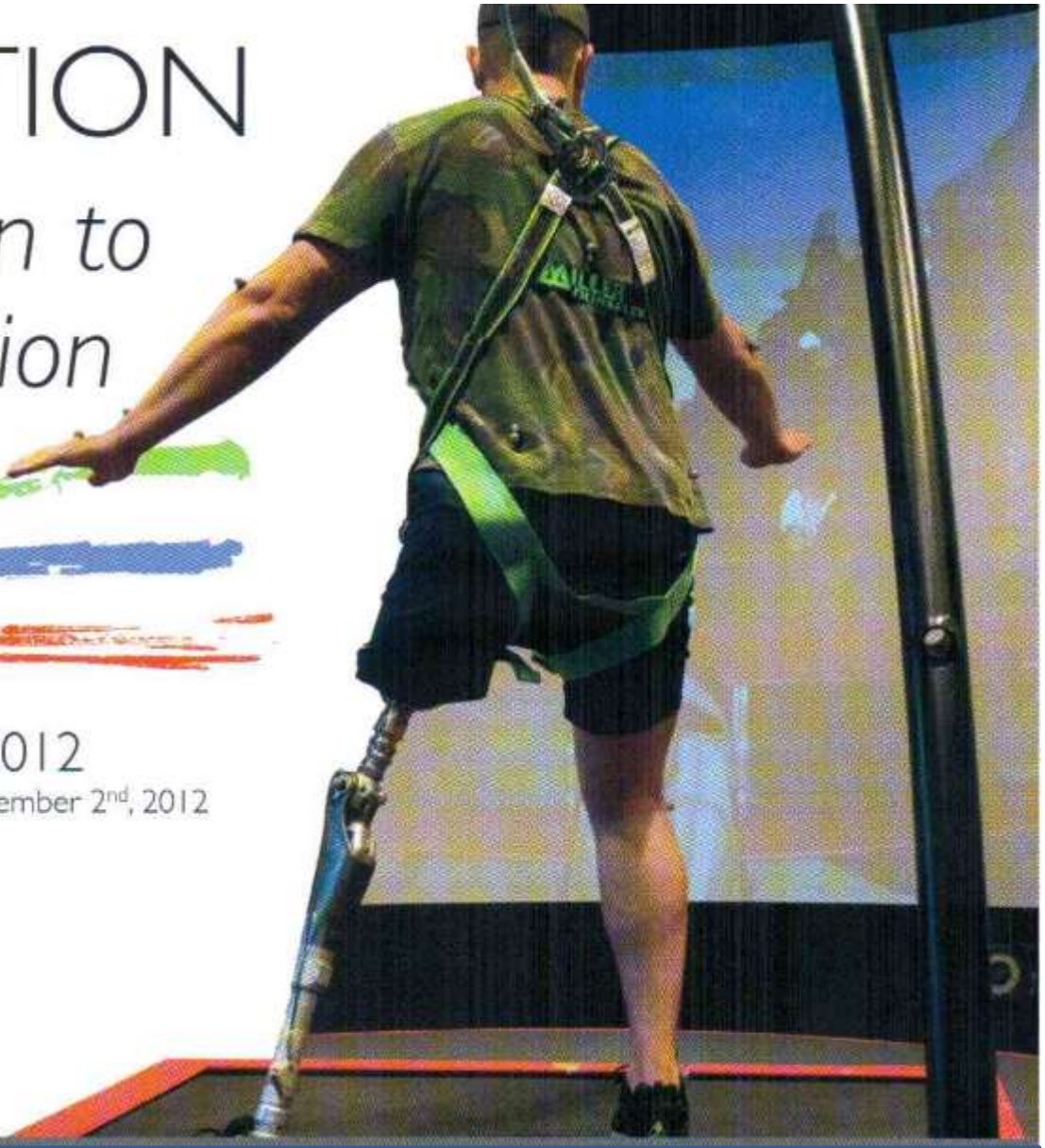
INNOVATION

From creation to implementation



VRA Annual Congress 2012

Thursday November 1st and Friday November 2nd, 2012

3D Minisymposium, Friday November 2nd: ***Wheeled mobility: an ergonomics perspective***

Annual Congress 2012 of the Netherlands Society of Physical and Rehabilitation Medicine

'Innovation: from creation to implementation'

VRA NEDERLANDSE VERENIGING VAN REVALIDATIEARTSEN

Wheeled mobility: an ergonomics perspective

Sonja de Groot, Riemer Vegter, Marieke Kloosterman, Floor Hettinga, Linda Valent, Lucas HV van der Woude

rijksuniversiteit groningen

WHEEL-i

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NEDERLANDSE VERENIGING VAN REVALIDATIEARTSEN

Restoration of mobility in SCI rehabilitation, *outcome measures at all levels of ICF*

Lesion characteristics
Secondary impairments,
Co-morbidity

Cardiova
functions
& sensory functions

Wheeled mobility

sports, family,
friends

Rehabilitation, AT, strategy,
treatment, exercise, training

Age, cultural background,
coping, fitness, gender,

ICF, 2001

VRA
NEDERLANDSE VERENIGING VAN REVALIDATIEARTSEN

roll, air, int friction
gear ratio/mechan. advantage
seat position/form
propulsion mechanism
work capacity
anthropometry
sex, age
handicap

