ERGONOMICS

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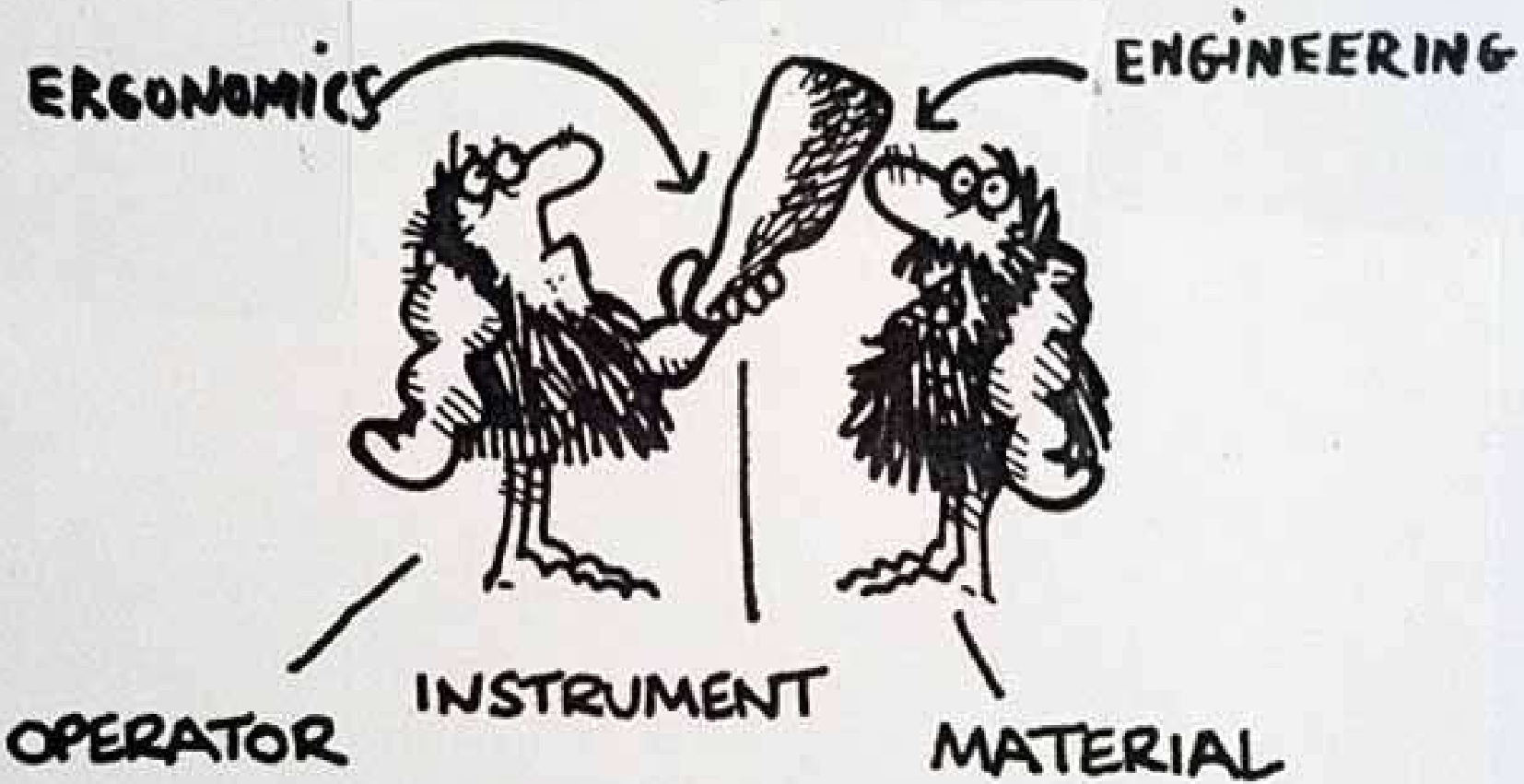
QEH 13 February 2009

This morning

- Ergonomics
  - What it is
  - What's it useful for
  - Applications to surgery

- Heuristics in surgery

Model of a surgeon at work


ERGONOMICS
ENGINEERING
OPERATOR
INSTRUMENT
MATERIAL

Ergonomics – definition

Ergonomics – definition

- Scientific study of people at work

Ergonomics – definition

- Scientific study of people at work

- based on
  - anatomy
  - physiology
  - psychology
  - engineering

Ergonomics – definition

- Scientific study of people at work
- based on
  anatomy, physiology, psychology, engineering

- combined in a systems approach

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Values!

Ergonomics – definition

- Scientific study of people at work
- based on
  anatomy, physiology, psychology, engineering
- Combined in a systems approach

- with a view to

  Improving training

  Safety ↑

  Productivity ↑

  Accuracy ↑

  Satisfaction at work ↑

Ergonomics – definition

- Scientific study of people at work
- based on
  anatomy, physiology, psychology, engineering
- in a systems approach

All these
can be measured

- With a view to

  Training ↑

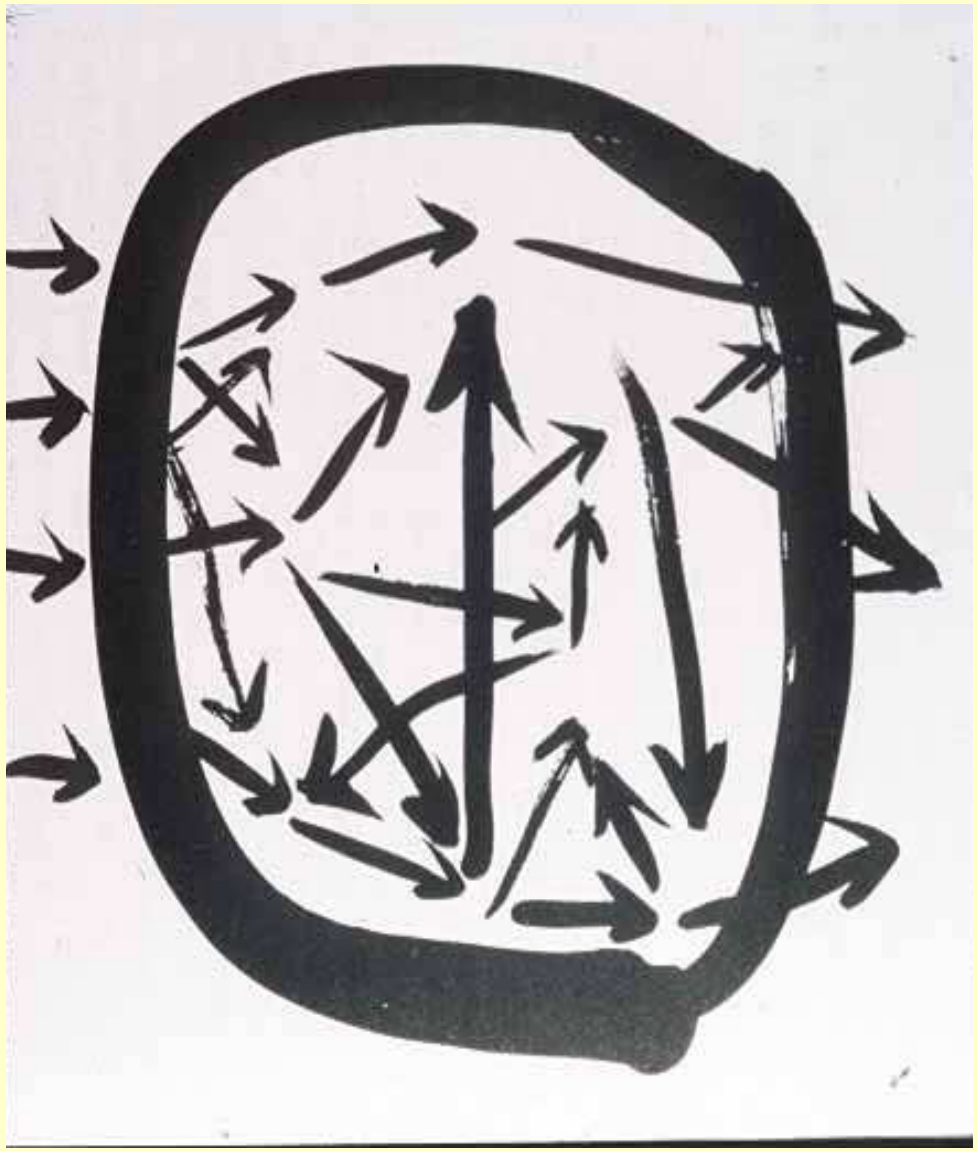
  Safety ↑

  Productivity ↑

  Accuracy ↑

  Satisfaction at work ↑

What is a system?

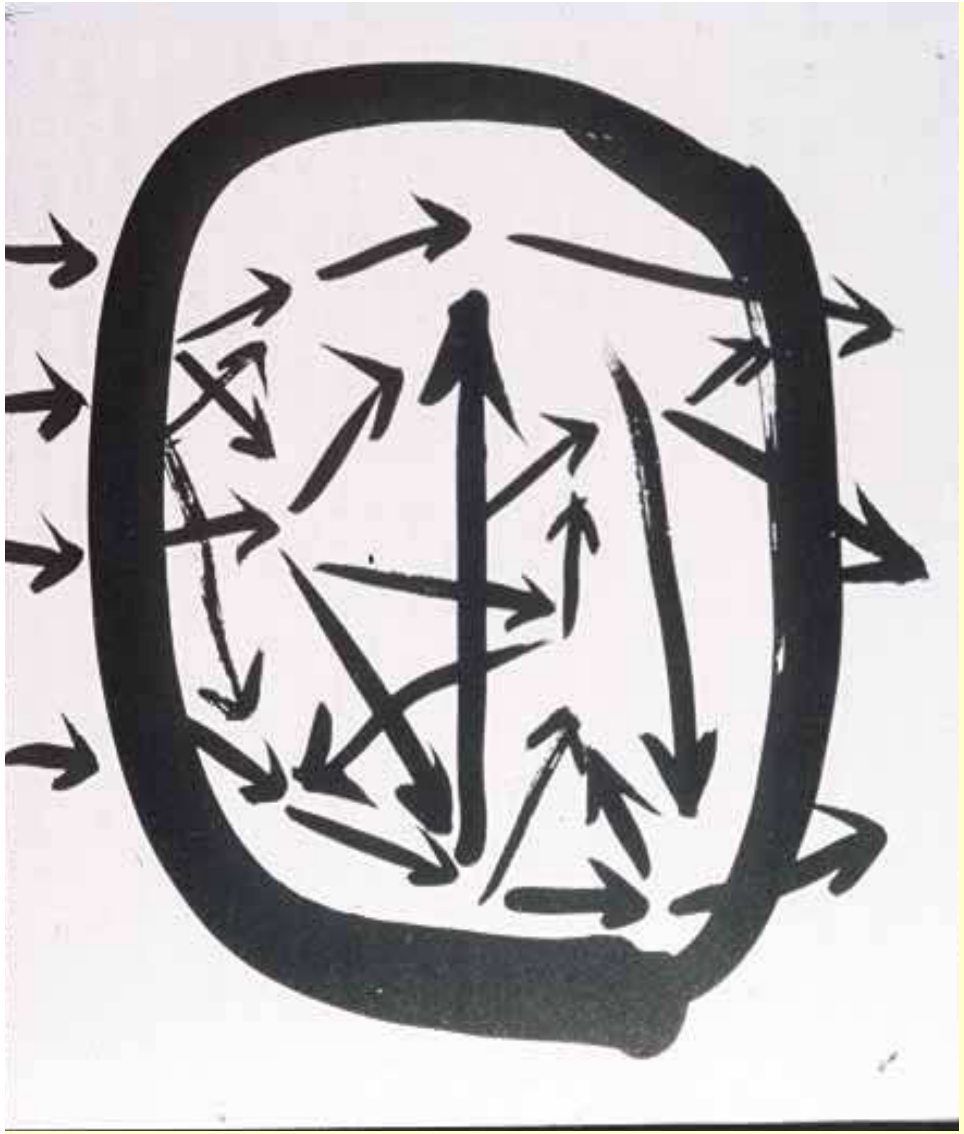


A system:

a set of items, links, and interactions
with inputs, outputs.

whose behaviour as a whole can not be predicted from behaviour of its elements or of groups of elements

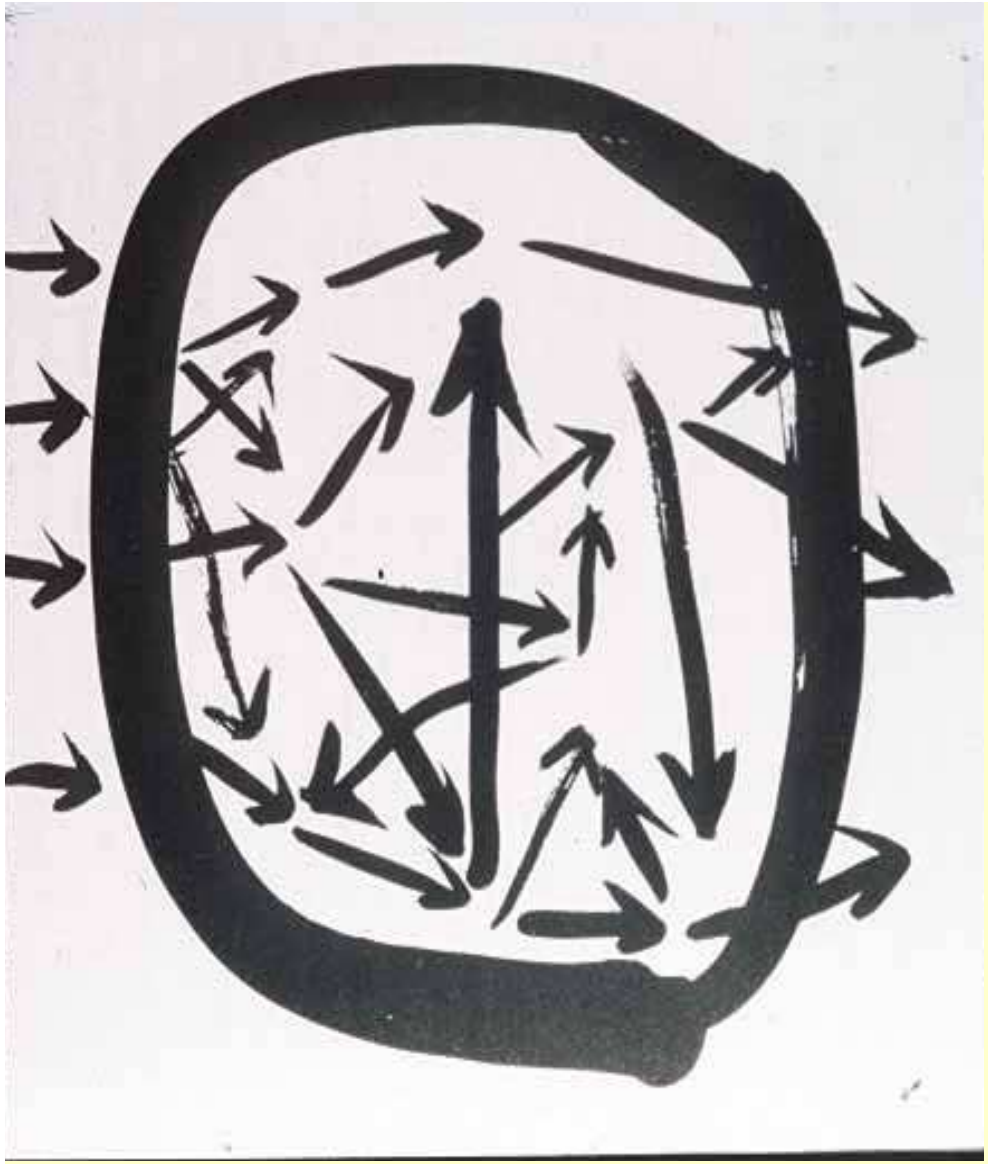
= emergent properties



A system:

