

# Upper limb movements

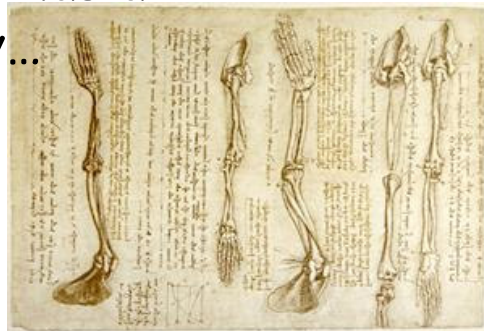
Ing. F. Menegoni

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## Introduction

The study of upper limb movements has a long history...



## Introduction

Upper limb movements are fundamental for daily living activities.



## Introduction

The study of upper limb movements not only is important in the clinical field, but also has an important role in the characterization of specific tasks in healthy subjects:



CLINICAL  
FIELD



There is a wide range of pathologies with consequences on functional limitation of upper limb movements:

CLINICAL  
FIELD

- Cerebral Palsy
- Multiple Sclerosis
- Parkinson's disease
- Spino-cerebellar lesions
- ...

## Brief description of upper limbs

THE  
PHYSIOLOGICAL ANATOMY  
AND PHYSIOLOGY  
OF MAN.

BY  
ROBERT BENTLEY TODD, M.D., F.R.S.  
FELLOW OF THE COLLEGE OF PHYSICIANS, PARTICULAR TO KING'S COLLEGE HOSPITAL,  
AND PROFESSOR OF PHYSIOLOGY IN KING'S COLLEGE, LONDON.

AND  
WILLIAM BOWMAN, F.R.S.  
FELLOW OF THE COLLEGE OF SURGEONS, ASSISTANT SURGEON TO KING'S  
COLLEGE HOSPITAL, AND DEMONSTRATOR OF ANATOMY  
IN KING'S COLLEGE, LONDON.



IN TWO VOLUMES.

VOL. I.

LONDON:  
JOHN W. PARKER, WEST STRAND.  
ROBEY & CO.

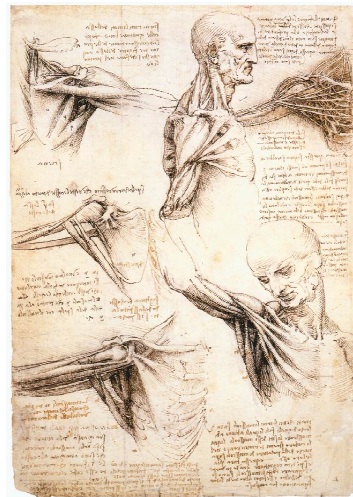
## Upper limbs

*Upper extremity.*—The disposition and structure of the bones of the upper extremity afford a marked contrast to those of the lower. The latter are organs of support, and therefore are solid, firm, strong, and, withal, elastic. The former are destined to perform extended motions, as well as minute and nicely adjusted ones; and, therefore, while they possess all the requisite strength, they are light, present little expanse of surface, and are articulated by numerous very moveable articulations.

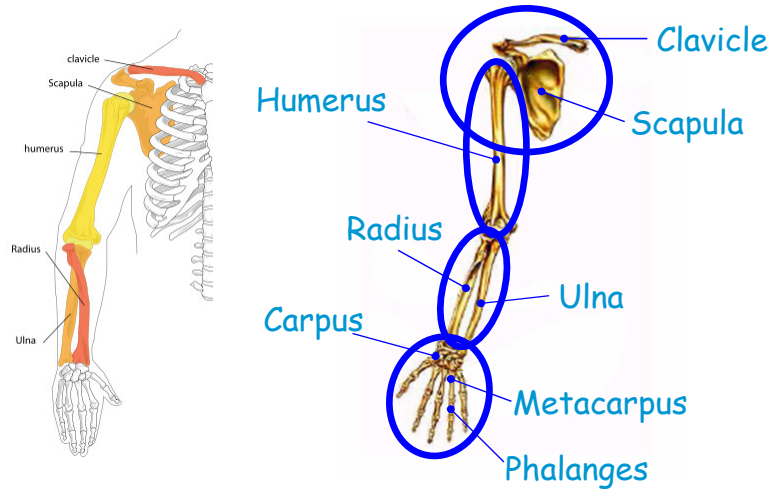
Robert Bentley Todd, Sir William Bowman,  
1857, *The Physiological Anatomy and  
Physiology of Man*