Oxygen
Foodstuff

WHEELCHAIR-USER | INTERFACE | WHEELCHAIR

$P_{out} = F \cdot V$

$P_{out} = ME \cdot \dot{E}_n$

$P_{out} = A \cdot f_r$

P_{int}
P_{air}
P_{roll}
P_{incl}

displacement
velocity
acceleration

muscle use
coordination

propulsion technique
push force/angle/frequency

Objectives

The attendees will appreciate, learn and understand:

- the importance of an ergonomics perspective on wheeled mobility (and assistive technology in general) in rehabilitation practice and in daily life.
- the mechanisms and outcomes as well as measurement of physiological strain and work capacity in wheelchair arm work.
- The mechanisms and measurement of upper body overuse, strain and its long term consequences.
- The mechanisms of physical inactivity in wheelchair use and its health consequences.
- The preventive role of an active lifestyle with optimal conditions of wheelchair mechanics, wheelchair-user interface and wheelchair work capacity in the context of these long term health problems and quality of life.
- The role of wheeled mobility technology in maintaining a healthy and a productive life.

Wheeled mobility: an ergonomics perspective

.WHEEL-I: the development of a wheelchair propulsion lab for rehabilitation and sports
Sonja de Groot, Rehabilitation Center Reade, Amsterdam, Center for Human Movement Sciences, UMCG/RUG, Groningen

.Motor learning in handrim wheelchair propulsion
Riemer Vegter, Center for Human Movement Sciences, UMCG/RUG, Groningen

.Power assist wheelchairs: the good alternative?
Marieke Kloosterman, Roessingh Research & Development, Enschede

.Handcycling sports & performance
Floor Hettinga, Center for Human Movement Sciences, UMCG, Groningen

.Staying fit in a wheelchair
Linda Valent, Rehabilitation Center Heliomare, Wijk aan Zee

.Ergonomics of sports wheelchairs
Lucas van der Woude, Center for Human Movement Sciences, UMCG/RUG, Groningen

.General discussion

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VRA NEDERLANDSE VERENIGING VAN REVALIDATIEARTSEN

Ergonomics of sports wheelchairs

Lucas HV van der Woude e.a.

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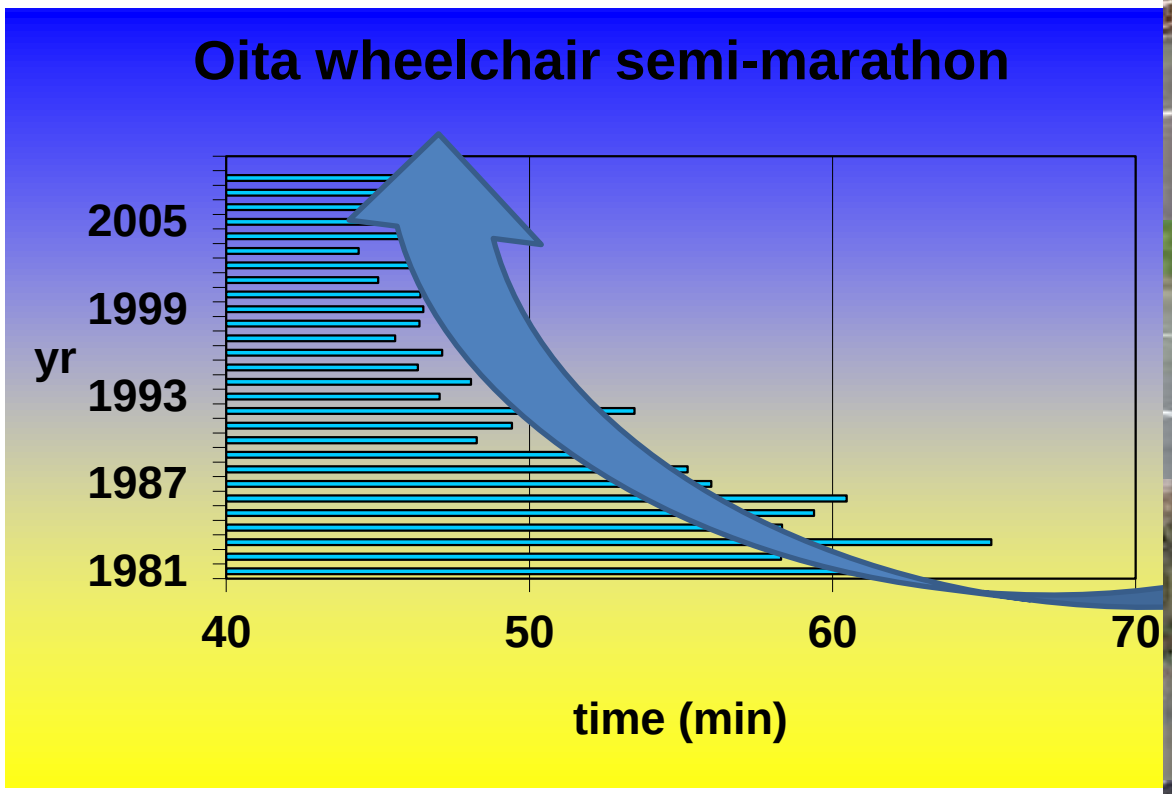
Adapted Sports Performance ↑↑