emergent properties

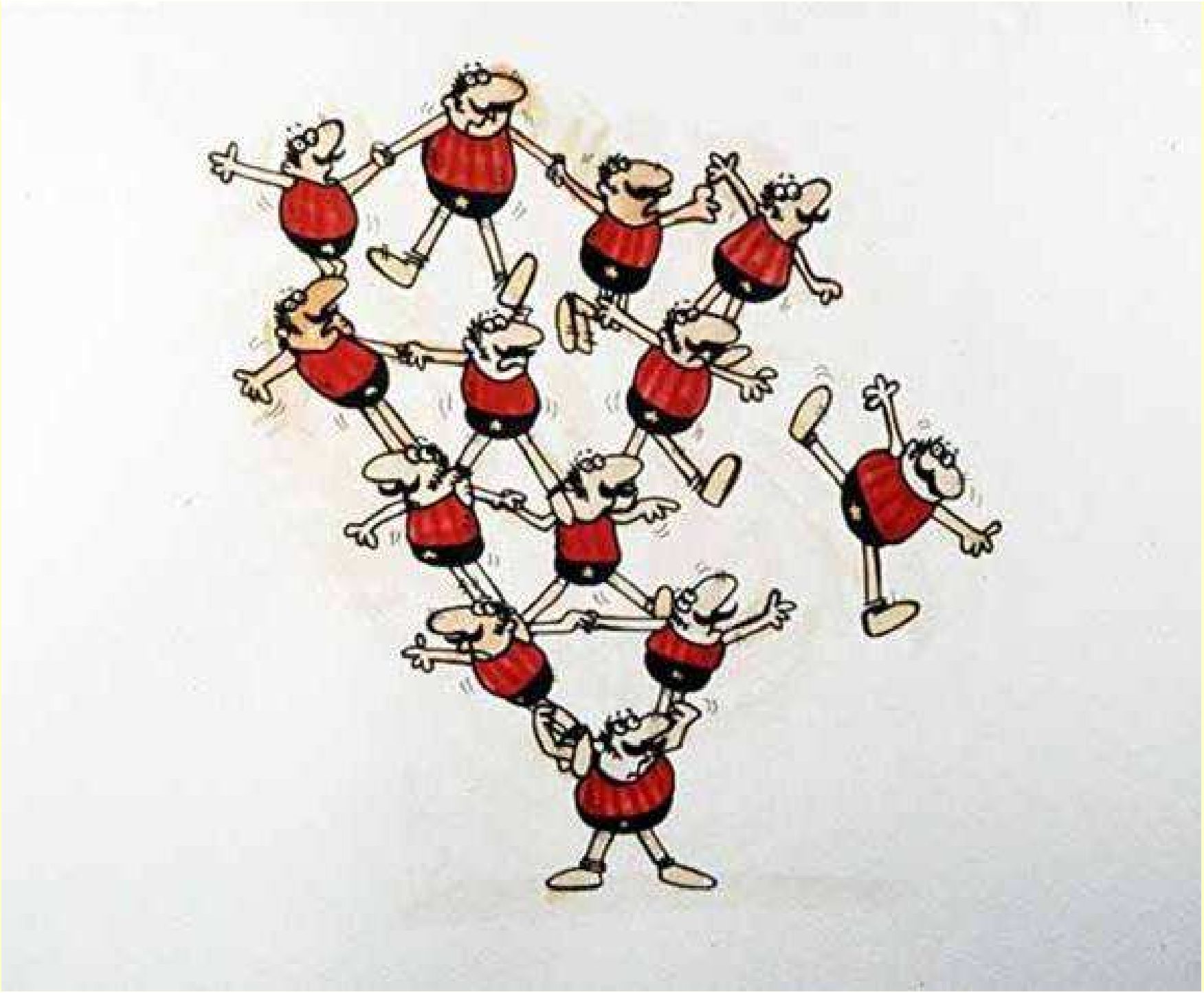
…. “it seemed like
a good idea
at the time”

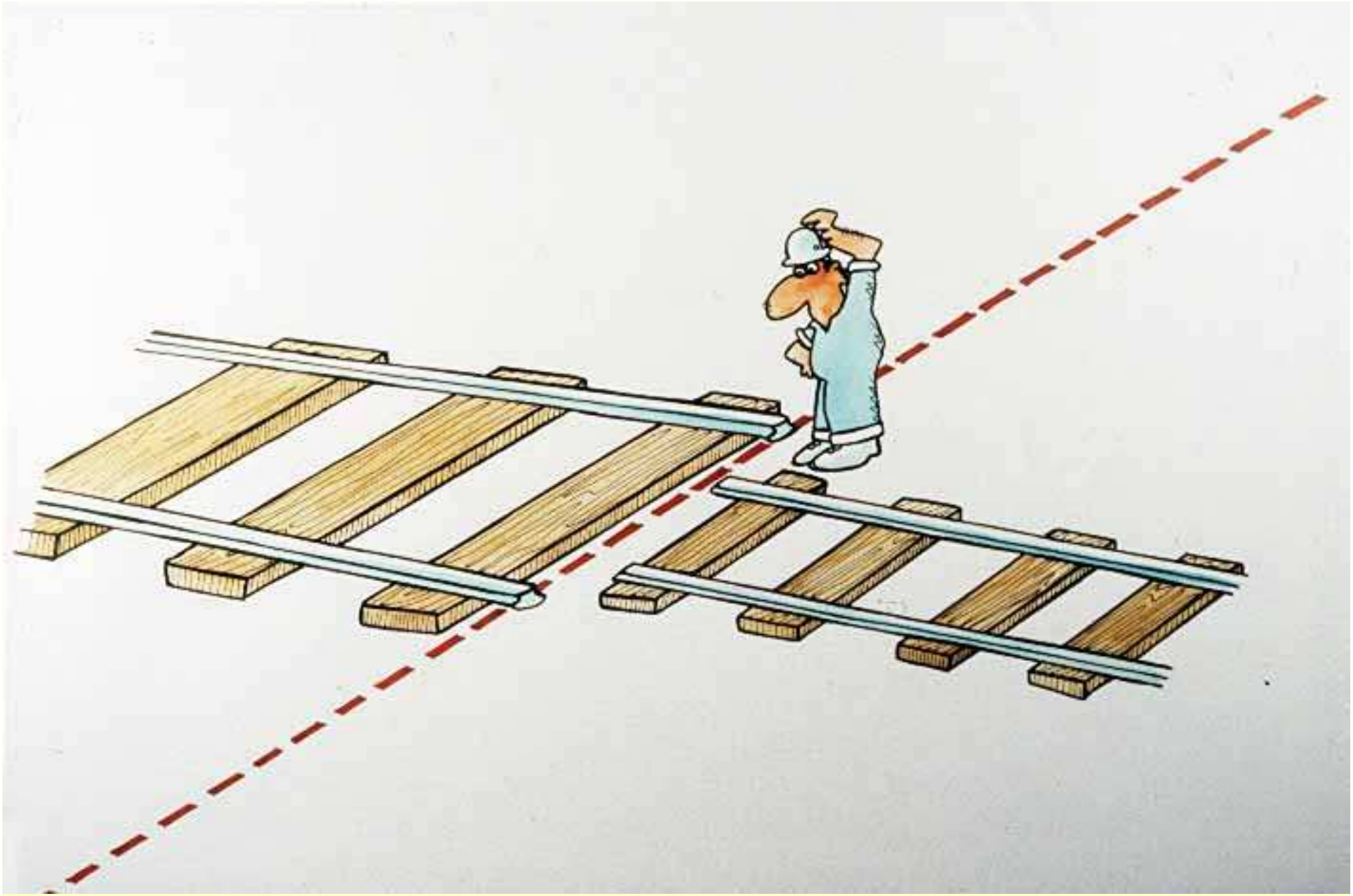


A system:

Also,

stability and coupling vary





… yet another system problem ...

Ergonomics – history

Ergonomics – context

Good managers, engineers and craftspersons have often been intuitive ergonomists

- Ancient Greek and Egyptian water carriers
- Duke of Malborough provided boots for soldiers
- Utson and the Sydney Opera House – poor backstage facilities, poor acoustics, poor car parking

Ancient water carriers –

Which was from Greece & which from Egypt?

Why?

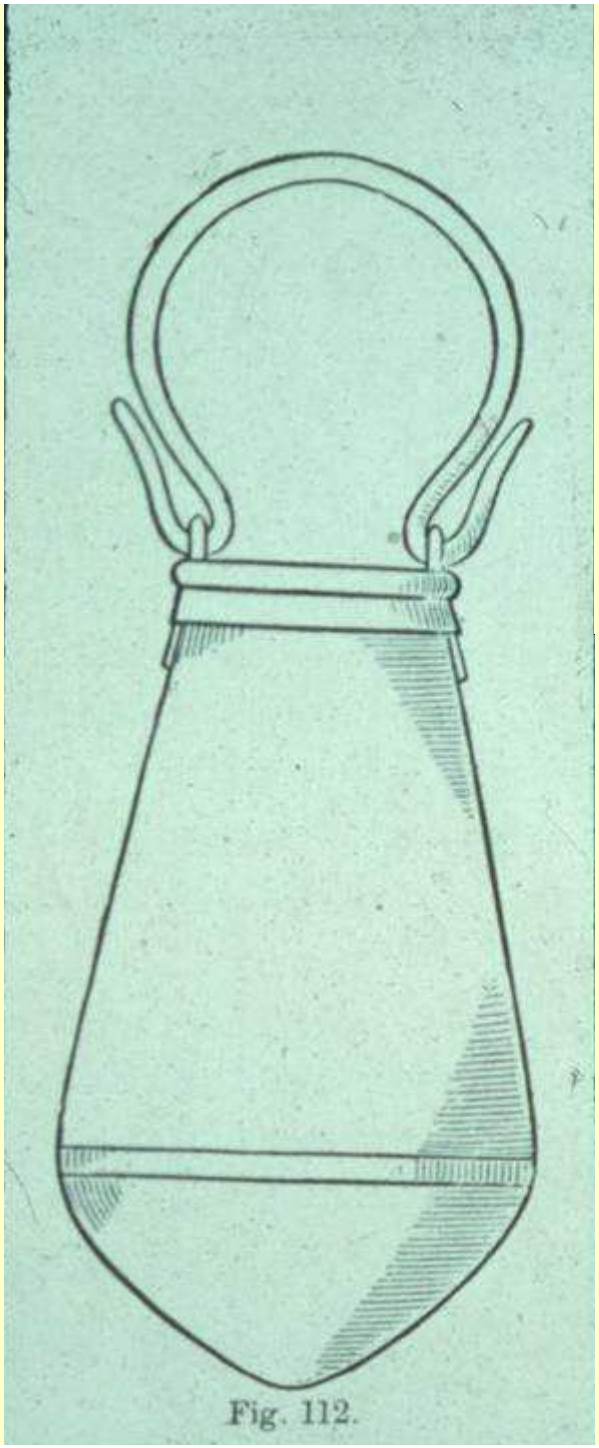
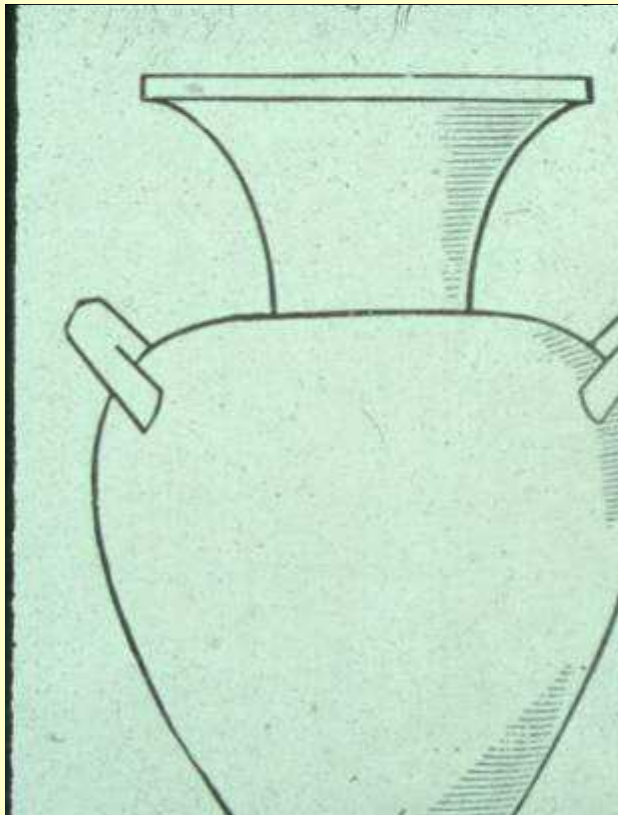
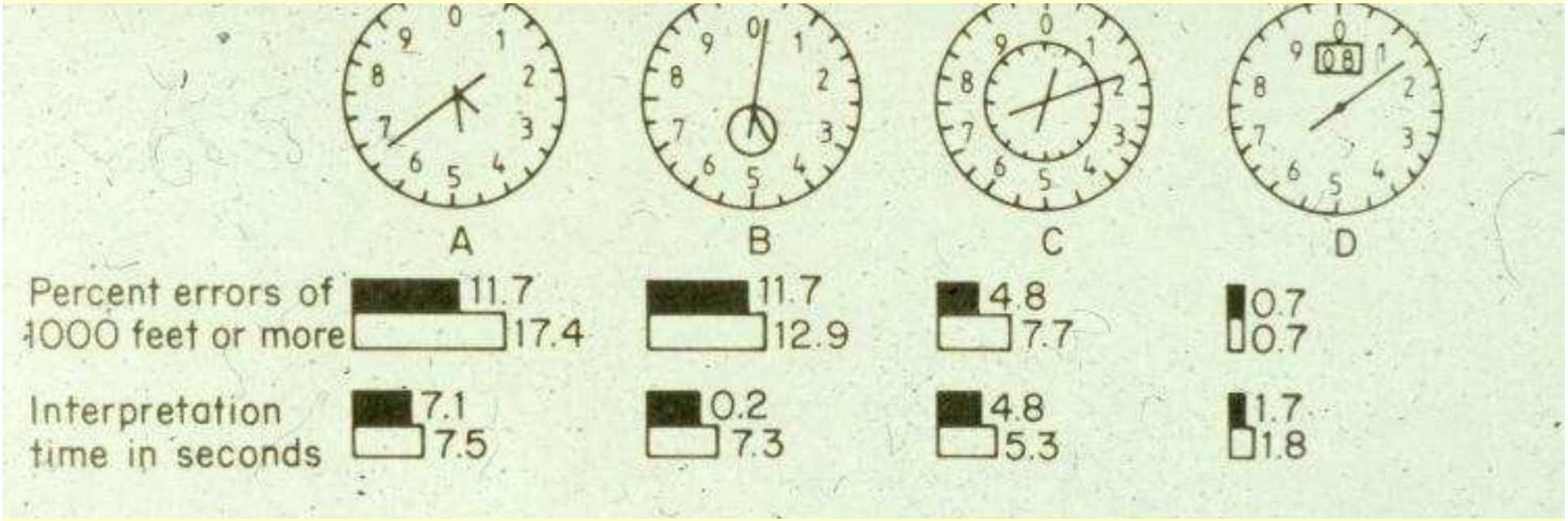


Fig. 112.