## Muscular apparatus

### Muscles of the upper limb



## Bones of upper limbs



## Shoulder joint

### Upper arm flexion/extension



## Shoulder joint

Upper arm abdo/adduction



## Shoulder joint

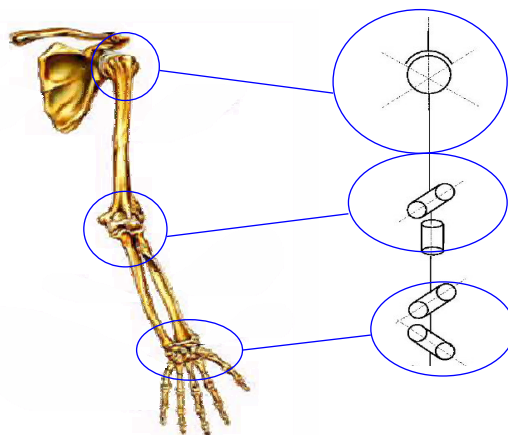
Sterno-clavicular movement:



## Elbow joint



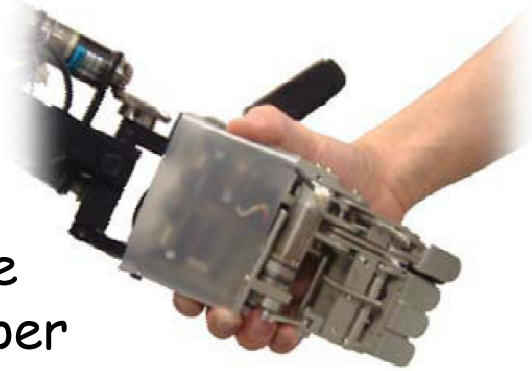
## Potential model



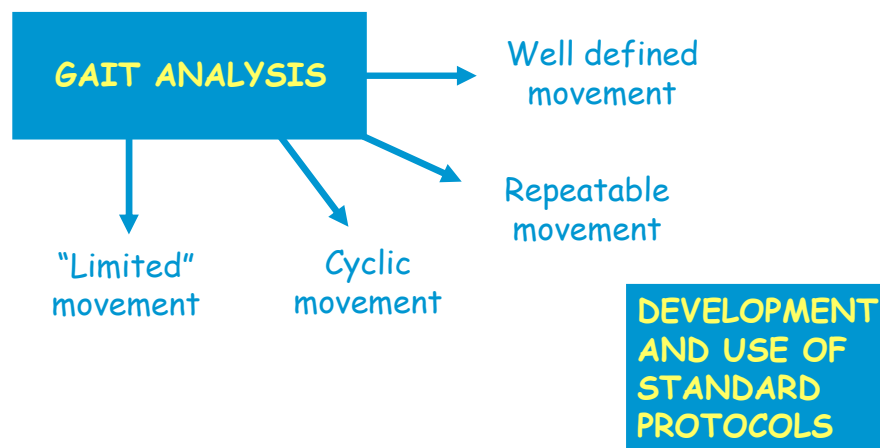
Ball and  
socket  
joint

Rotating  
hinge  
joints

## Quantitative analysis of upper limb movements

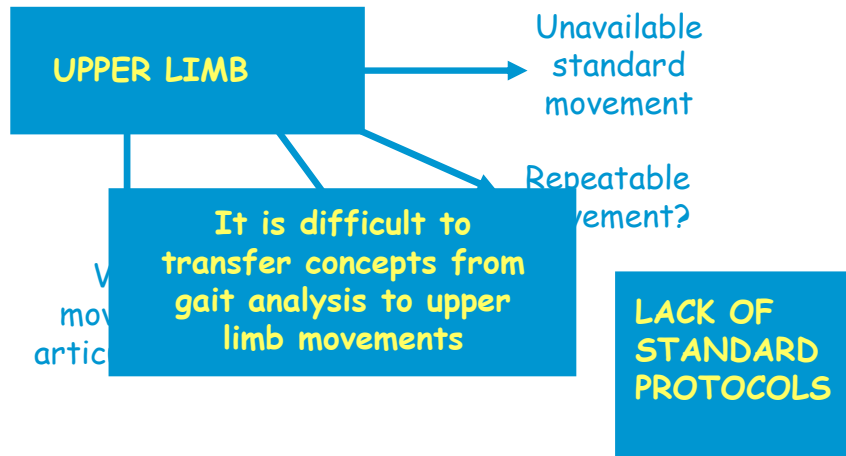


## Gait Analysis: main aspects





## Upper limb: main aspects



## Experimental setup

1) Choice of a movement

2) Marker and EMG placement, related to pathology and deficiencies

3) Choice of variable of interest for the considered pathology

The choice of experimental setup is based on pathology and variables of interest

## Experimental protocol

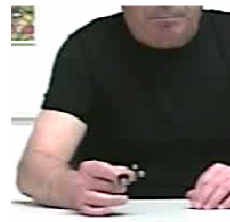
The choice of experimental setup is related to considered pathology

Reaching



Hand to mouth

Grasping



Finger

## Experimental protocol

The choice of the experimental protocol is influenced by pathology, analyzed movement and variables of interest.