Performance ~> Talent – Training status – Technique – Interfacing – Environment – Tactics – Wheelchair technology ……

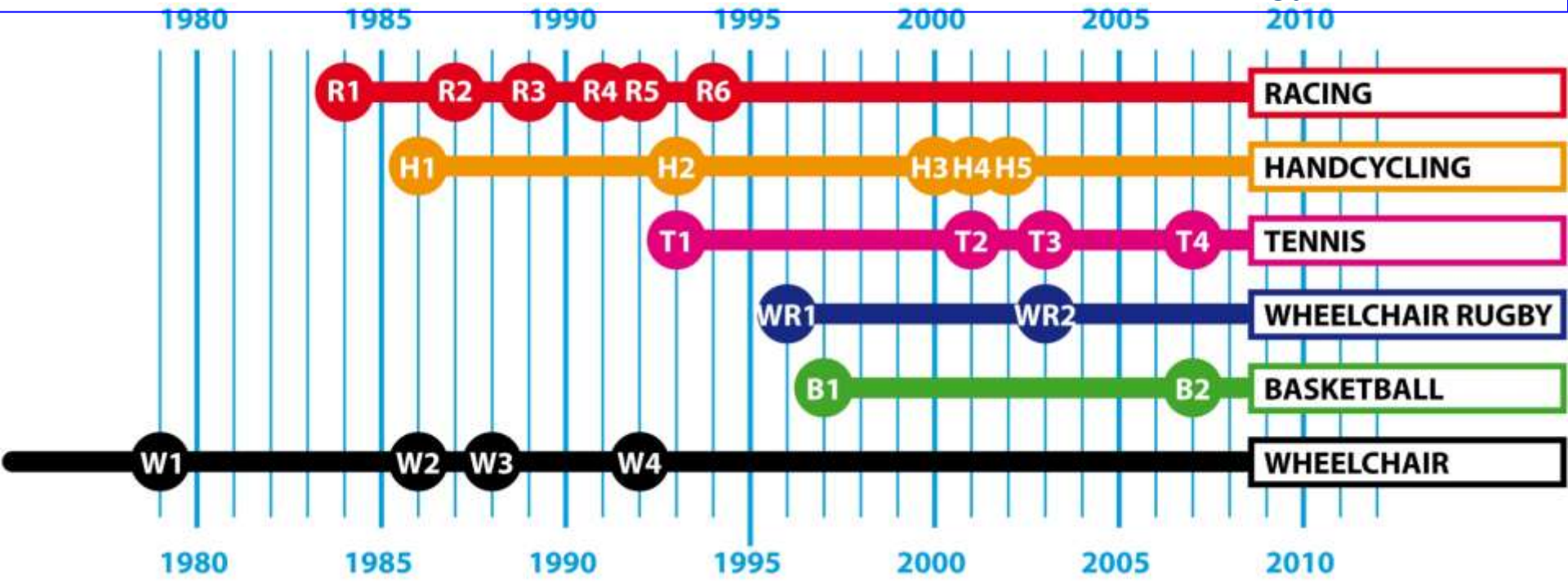


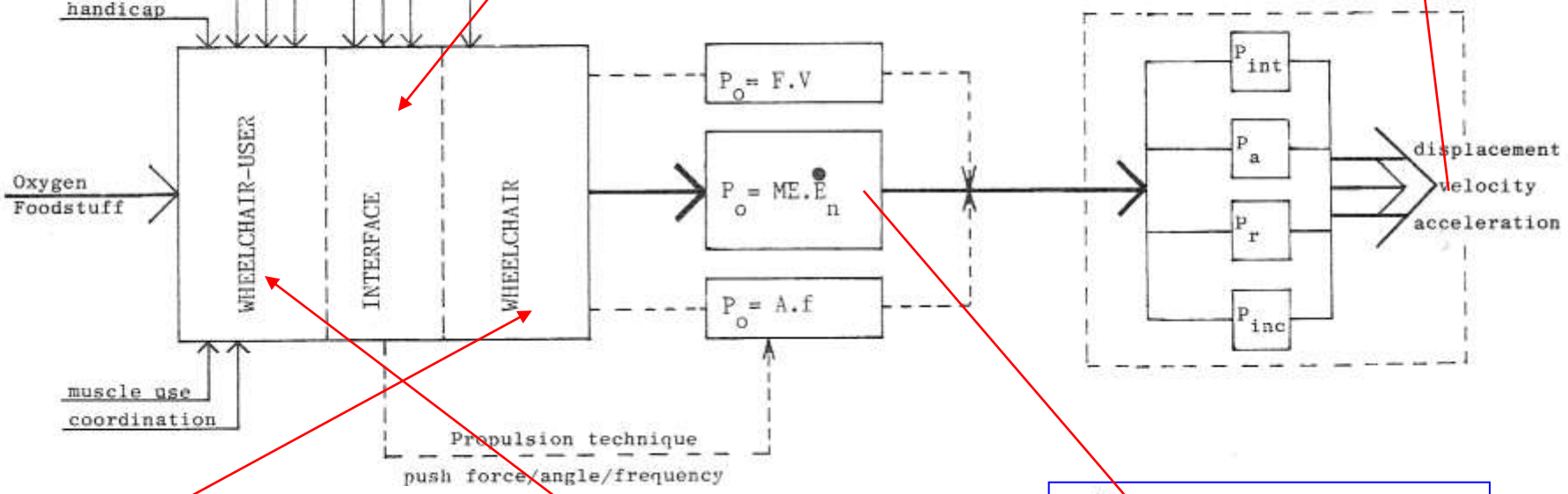
Figure 1. Historical overview sport wheelchair innovation in different wheelchair sports (Van Breukelen 2009):