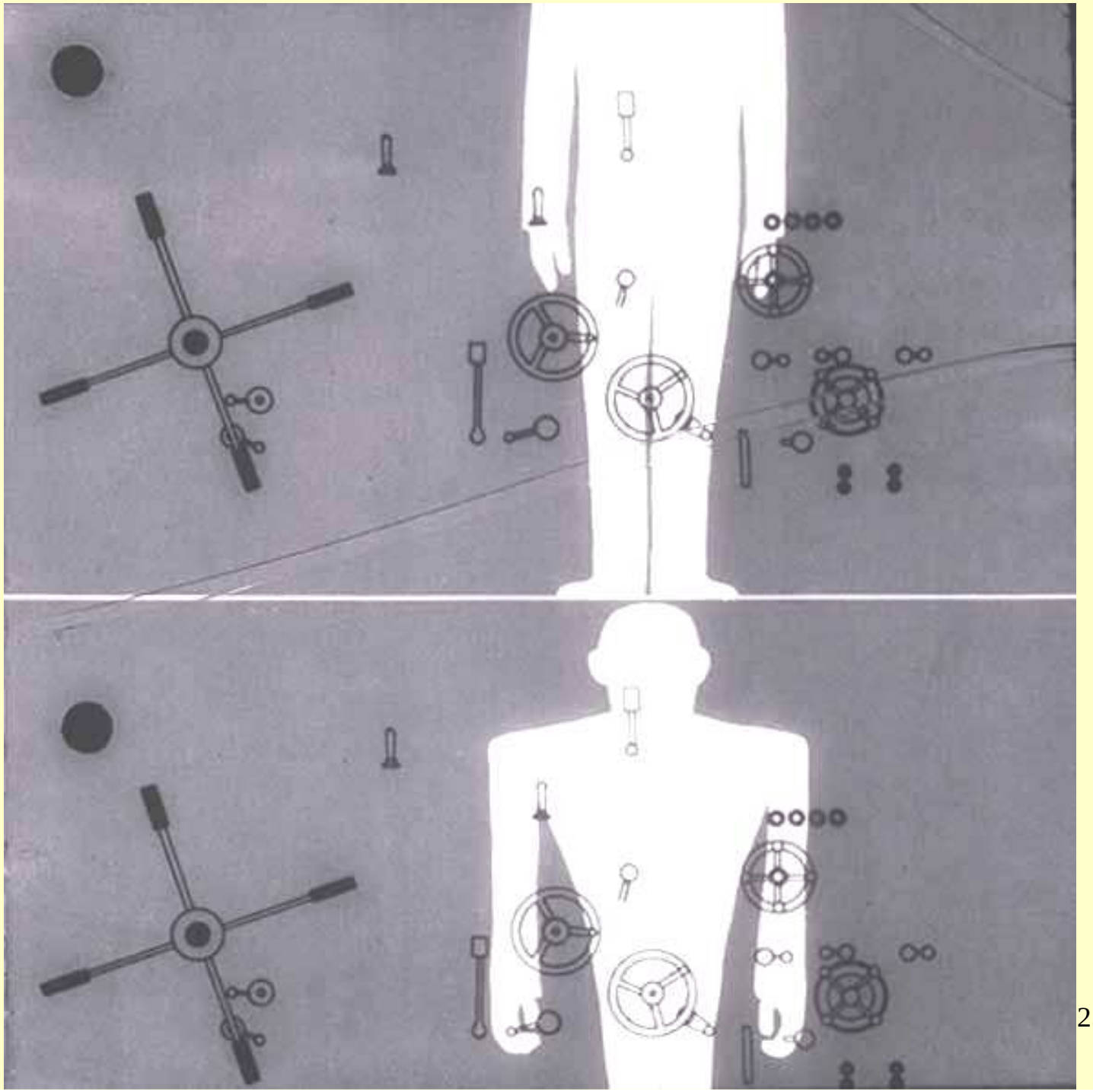
Ergonomics – early history

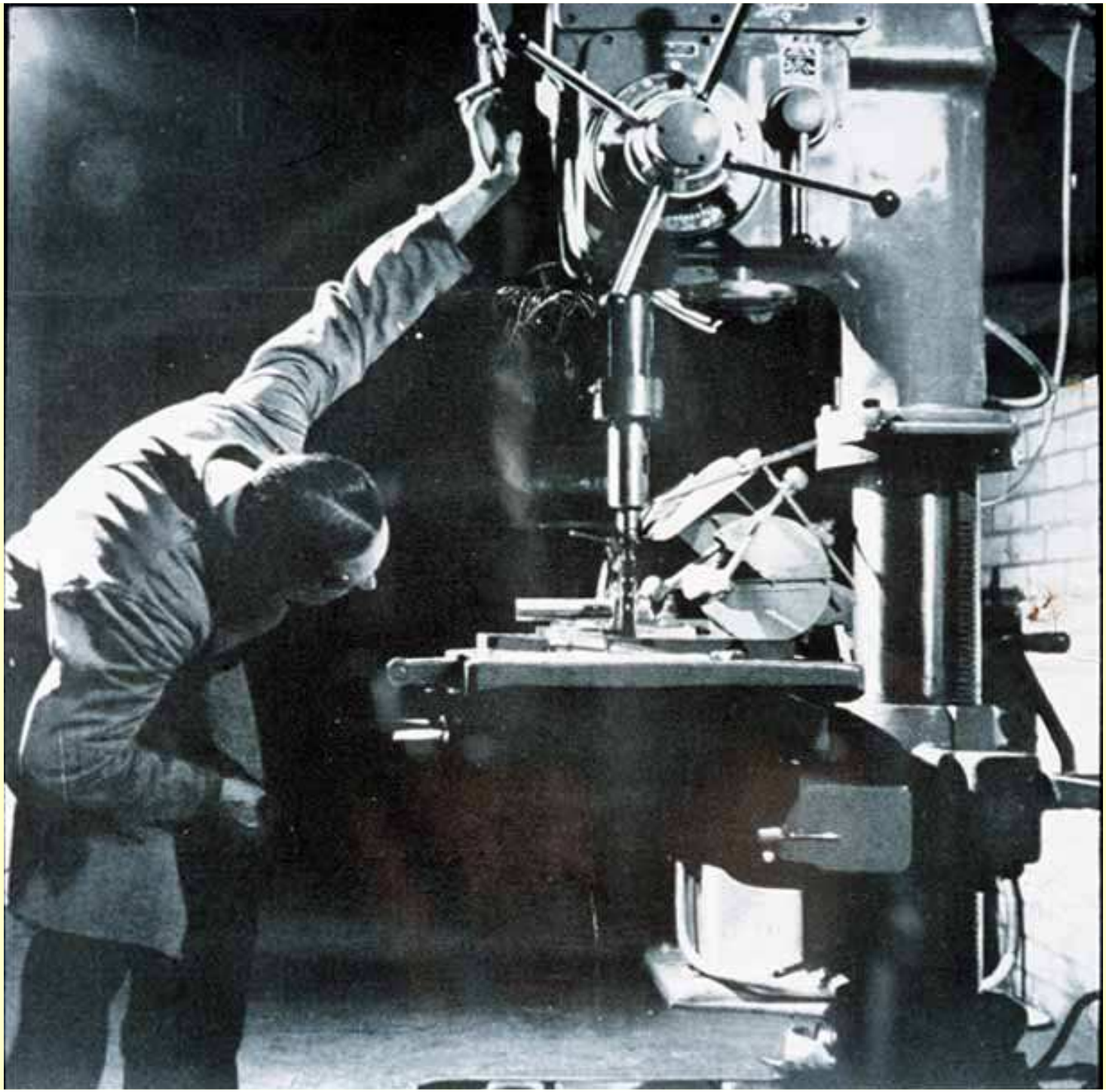
- 1880s – time and motion study
- 1881 – FW Taylor, Bethlehem Steel Works, Pittsburgh – shovelling of coal, loading of trucks
- 1900s – scientific management, Frank Gilbreth (“Cheaper by the Dozen”)
- 1940s – WW2 – eg altimeters in fighter aircraft
- 1950s – aerospace program
- 1960s – factories, product design
- 1970s - occ health & safety, RSI
- 1980s – human-computer interaction, macroergonomics, cognitive ergonomics
- 1990s – James Reason (human error), CRM


A
B
C
D
Percent errors of 1000 feet or more
11.7
17.4
11.7
12.9
4.8
7.7
0.7
0.7
Interpretation time in seconds
7.1
7.5
0.2
7.3
4.8
5.3
1.7
1.8

Original Improved

Other dials and indicators





Karl Storz OR of the future

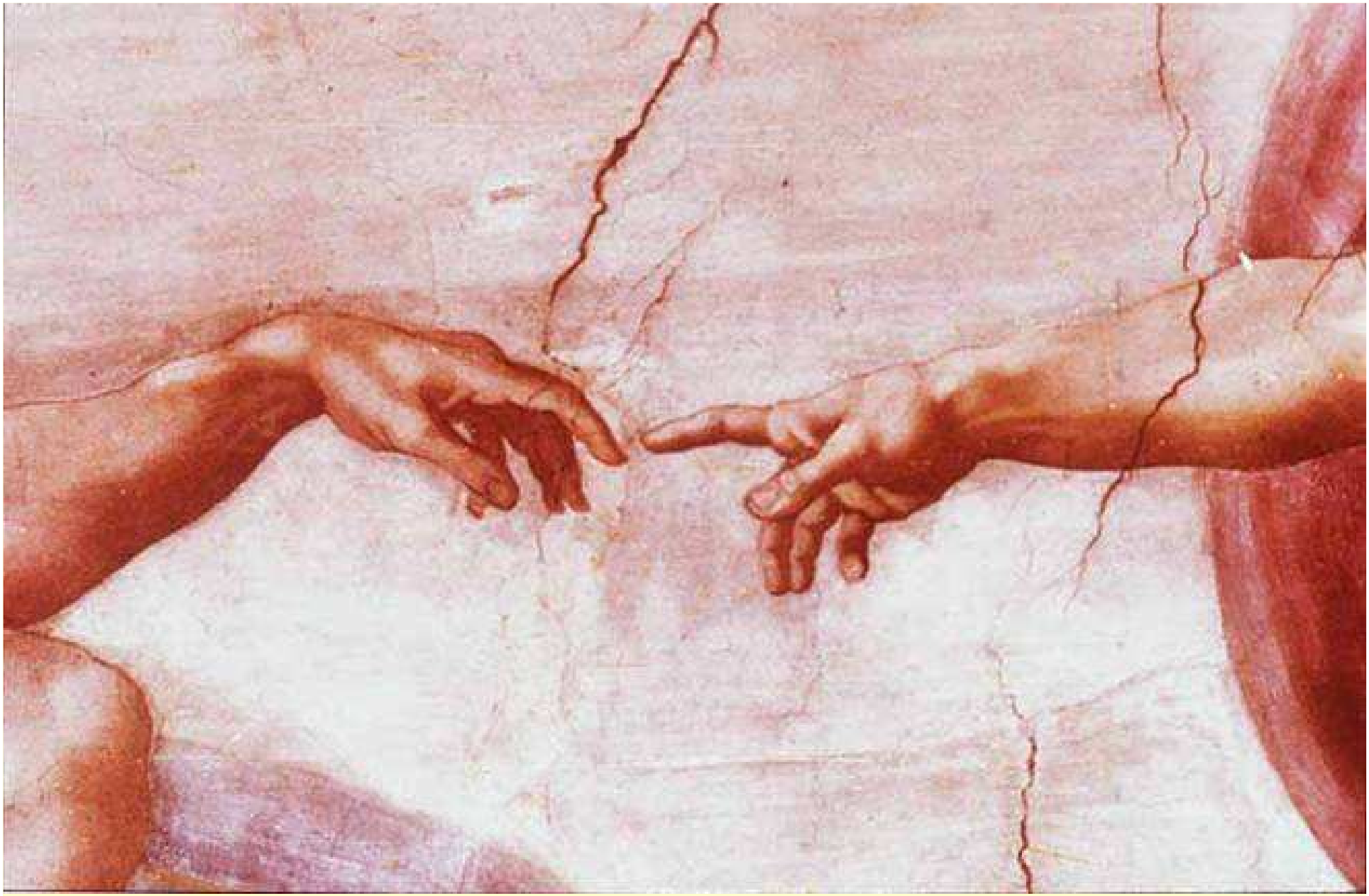
Lap sub-total hysterectomy, Hubertus Hosp. Berlin

today Ergonomics comprises

- physical ergonomics
- cognitive ergonomics
- macro-ergonomics

Areas of physical ergonomics

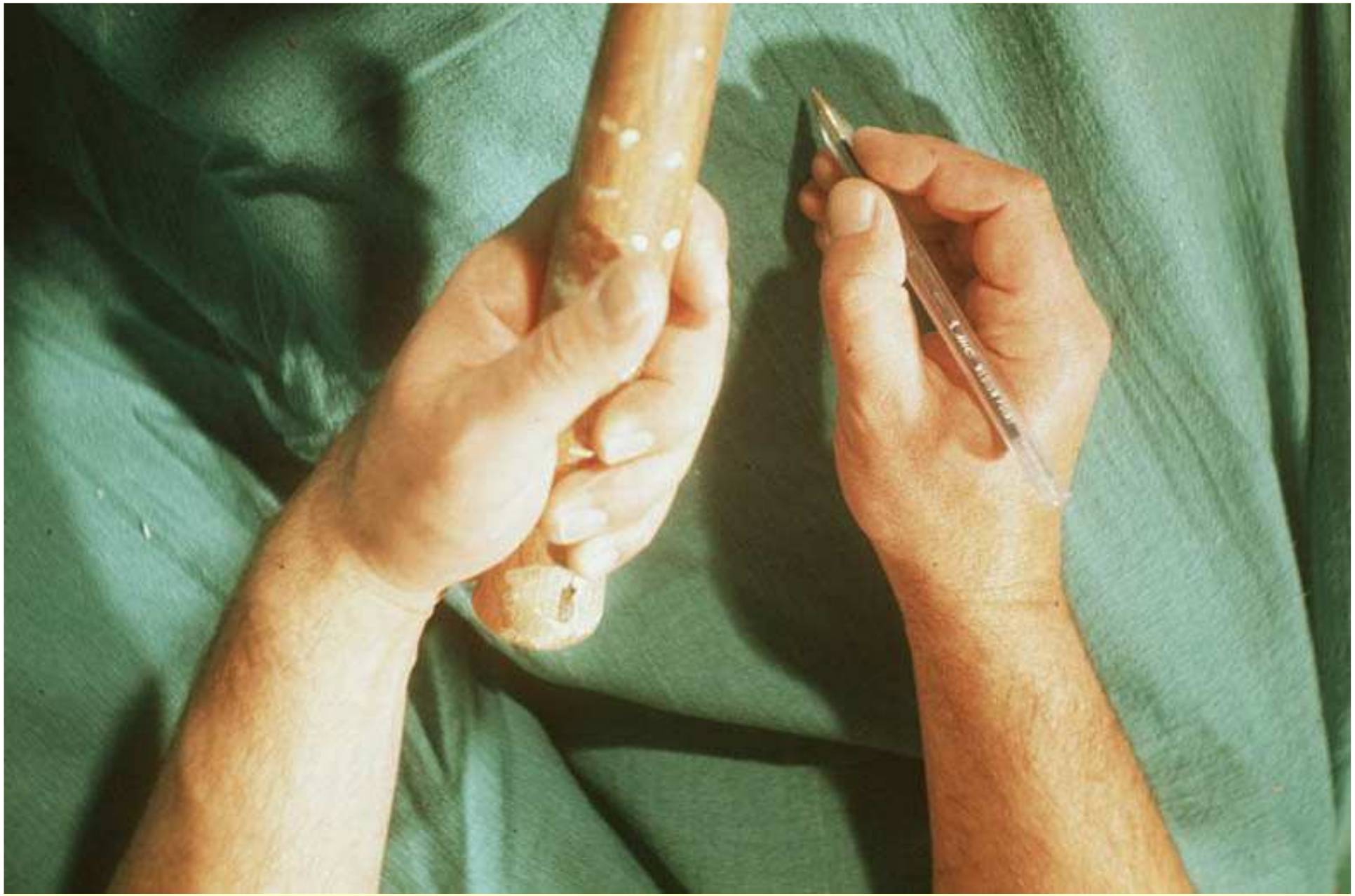
- Equipment design - handles
- Workplace layout – desk, office
- Environmental factors – lighting, noise, temperature, smell etc
- Skill, training, safety