P. Archambault · P. Pigeon · A.G. Feldman · M.F. Levin · Exp Brain Res (1999) 126:55–67

**Recruitment and sequencing of different degrees of freedom during pointing movements involving the trunk in healthy and hemiparetic subjects** 6 markers

PEDIATRIC RESEARCH Vol. 57, No. 6, 2005  
**Kinematic Characteristics of Reaching Movements in Preterm Children with Cerebral Palsy** 1 marker

JOLANDA C. VAN DER HEIDE, JOHANNA M. FOCK, BERT OTTEN, ELISABETH STREMMELAAR, AND MINA HADDERS-ALGRA

Arch Phys Med Rehabil Vol 87, February 2006  
**Deficits in Upper-Limb Task Performance in Children With Hemiplegic Cerebral Palsy as Defined by 3-Dimensional Kinematics** 21 markers

Anna H. Mackey, PhD, Sharon E. Walt, PhD, N. Susan Stolt, PhD, MD

## Experimental protocol

Many parameters can be computed and they are strictly related to analyzed movement, marker set, and biomechanical model.

The aim is the functional characterization of movement: quantify functional limitation, highlight motor synergies, focus on motor control, ...

Angles

Trajectories

## Experimental protocol

Arch Phys Med Rehabil Vol 78, May 1997  
**Quantification of Upper Extremity Function Using Kinematic Analysis**

EdUARdo Ramos, MD, Michael P. Latash, BS, Edward A. Hurvitz, MD, Susan H. Brown, PhD

Arch Phys Med Rehabil Vol 87, February 2006  
**Deficits in Upper-Limb Task Performance in Children With Hemiplegic Cerebral Palsy as Defined by 3-Dimensional Kinematics**

Anna H. Mackey, PhD, Sharon E. Walt, PhD, N. Susan Stott, PhD, MD

Journal of Biomechanics 39 (2006) 681–688  
An upper extremity kinematic model for evaluation of hemiparetic stroke

Brooke Hingtgen<sup>a,c</sup>, John R. McGuire<sup>b</sup>, Mei Wang<sup>a,c</sup>, Gerald F. Harris<sup>a,c,\*</sup>

OCMAS 2007

**Upper extremity model for clinical motion analysis**

<sup>1</sup>John Henley, <sup>2</sup>James Richards, <sup>3</sup>Scott Coleman, <sup>4</sup>Chris Church, <sup>1</sup>Freeman Miller

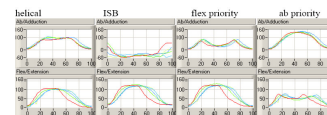
<sup>1</sup>A. I. duPont Hospital for Children, Wilmington, DE. Contact: [jhenley@nemours.org](mailto:jhenley@nemours.org)

<sup>2</sup>University of Delaware, Newark, DE <sup>3</sup>Baylor University Medical Center, Dallas, TX

Elbow flex/ext: morphology, velocity, peaks, ...

Elbow flex/ext, shoulder angles, trunk angles: velocity, range of motion, ...

Elbow flex/ext, shoulder angles: velocity, acceleration, frequency analysis, ...



## Experimental protocol

P. Archambault · P. Pigeon · A.G. Feldman · M.F. Levin  
Exp Brain Res (1999) 126:55–67

**Recruitment and sequencing of different degrees of freedom during pointing movements involving the trunk in healthy and hemiparetic subjects**

Movement time, initial direction, velocity peaks, ...

PEDIATRIC RESEARCH Vol. 57, No. 6, 2005  
**Kinematic Characteristics of Reaching Movements in Preterm Children with Cerebral Palsy**

JOLANDA C. VAN DER HEIDE, JOHANNA M. FOCK, BERT OTTEN, ELISABETH STREMMELAAR, AND MINA HADDERS-ALGRA

Movement time, index of curvature, number of movement units, ...

Clinical Biomechanics 20 (2005) 381–388  
Kinematical measure for spastic reaching in children with cerebral palsy

Jyh-Jong Chang <sup>a,b</sup>, Tung-I Wu <sup>a</sup>, Wen-Lan Wu <sup>c</sup>, Fong-Chin Su <sup>a,\*</sup>

Number of movement unites, normalized Jerk:

$$NJS = \sqrt{\frac{1}{2} \cdot \int (r''')^2 dt \cdot (t^5 / l^2)}$$

DISABILITY AND REHABILITATION, 2004; VOL. 26, NO. 10, 603–613  
The influence of object size on discrete bimanual co-ordination in children with hemiplegic cerebral palsy

Velocity profiles, grasp aperture, ...

A. UTLEY†\*, B. STEENBERGEN‡ and D. A. SUGDEN§