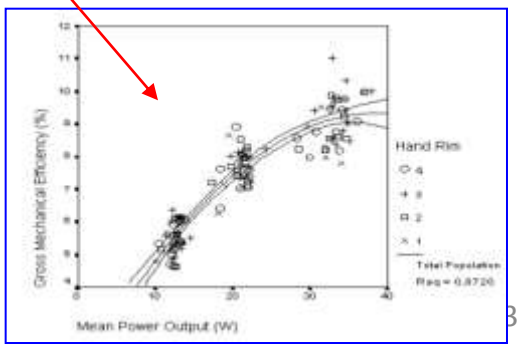
Rigid chair, box frame + axle plates (W1), camber bar (W2), foot placement: vertical (W3), backwards (W4), bucket seat (R1), 3-wheel racing chair (R2), wheelbase↑ (R3), Oversized tubing (R4), kneeling position (R5), front fork + frame alignment (R6), etc, etc, etc

Typical basketball wheelchair: task-specific, individualized

>> Agility, manouvrability, de-/acceleration, position in the field.....speed, endurance

Model Power Balance applied to wheeled mobility





Mechanical factors and their influence on rolling resistance:

Coping with taskload >>…speed, endurance

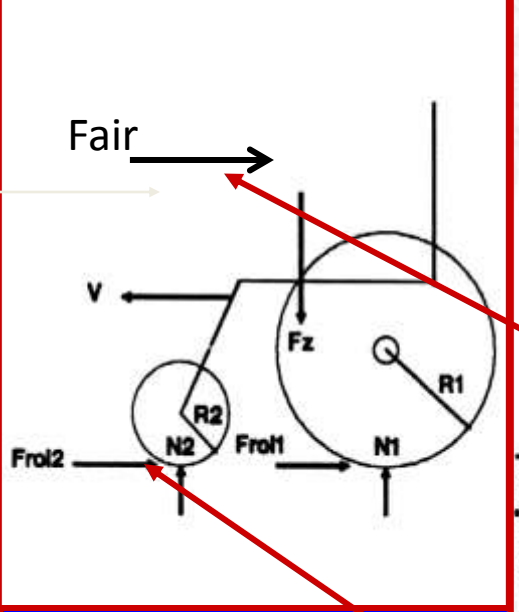
Factors	Rolling resistance
Body Mass ↑	↑
Wheelchair Mass ↑	↑
Tire pressure ↓	↑
Wheel size ↑	↓
Hardness floor ↓	↑
Camber angle ↑	?
Toe-in/out ↑	↑↑
Castor shimmy ↑	↑
Center of mass closer to large rear wheels	↓
Folding frame (vs. box frame)	↑
Maintenance ↓	↑

Speed, endurance!

40km/hr?

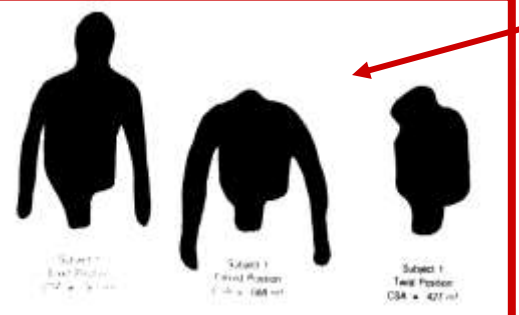
>> 11m/s!!

>>>500W?