Hand grips and handle design

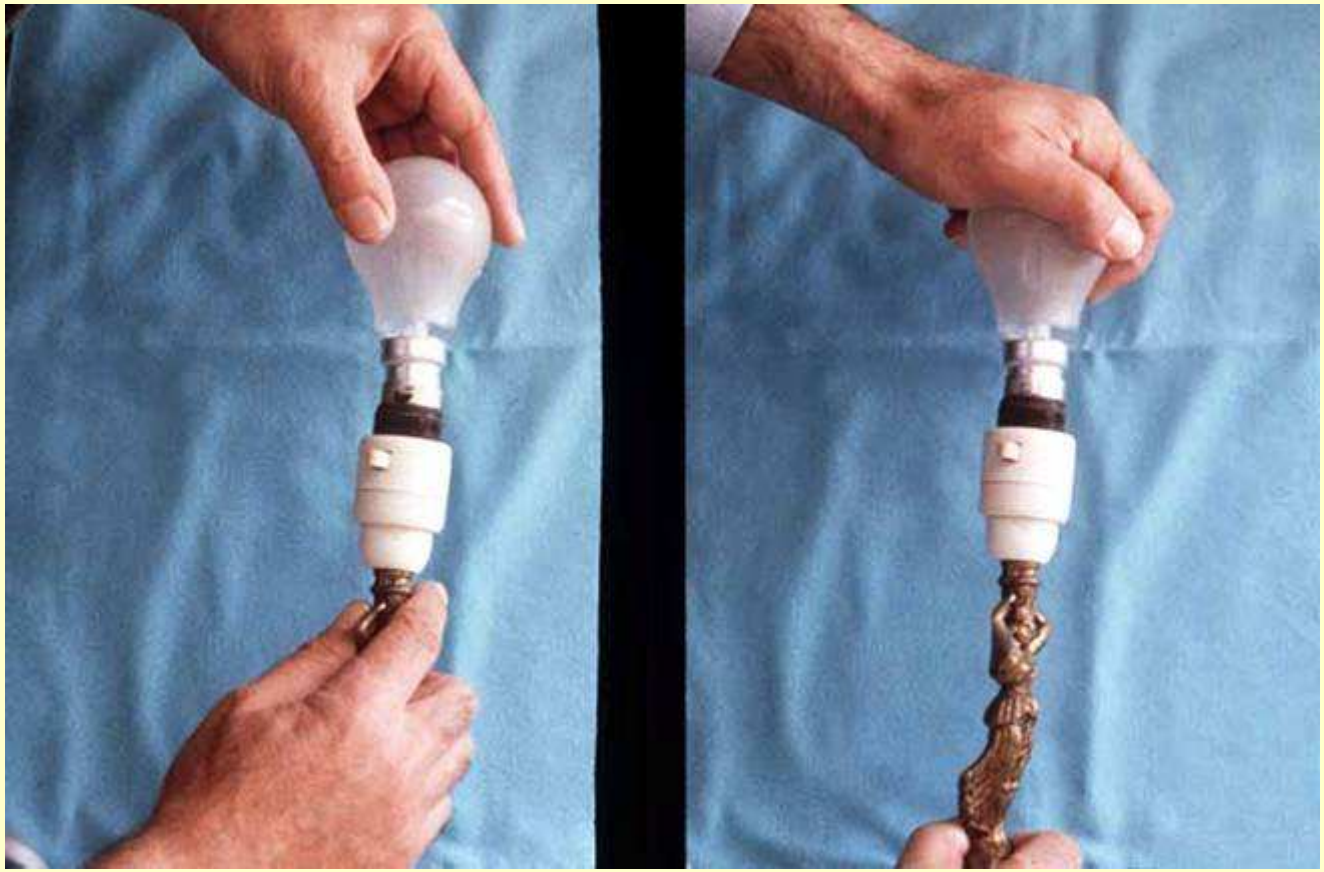
Types of hand grip

- Power grip
- Precision grip
- Double grips
- Variations

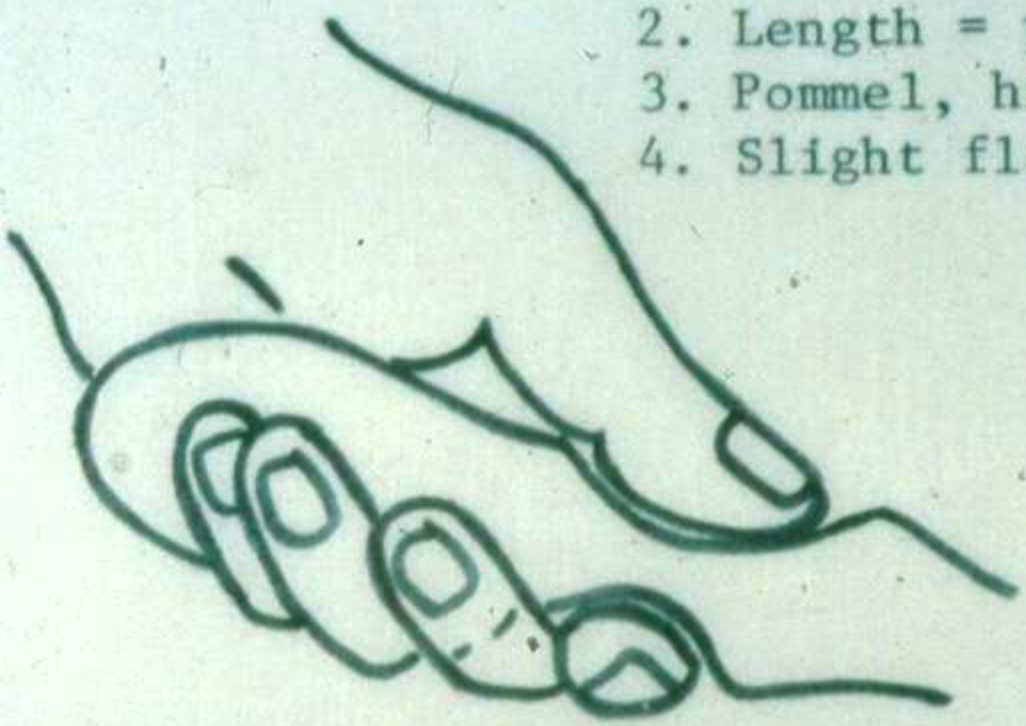


Power grip

precision grip



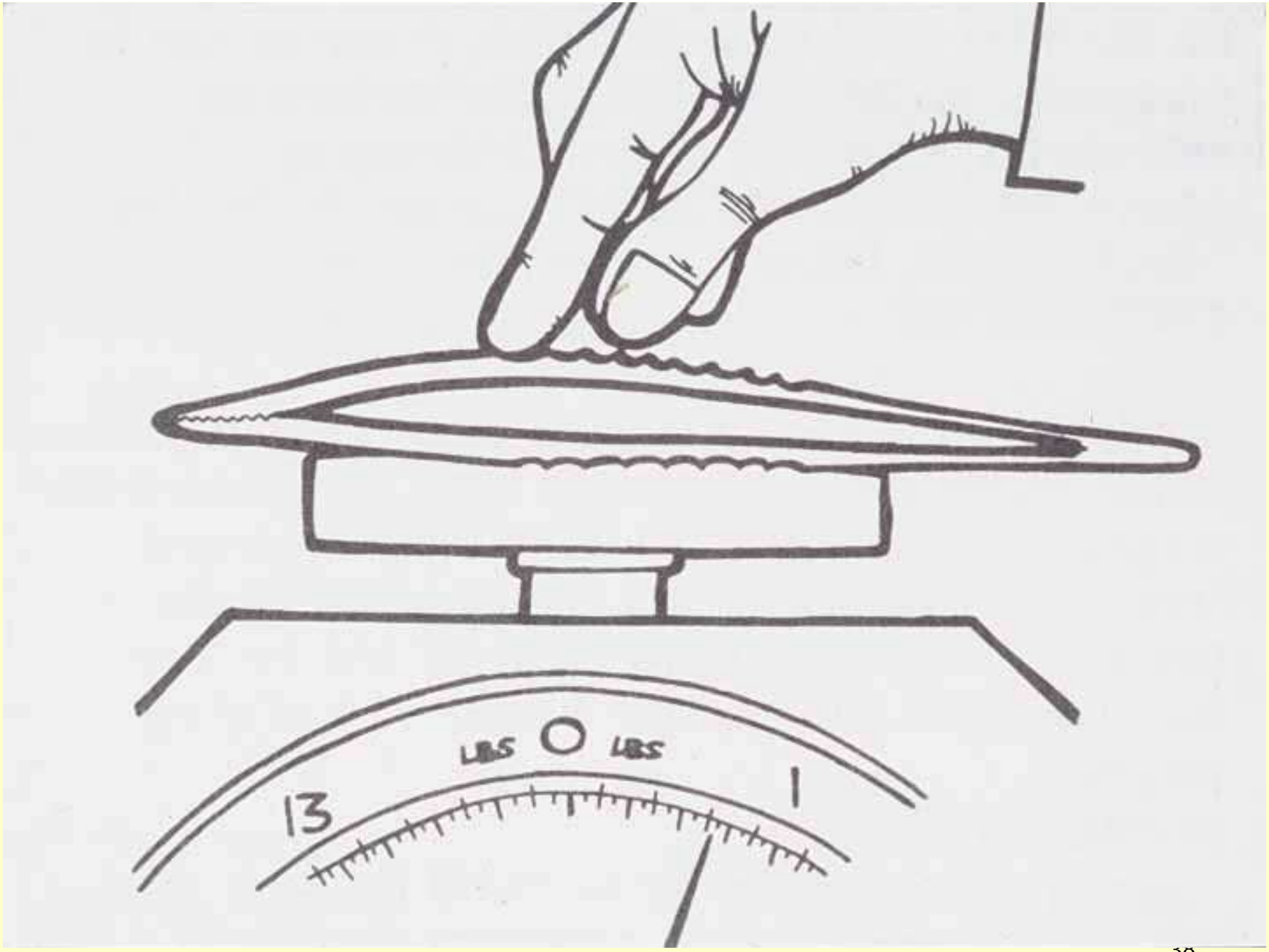
1. Large contact area
2. Length = palm width
3. Pommel, hilt
4. Slight flattening (rotat



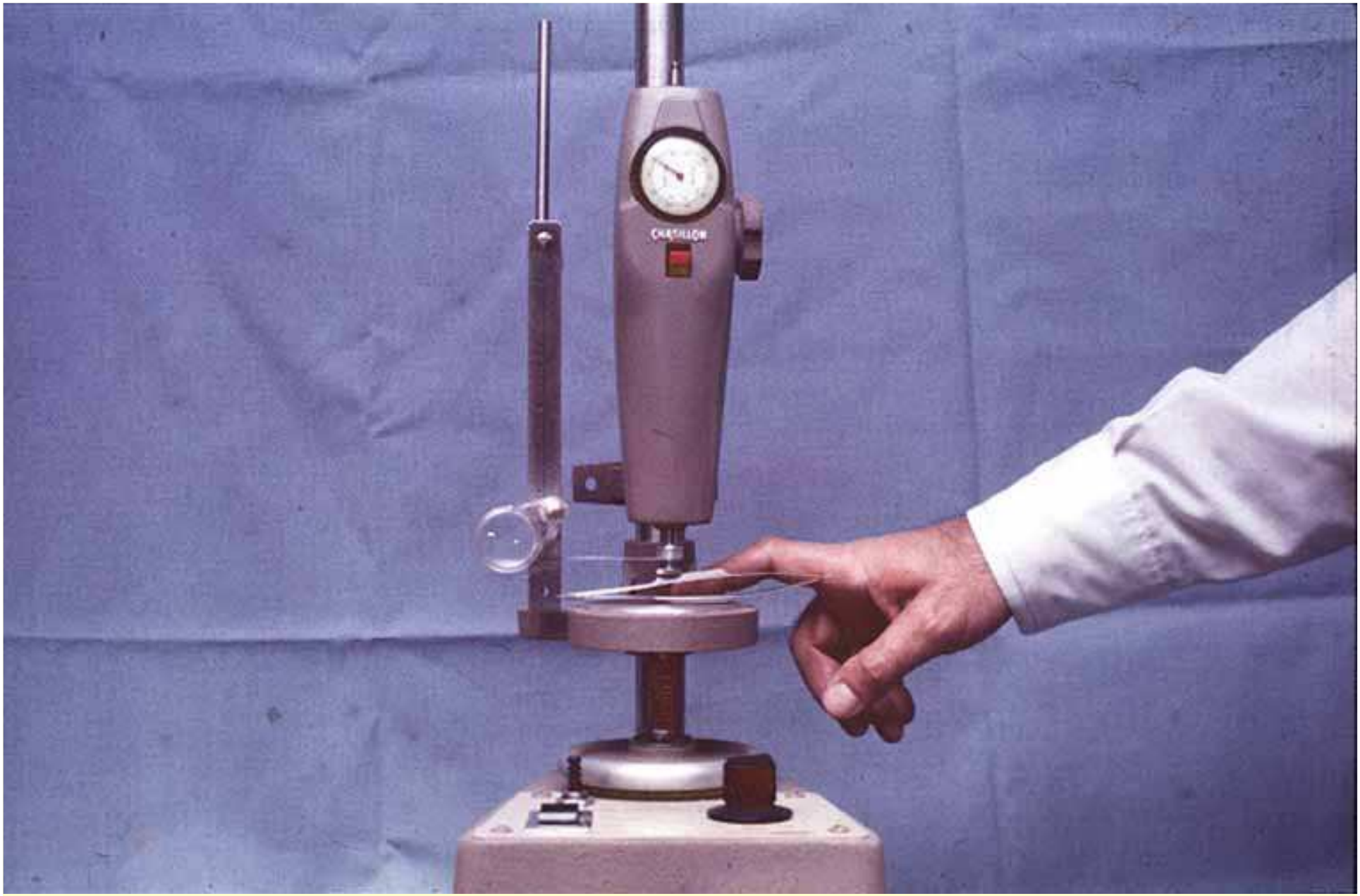
5. Slight hollowing, for thumb, index
6. Angled to shaft, if appropriate
7. Within envelope of reach for limb segment
8. No sharp projections
9. Clearance, including gloves
10. Insulation - heat, vibration, electricity