Need to reduce rolling & air resistance

= POWER (W) ↓



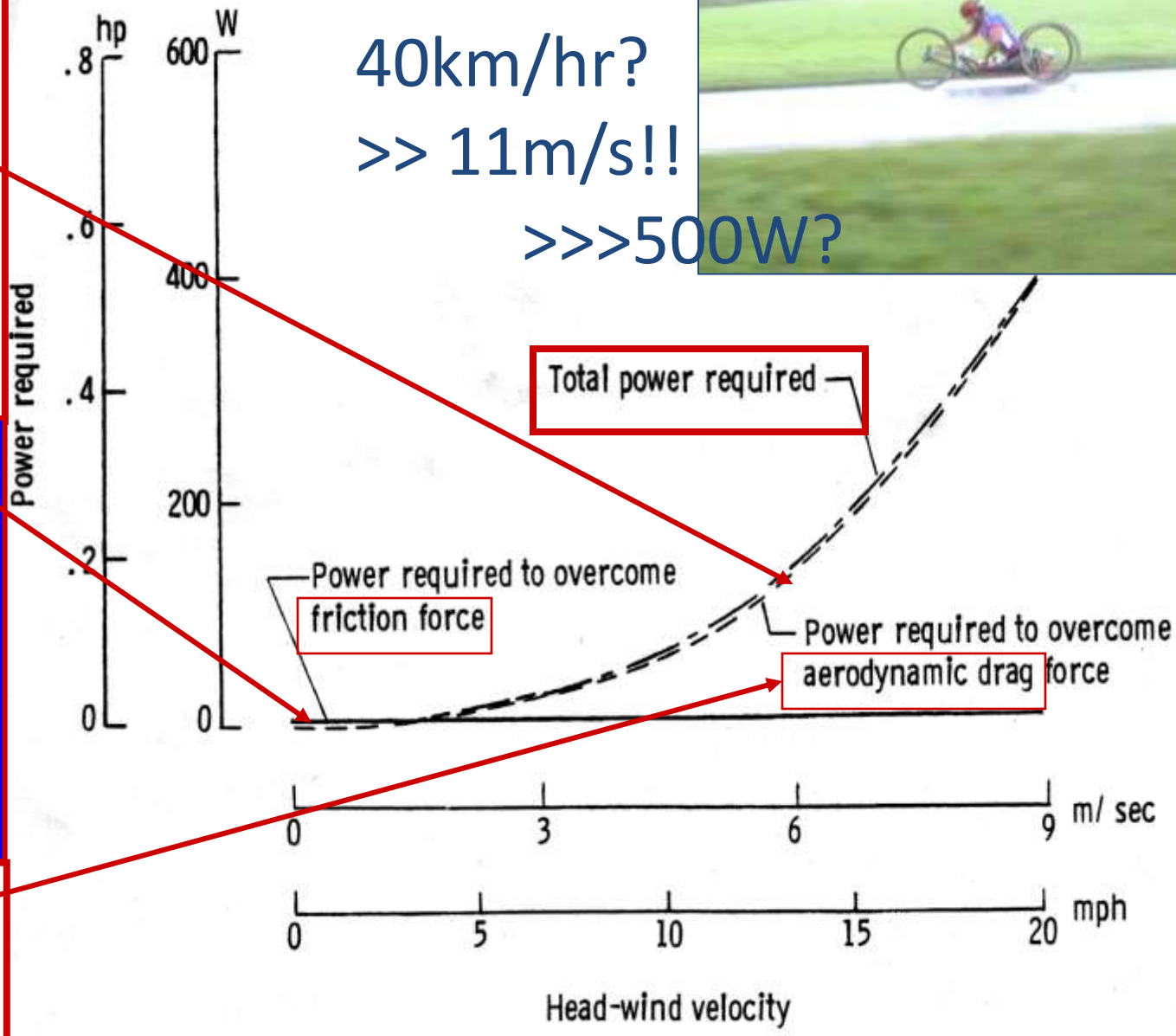


Figure 9.- Variation of power required to overcome retarding force with head-wind velocity.

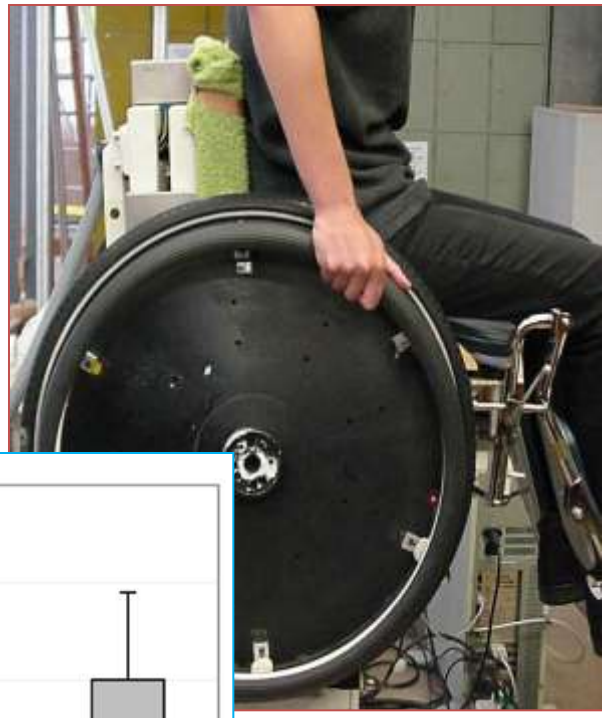
Manipulating the wheelchair-athlete interface