Precision grip criteria for micro needleholder design

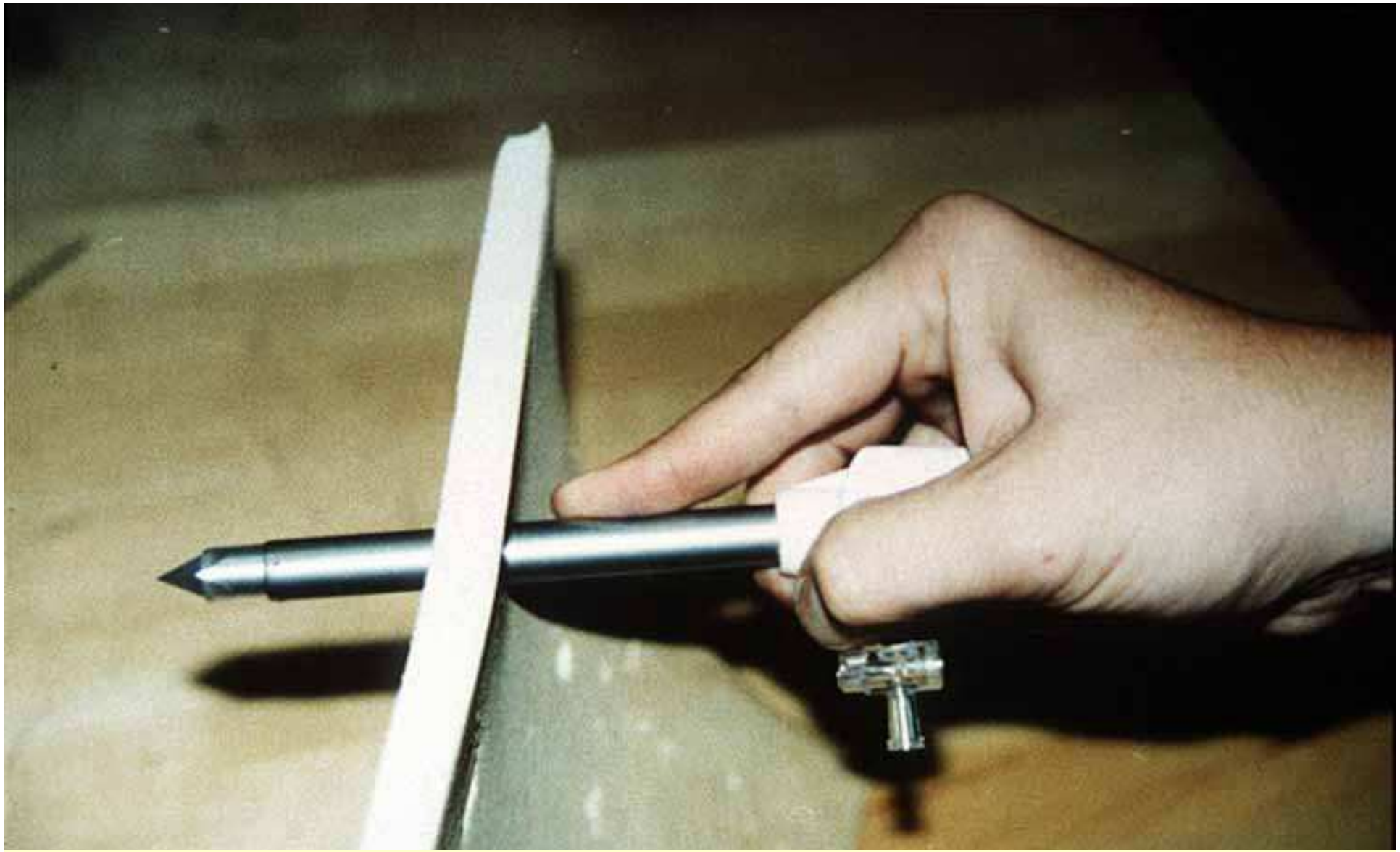
- length - 10 cm from fingertips to thumb cleft
- crossection - circular
- thickness - 1 cm within fingertips
- stiffness - 50 to 80 gm weight (0.5 - 0.8 N)



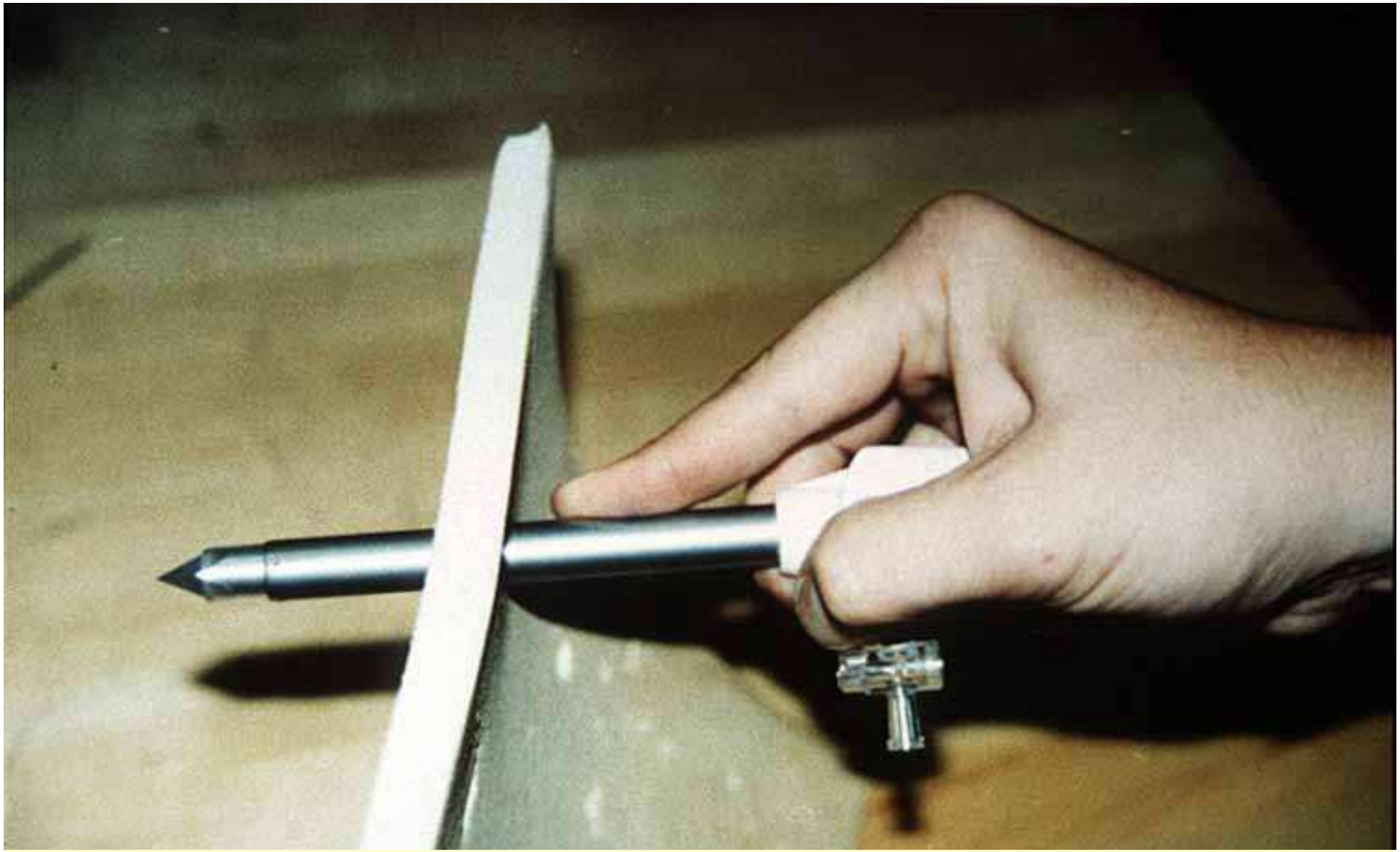
- Stiffness of dissecting forceps



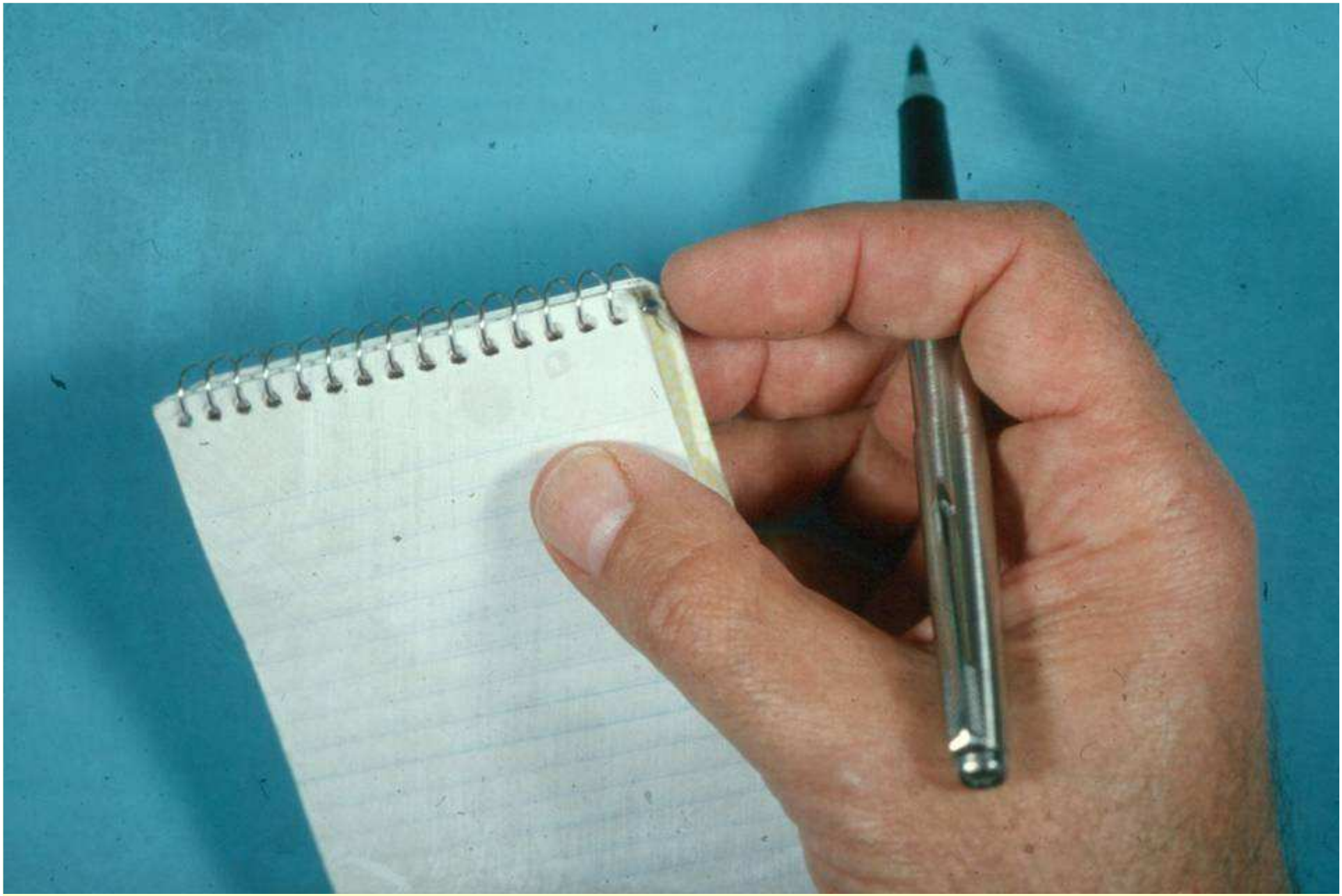
Measuring stiffness of microsurgical needleholder



> 20 deaths from lap trochar injuries in U.S.A. in 1992 - why ?



Why ? Tense grip - distortion - failure of safety shield



Reprinted from THE LANCET, *June* 26, 1965, *pp.* 1384-1385

THE HAND HAS TWO GRIPS

An Aspect of Surgical Dexterity

MICHAEL PATKIN
M.B. Melb., F.R.C.S., F.R.C.S.E.
LATE SURGICAL REGISTRAR, NORTH MIDDLESEX HOSPITAL, LONDON, N.18 *

EVERY table tennis-player knows that the hand can control two balls comfortably (fig. 1). Similarly, the car driver can control both the steering-wheel and a cigarette placed between index and middle fingers. Surgeons also use their hands for multiple functions at the same time; but little attention has been paid to this, since descriptions of operative technique usually concentrate on the tissues and instruments.

STORING INSTRUMENTS

A pair of dissectors can readily be stored out of the way with the ring and little fingers securing the instrument against the palm. This leaves the thumb, index, and middle fingers free to tie a knot (fig. 2). This technique is used for interrupted sutures: it saves putting down the dissectors (often out of the field of vision) and picking them up again.

In terms of conventional time-and-motion studies,[1] a number of "Therbligs" or basic elements of motion have been eliminated. As applied to the transport empty again, search, grasp, transport loaded, secure tissue for next suture.

The saving in time lies not in the increase of speed in each motion, but in eliminating unnecessary movements. There is the disadvantage of learning a new technique, but the time and effort taken are very little compared with the permanent improvement in operation.