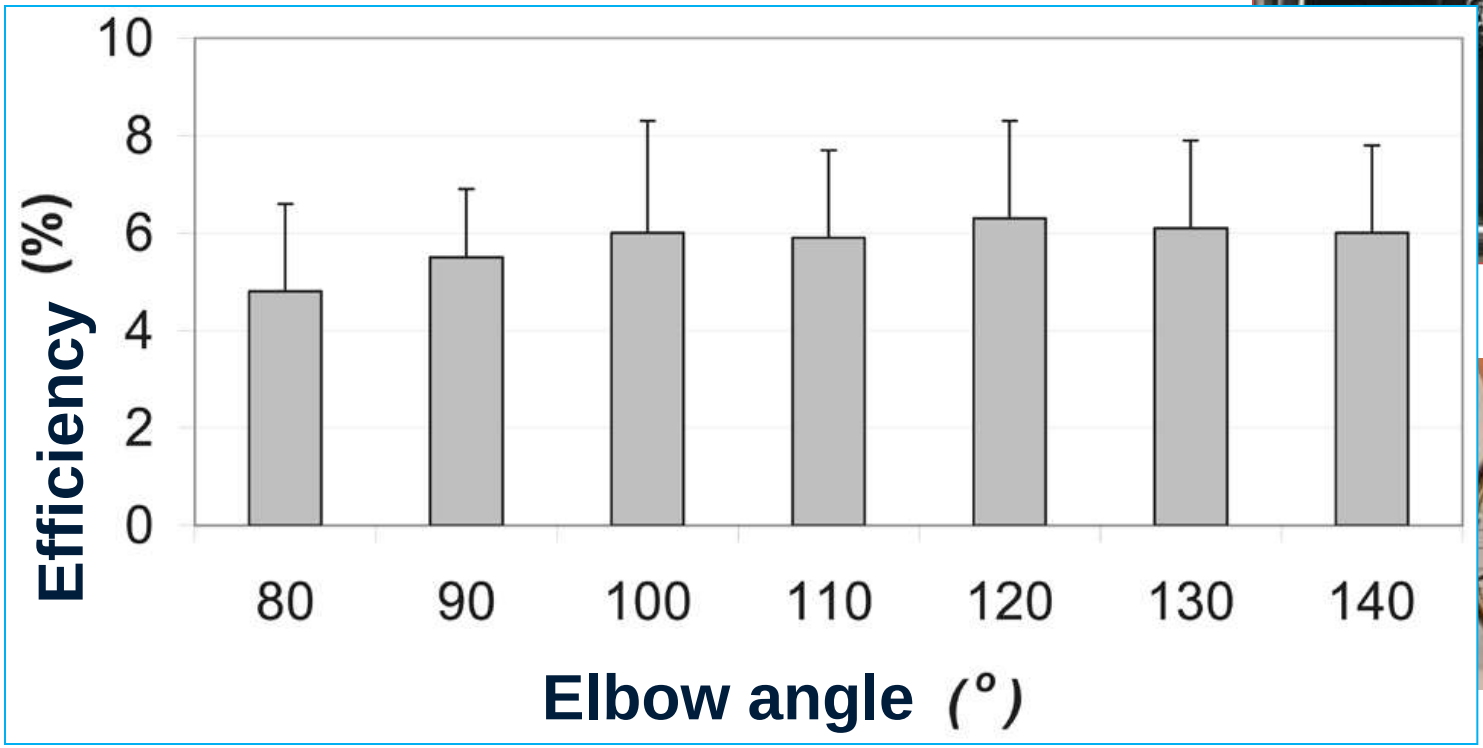
Hand rim diameter variation

(Woude ea '88)

Individual ‘fine-tuning’ seat height?

Sports?





N=12 subjects with SCI during Rehabilitation; 180 degrees is full extension

The Effects of Camber on the Ergonomics of Propulsion in Wheelchair Athletes

Mason BS, Woude van der LHV, Groot de S & Goosey-Tolfrey VL (2010). The effects of

ca *n Sports*

&

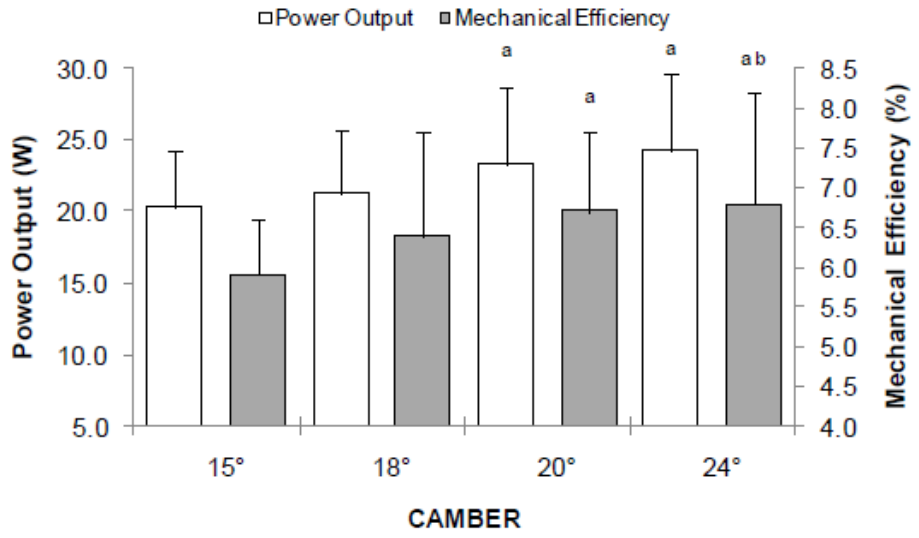


Figure 5.1 – Mean (± SD) power output and mechanical efficiency values across camber settings. [a] denotes a significant difference to 15°; [b] denotes a significant difference to 18°, $P < 0.05$.