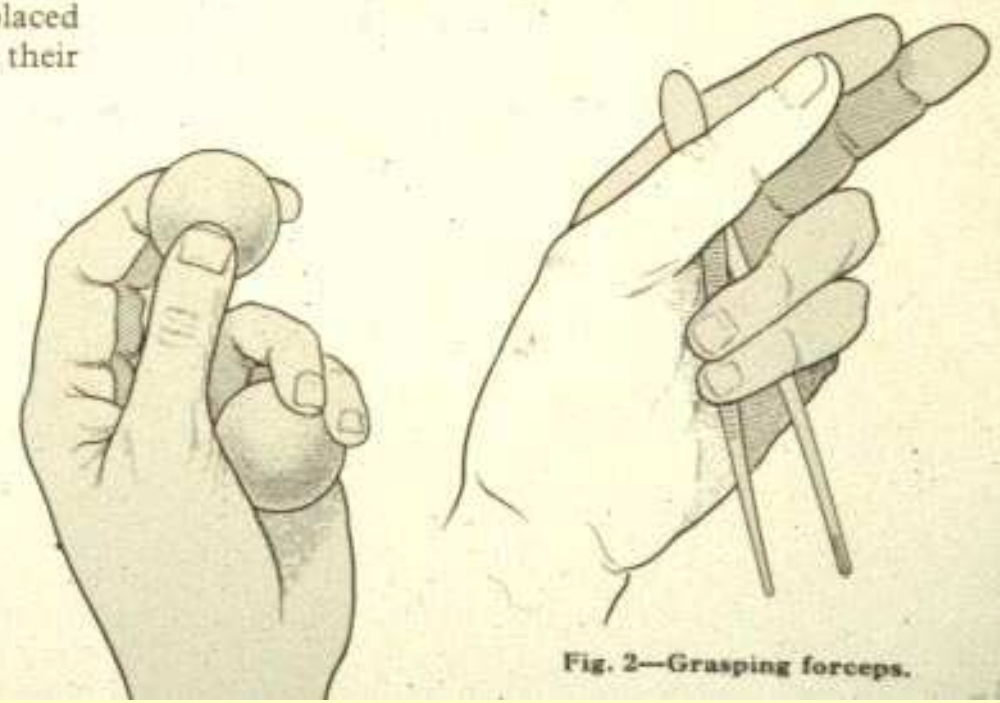
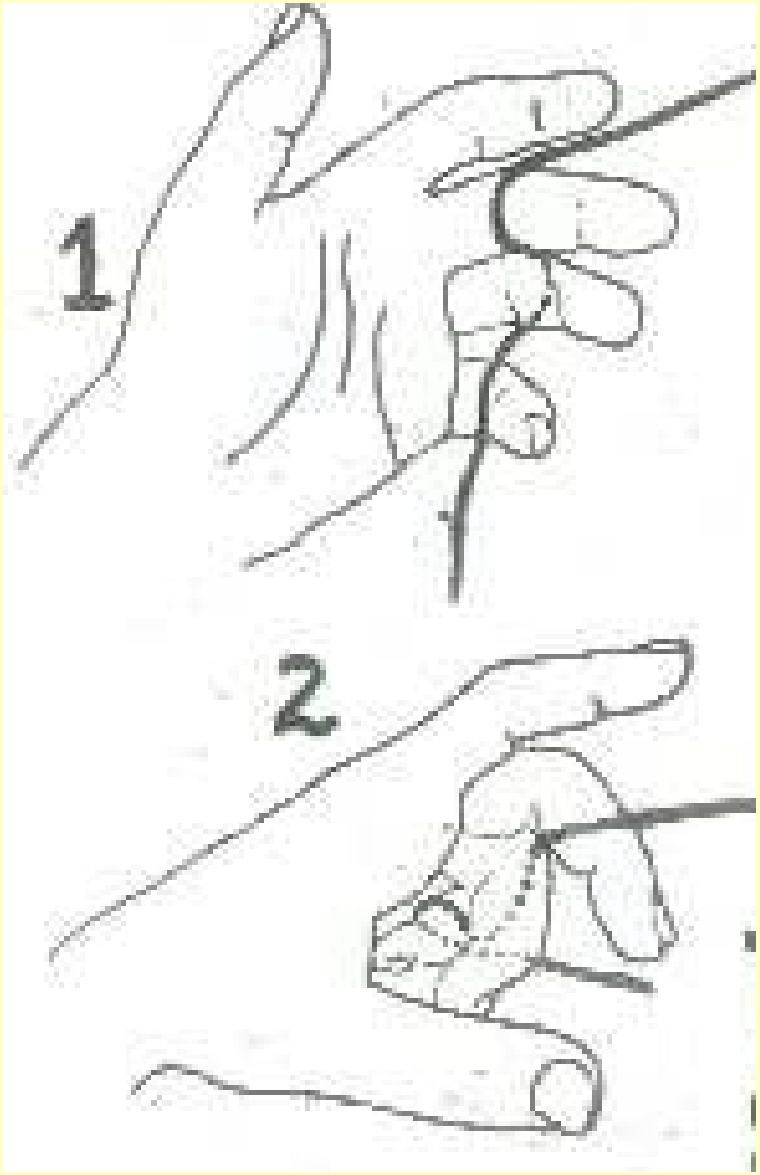
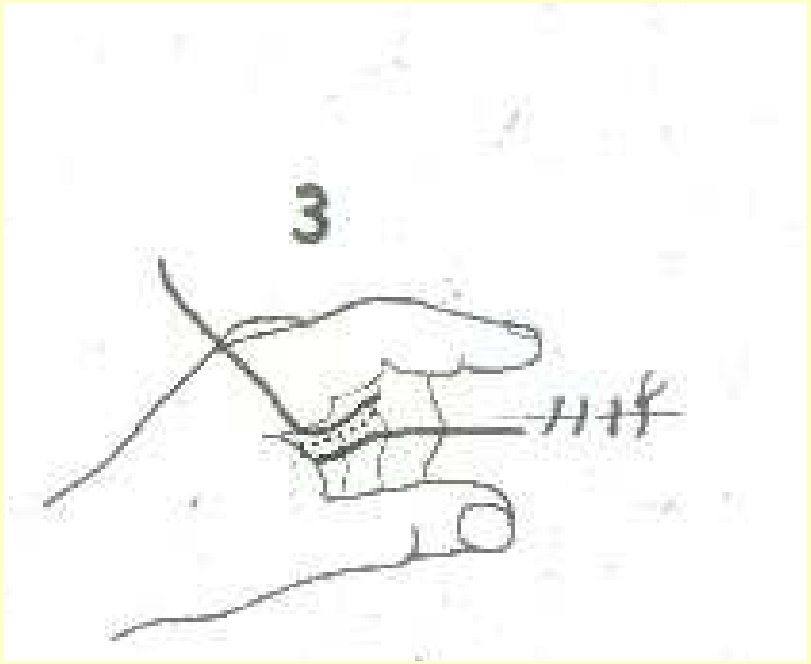


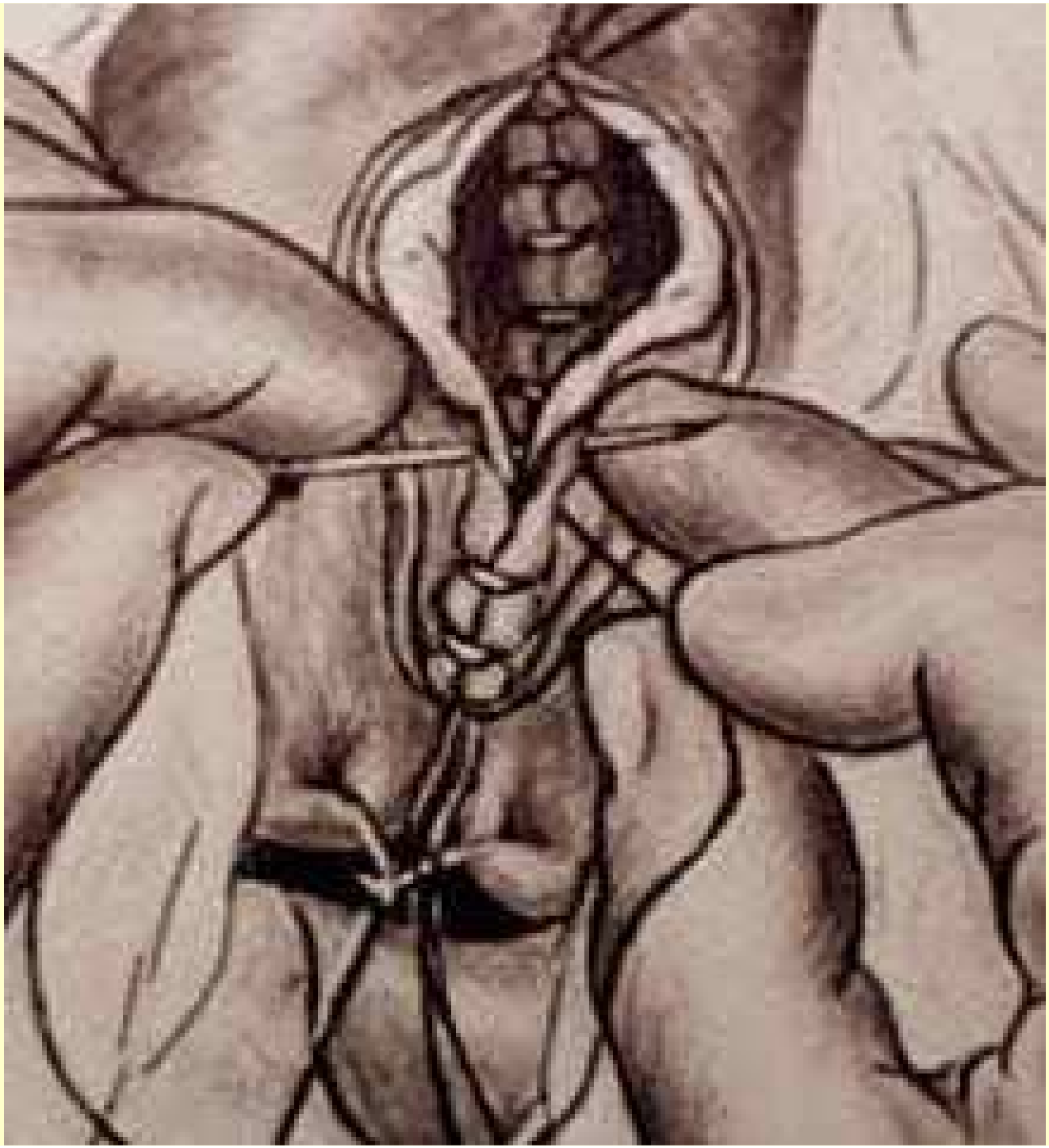
Fig. 2—Grasping forceps.