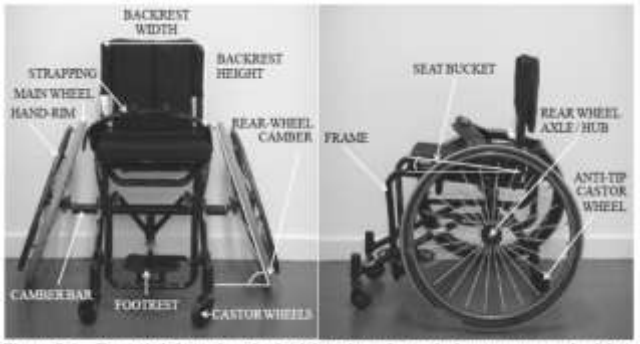


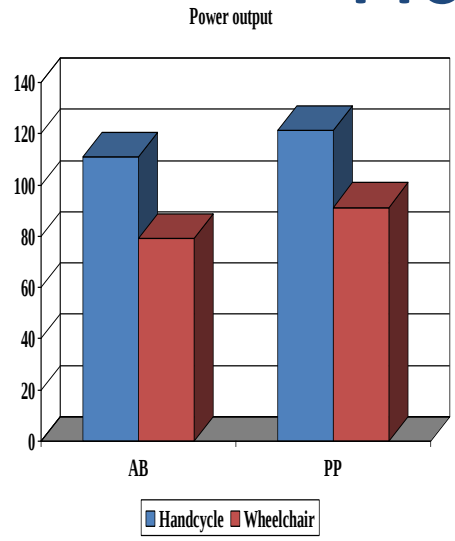
Figure 2.6 – Frontal (left) and sagittal (right) view of a typical court sports wheelchair and a number of the adjustable areas of configuration.

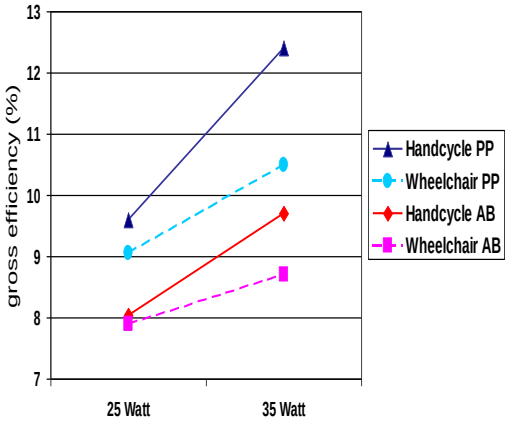
Table 5.1 – Relative increases (%) in mechanical efficiency, power output and oxygen uptake in relation to the 15° camber setting.

	15° to 20°	15° to 24°
ME (%)	11.4	10.4
P_O (W)	11.7	14.1
$\dot{V}O_2$ (L·min^{-1})	2.7	5.4

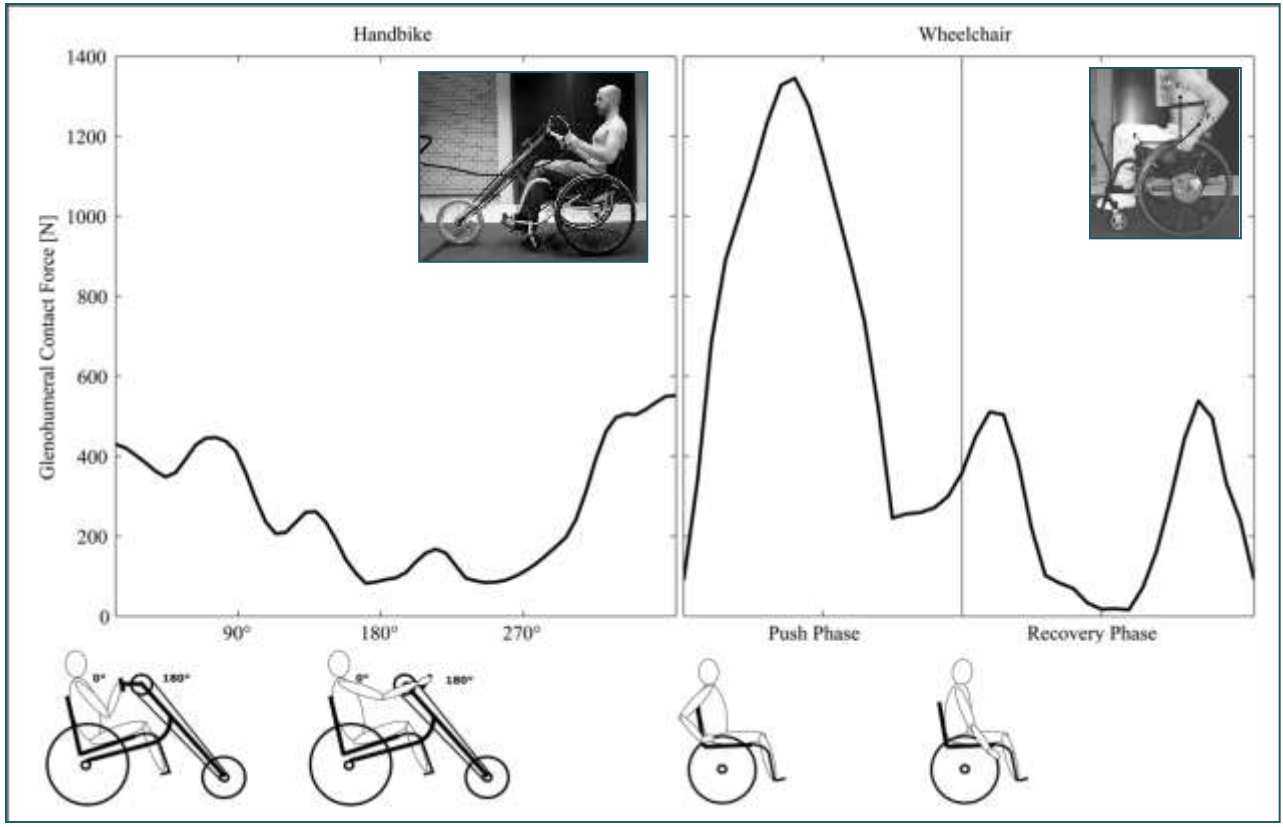
Manouvrability, agility, turning, …… speed, endurance?