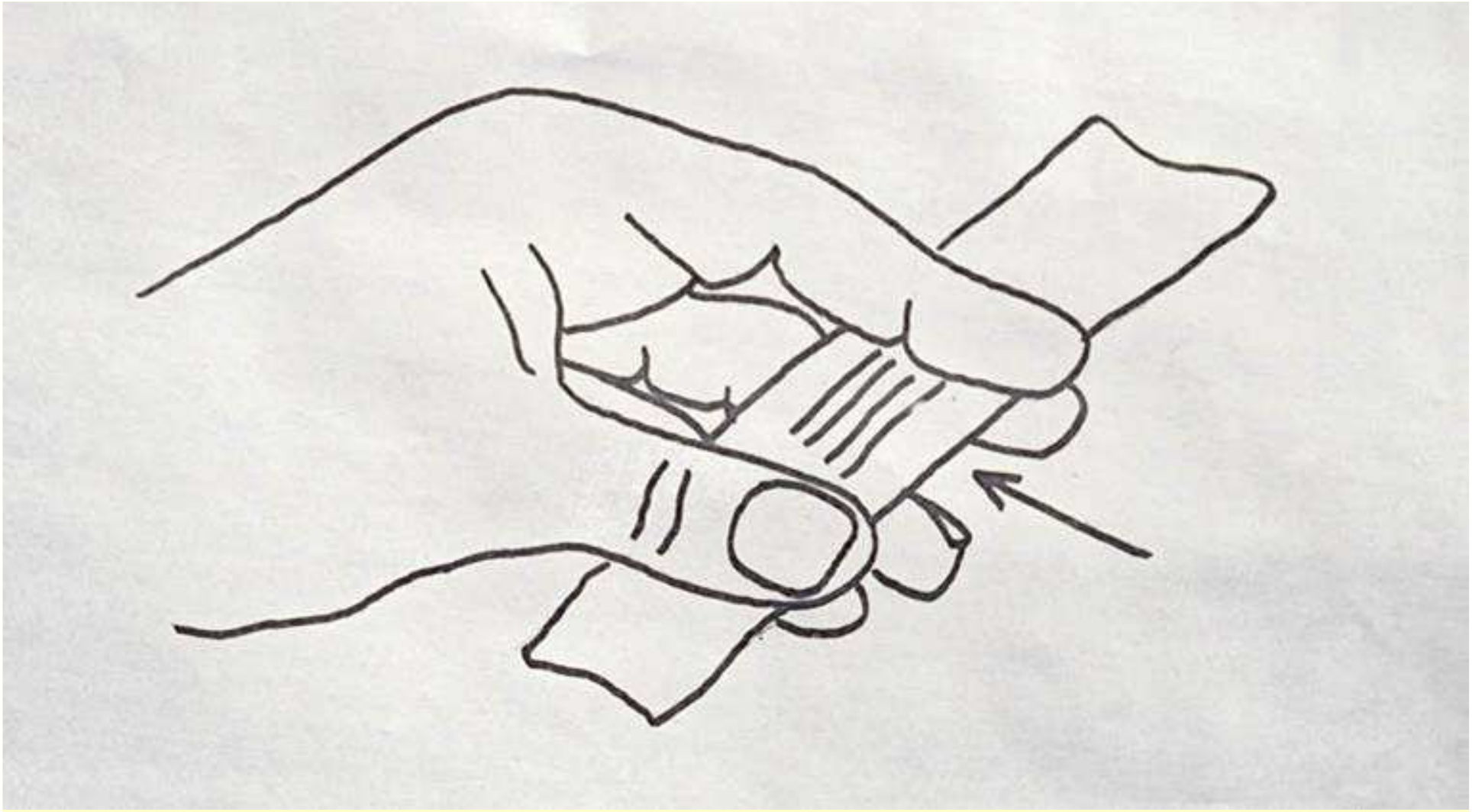
- Double grips of the hand



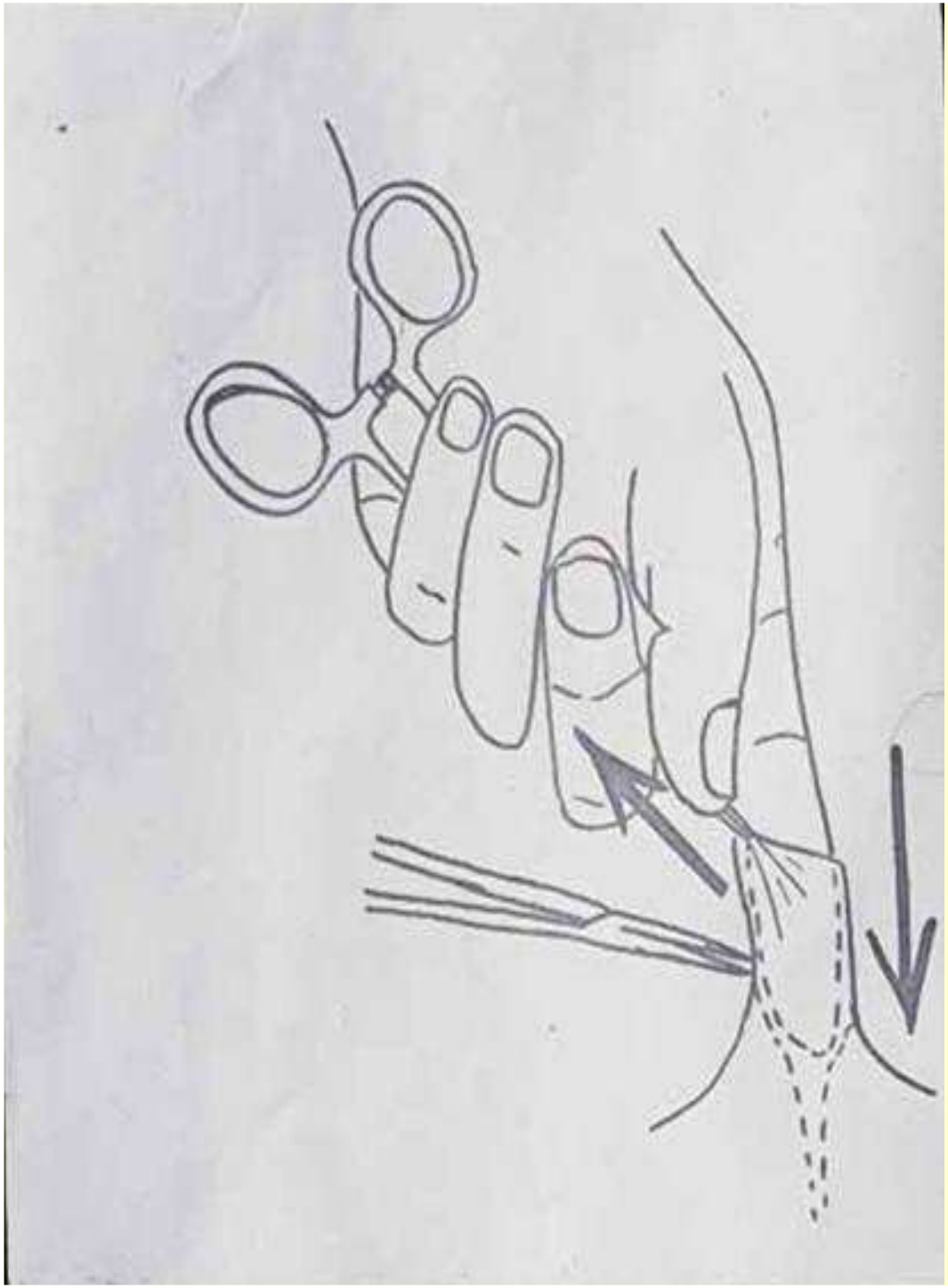


Suture storage grip





- Double grip, stretch
- Incision at right angle to line of tenson



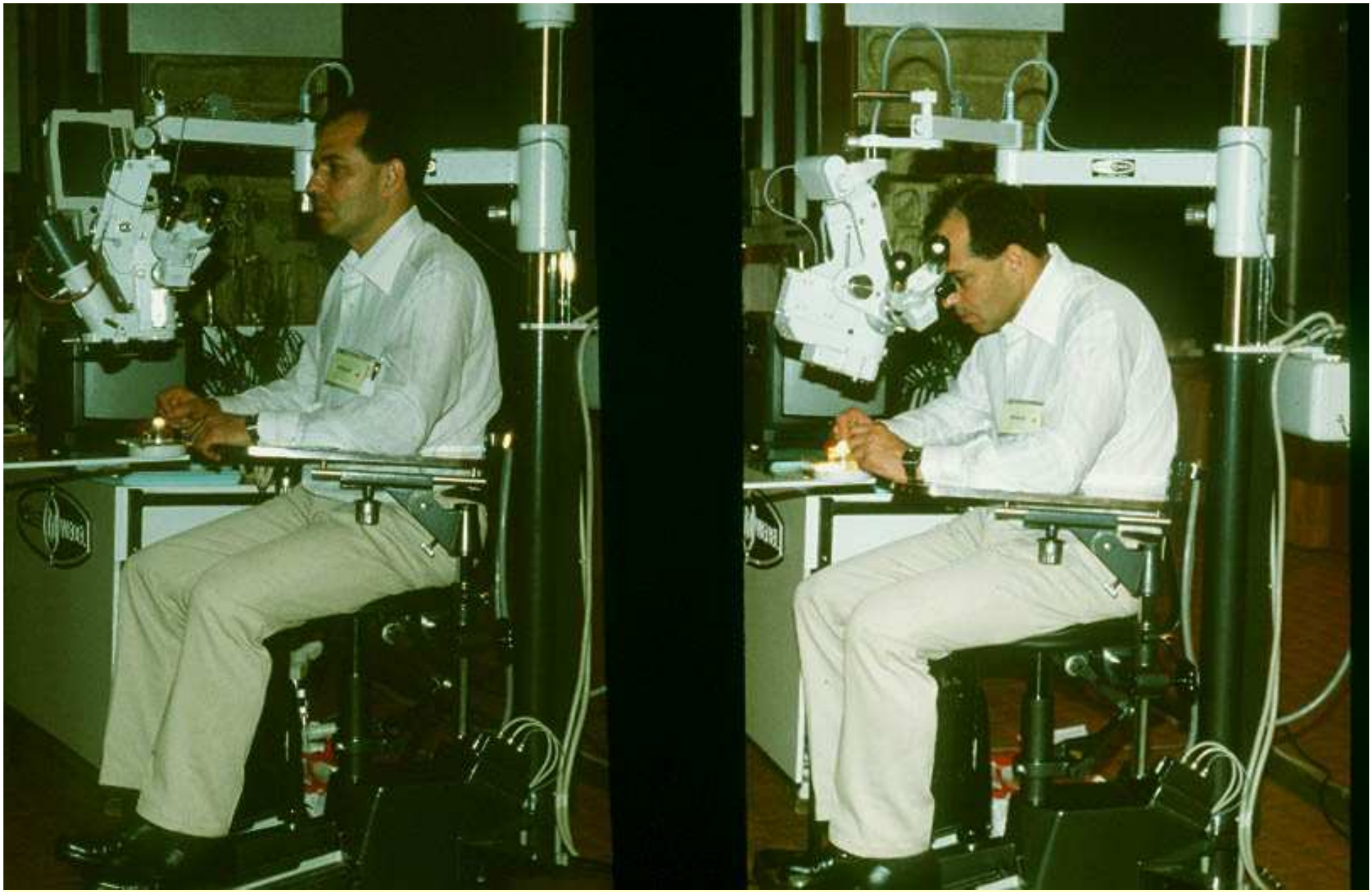
Double hand function

(traction on hollow structure with fingertip inside)

e.g.

- adherent hernial sac
- scarred duodenal stump
- horrible gall-bladder

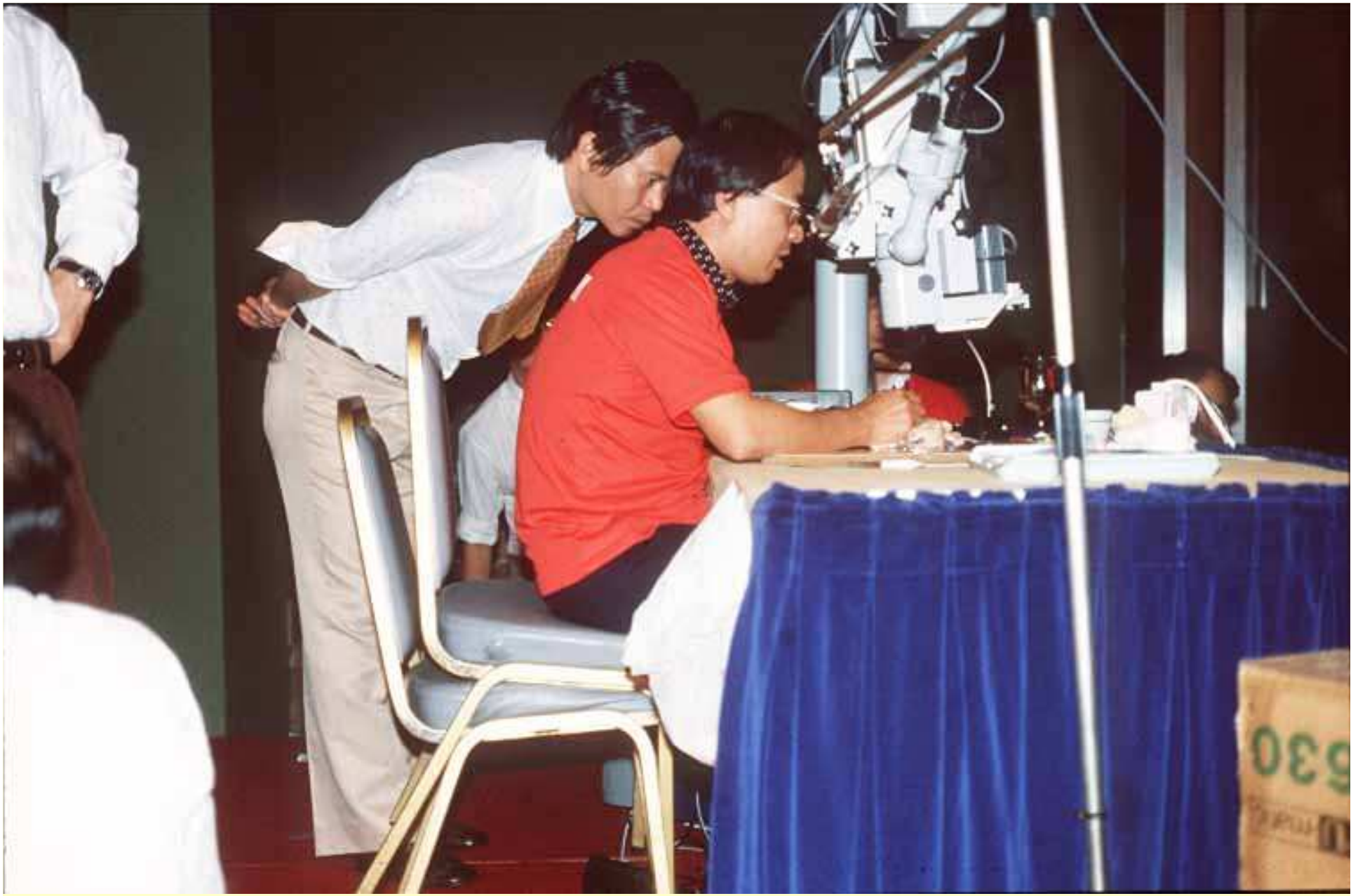
seating



Zeiss microscope at Singapore 1977

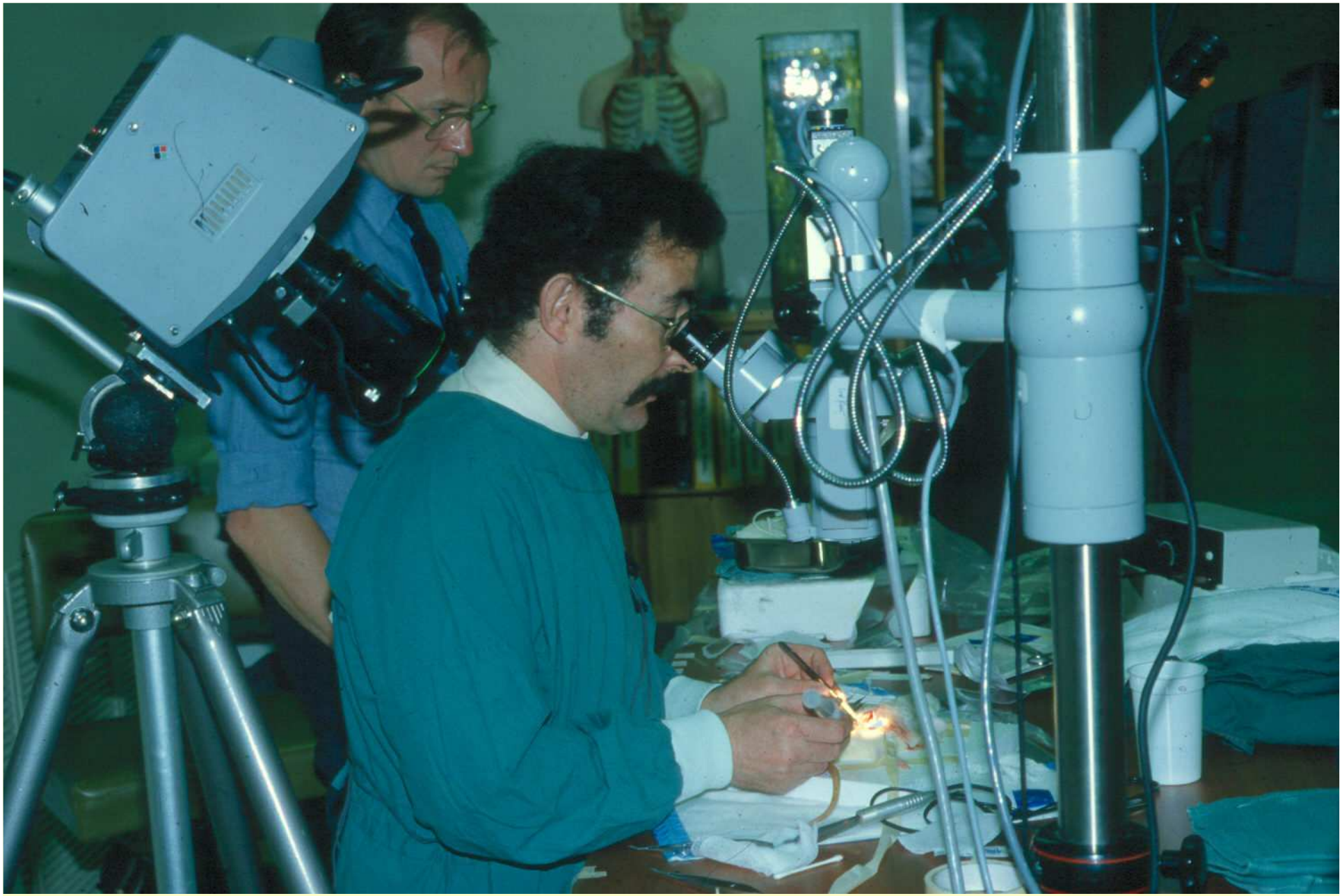
- 20 cm ocular extension needed

Pioneer microsurgeon needs back-brace



Prof. Harii at Singapore 1978


TODAY'S PROGRAMME



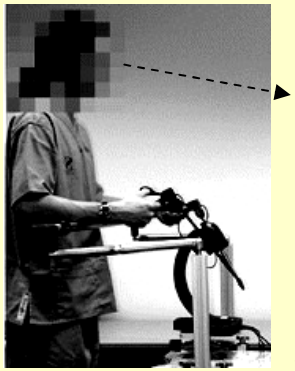
Robert Winston at gynae micro workshop, Adelaide 1981

POSTURAL NEEDS IN MICROSURGERY

1. Hand support
2. Forearm horizontal
3. Arm by side, elbow in
4. Trunk & head vertical
5. Gaze 15-45° downwards
6. Objective over fingertips
7. Focal length to tissue plane
8. Seat height, area, slope, edge, give.
9. Lumbar support
10. Leg clearance
11. Foot support, pedal design
12. ...alter exposure, start again.

10 years before office ergonomics

Lap surgery is tiring - be ergonomic



Neck flexed

Arm by side, support if available

Relaxed hand-grip

Subdued lighting from side or above

Monitor 15-30^0 below horizontal and close

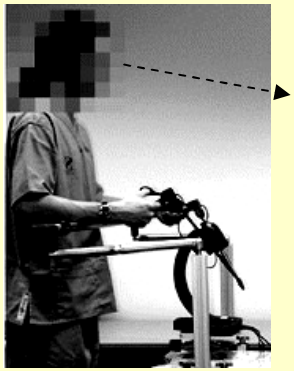
Port sites for neutral wrist posture, hands at elbow height

Operating table at pubis height for non-obese patient

Platform for shorter operator or assistant

www.mpatkin.org 060901

Lap surgery is tiring - be ergonomic



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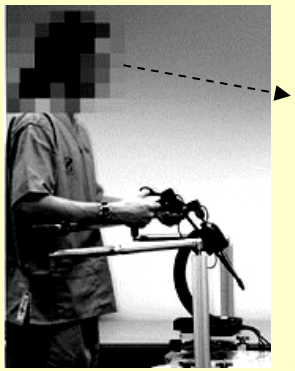

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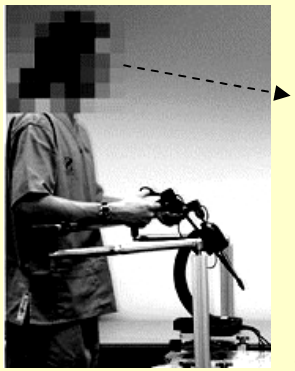