Handcycling vs hand rims





Dallmeijer et al 2001



Arnet et al 2011

Endurance, speed, …… Shoulder preservation & health

=>Sport & Task-specific!!

Basketball

Racing

Dance

Tennis

Hockey

Rugby

=>Tuned to the Individual!

All in All:
Take home messages

- Individual & task/sports specific fine tuning WC-Athlete combination
- Optimization WC-Athlete interface, WC, Athlete skill, technique, capacity
- What holds for Wheelchair .....(= exemplary for any assistive technology)
- Propulsion Technique = complex, Athlete = highly adaptive learner
- Handrim wheelchair = inefficient & straining, risk for over-/underuse
- Handcycle (>> handrim wheelchair) training device
- Coach's obligation: monitor, measure, learn, read.....lifetime investment!

Some additonal information for further orientation

Human Biological (Movement) System

- An inherently *adaptive* system
- Seeking for *optimum* functioning within its *biological* and *environmental* (physical & social) boundary conditions & *developmental* stage

A sample of today's top-class manual (sports) wheelchairs

Guidelines

for the prescription of a seated wheelchair or mobility scooter for people with a traumatic brain injury or spinal cord injury

www.lifetimecare.nsw.gov.au/resources.aspx

NSW GOVERNMENT lifetime care & support

NSW GOVERNMENT Health Support Services EnableNSW

PRESERVATION OF UPPER LIMB FUNCTION

CLINICAL PRACTICE GUIDELINE:

SPINAL CORD MEDICINE

Preservation of Upper Limb Function Following Spinal Cord Injury:

A Clinical Practice Guideline for Health-Care Professionals

consortium for SPINAL CORD MEDICINE CLINICAL PRACTICE GUIDELINES

Administrative and financial support provided by Paralyzed Veterans of America

Wheelchair configuration:
Considerations for the court sports

Loughborough University

Peter Harrison Centre for Disability S

PAO Heyendael
kennismakers

ROLSTOELEN EN ORTHESEN

Locatie: Triavium Nijmegen

donderdag 29 november en vrijdag 30 november 2012

VRA
NEDERLANDSE VERENIGING VAN REVALIDATIEARTSEN

UMC St Radboud

Programma donderdag 29 november 2012:

Rolstoelen

09:30 Ontvangst en registratie

Optimalisatie zitten
Voorzitter: L. van der Woude

10:00 Orthopedische en neurologische aspecten van zitcorrectie
J. Becher
10:30 De aetiologie van drukwonden
C. Oomens
11:00 De ergonomische rolstoelzitting
K. van Breukelen

11:30 Pauze

12:00 Belasting en belastbaarheid & ergonomische optimalisatie
L. van der Woude

12:30 Lunch

Optimalisatie verplaatsen
Voorzitter: J. Becher

13:30 Schouder-armbelasting bij rolstoel ADL
D-J. Veeger
14:00 Elektrische rolstoelen en power-assist systemen
J.Schipper
14:30 Sport, lichamelijke activiteit en gezondheid
T. Janssen
15:00 ADL rolstoelen: vaardigheid en fitheid in de revalidatie
S. de Groot

15:30 Pauze

16:00 Eerste workshopronde:
- Observeren en meten van rolstoelaandrijvingstechniek (2x)
  R. Vegter, S. de Groot
- Zitdrukmeting & zithouding
  J. Hermkens
- Rolstoelpassing & zithouding (2x)
  C. Vuijk, K. van Breukelen
- Rolstoelvaardigheden: kan ik een wheely maken?
  L. van der Woude
- Handbiken voor fitheid en plezier
  T. Janssen

16:45 Tweede workshopronde

17:30 Toets

17:45 Schriftelijke evaluatie en sluiting

Groningen, April 23-25, 2014

UMCG, University of Groningen

5th International State-of-the-Art Congress

Rehabilitation: Mobility, Exercise & Sports

Noordelijk Expertise centrum Sport, bewegen & Handicap (NESH)