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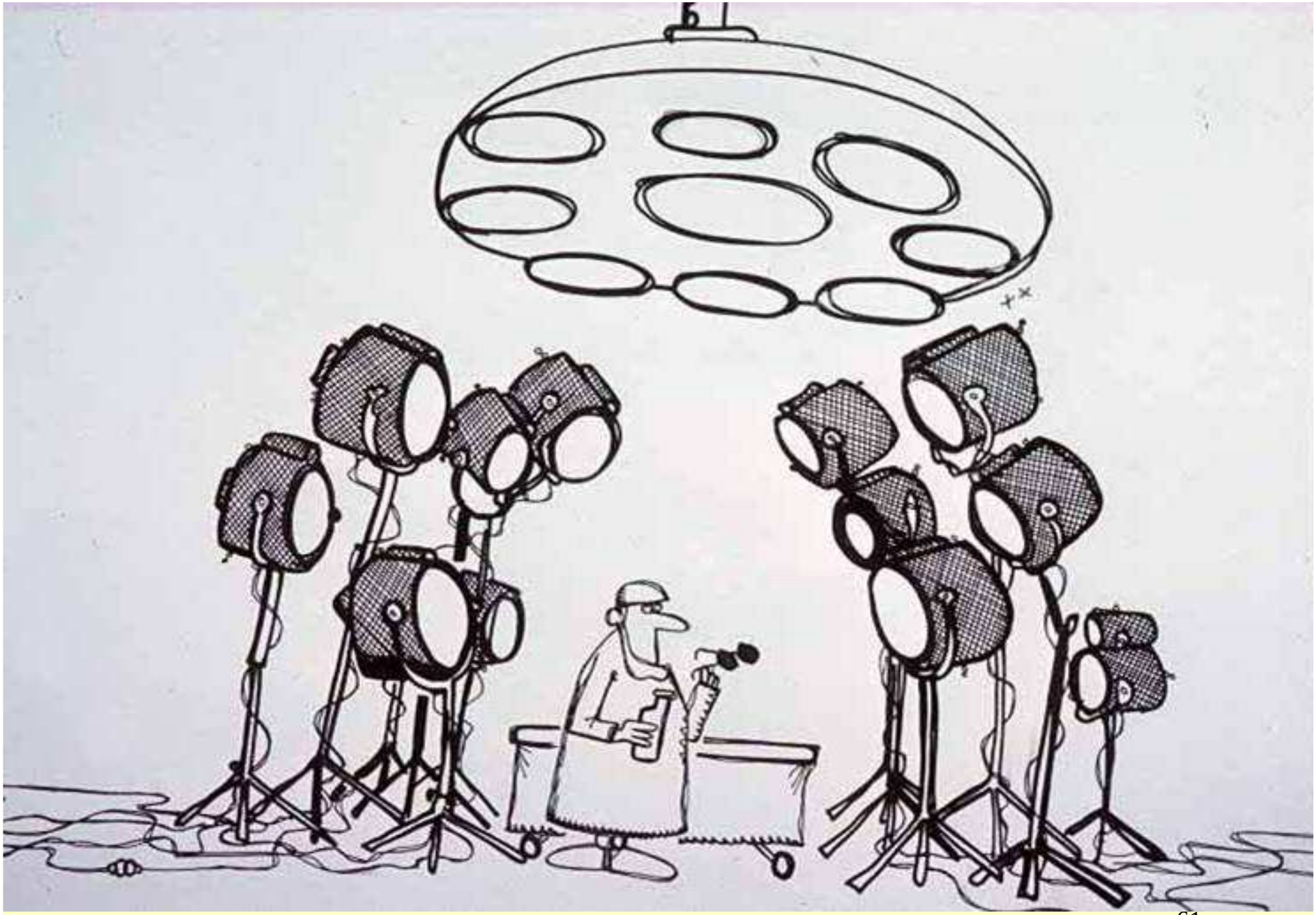
environmental factors

- Lighting, visual factors
- Temperature, humidity
- Noise etc etc



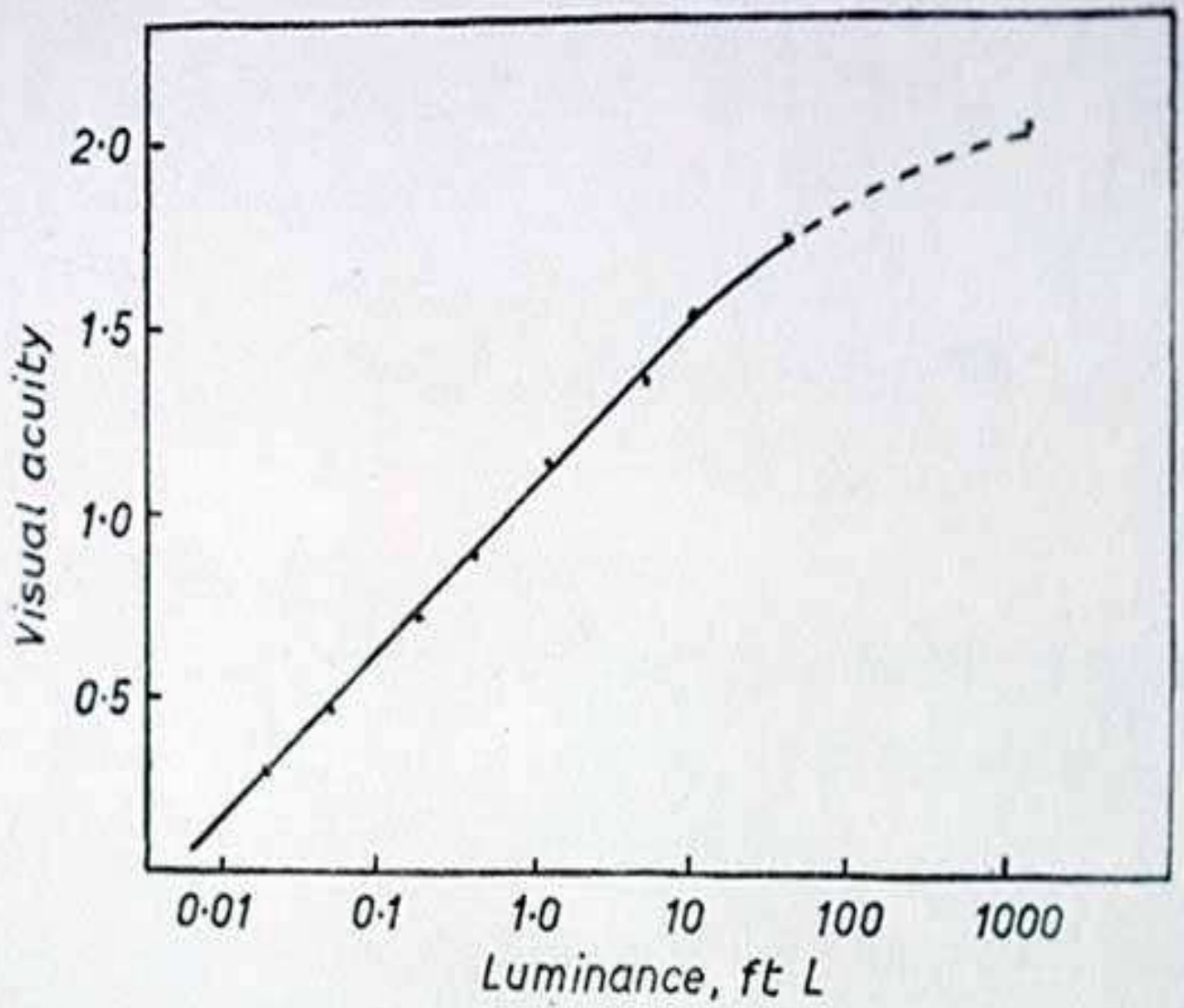


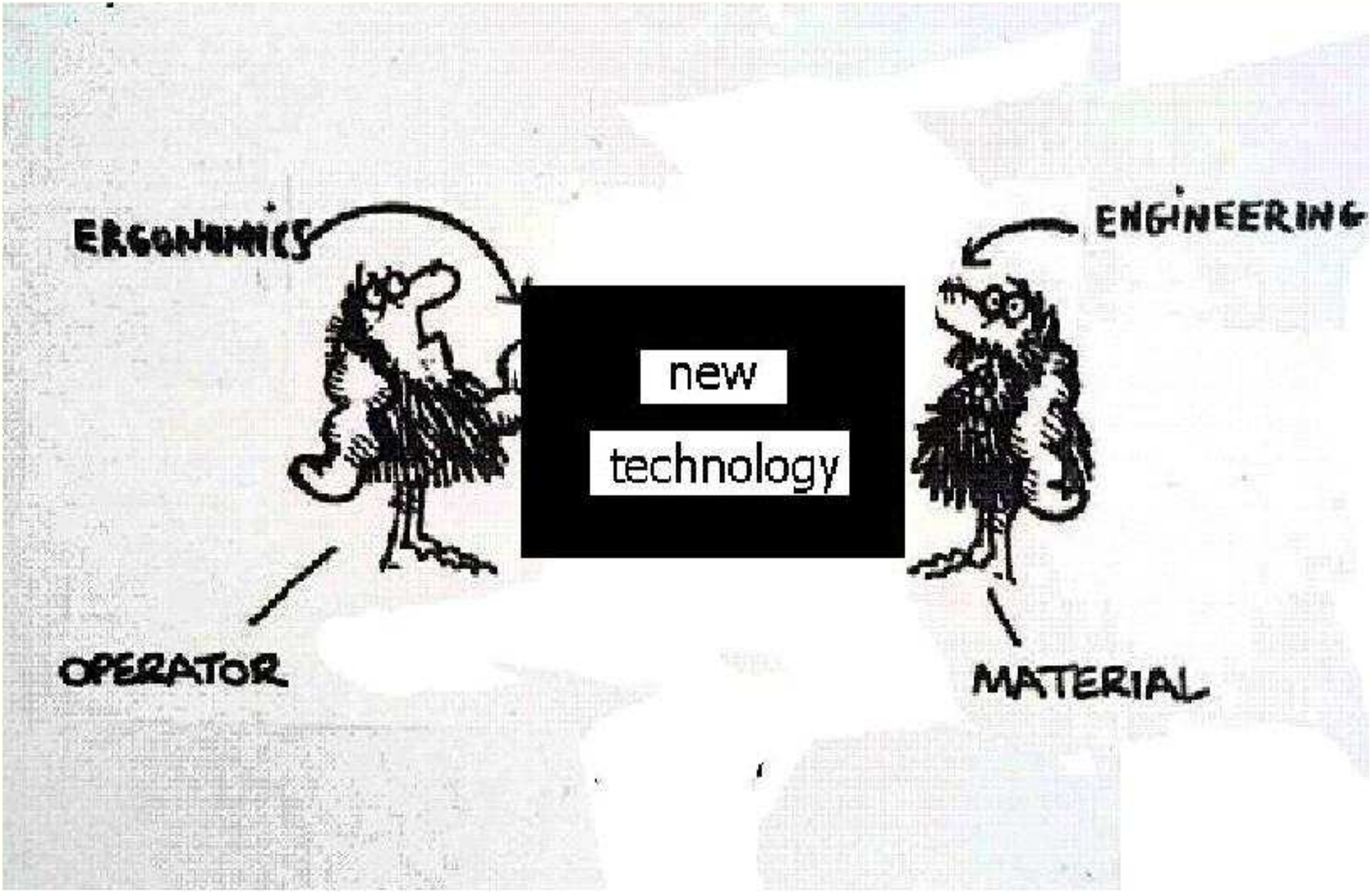
Fig. 100. The relationship between visual acuity and luminance (after Lythgoe, 1932).

Ergonomics in surgery - 3 phases

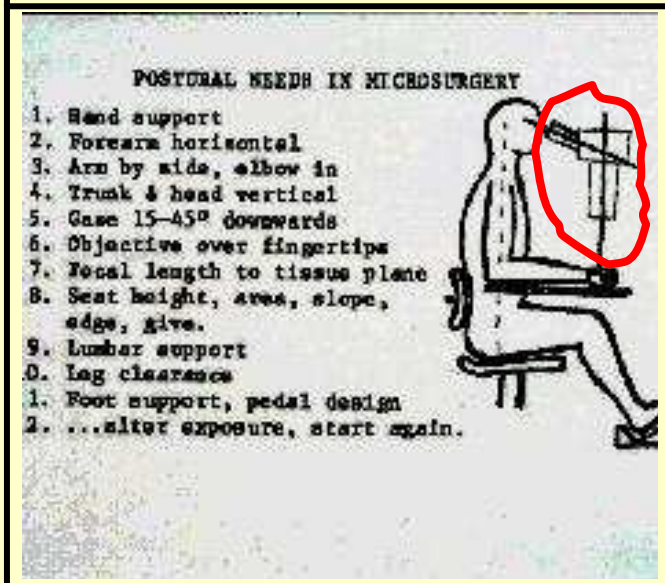
Ergonomics in surgery - 3 phases

- *pre-modern - 1846 anaesthesia*
- *modern*
- *post-modern*
  - *micro 1970s*
  - *lap 1990s*
  - *robotic 2000s*

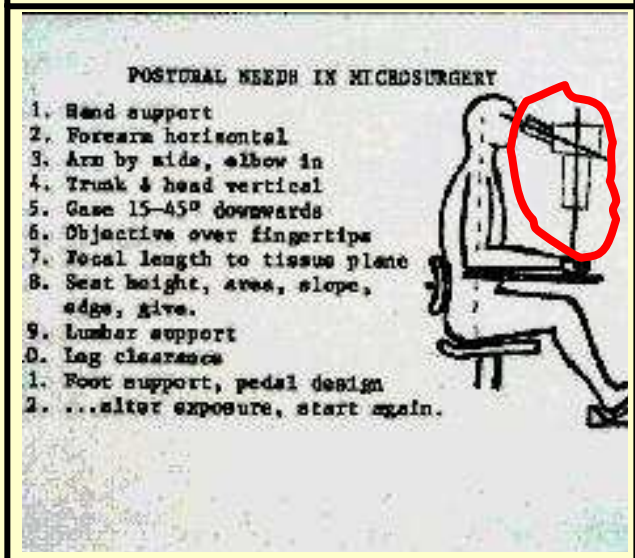
Unaided normal human capacity is no longer adequate


ERGONOMICS
ENGINEERING
new
technology
OPERATOR
MATERIAL

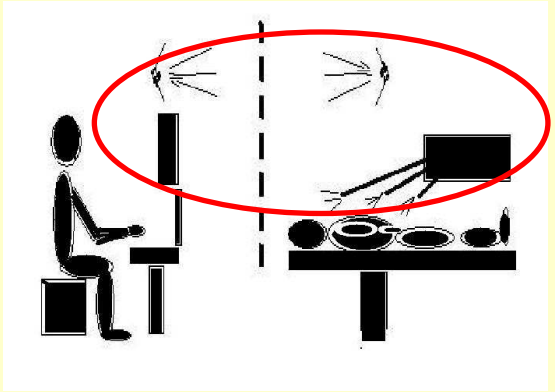
The extra layer of technology

micro	lap	robotic
		
• Microscope • V fine instruments		

The extra layer of technology

micro	lap	robotic
		
• Microscope • V. fine instruments	• Long instru-ments + friction • Video system	

The extra layer of technology

micro	lap	robotic
		
• Microscope • V fine instruments	• Long instru-ments + friction • Video system	• Mechatronics • Video system

Ergonomic factors in micro-surgery

- *[hand tremor]*
- *[instrument design]*
- *[visual factors]*

- seating

Ergonomics in lap surgery

Ergonomics in lap surgery

- 2-D view of 3D space

Ergonomics in lap surgery

- 2-D view of 3D space
- eye-hand coordination

Ergonomics in lap surgery

- 2-D view of 3D space
- eye-hand coordination
- limited degrees of freedom

Ergonomics in lap surgery

- 2-D view of 3D space
- eye-hand coordination
- limited degrees of freedom
- instruments not adequate

Cognitive ergonomics in surgery

- Error in hospitals
- Information design

ICU chart

Patient records

Documentation for equipment

etc.

Future applications and research

Video analysis

Heuristics of tissue dissection

Heaps of stuff – Nintendo surgery, intelligent agents


CRB
22-C-172


CRB
22-C-173


CRB
22-C-173


CRB
22-C-173


CRB
22-C-173

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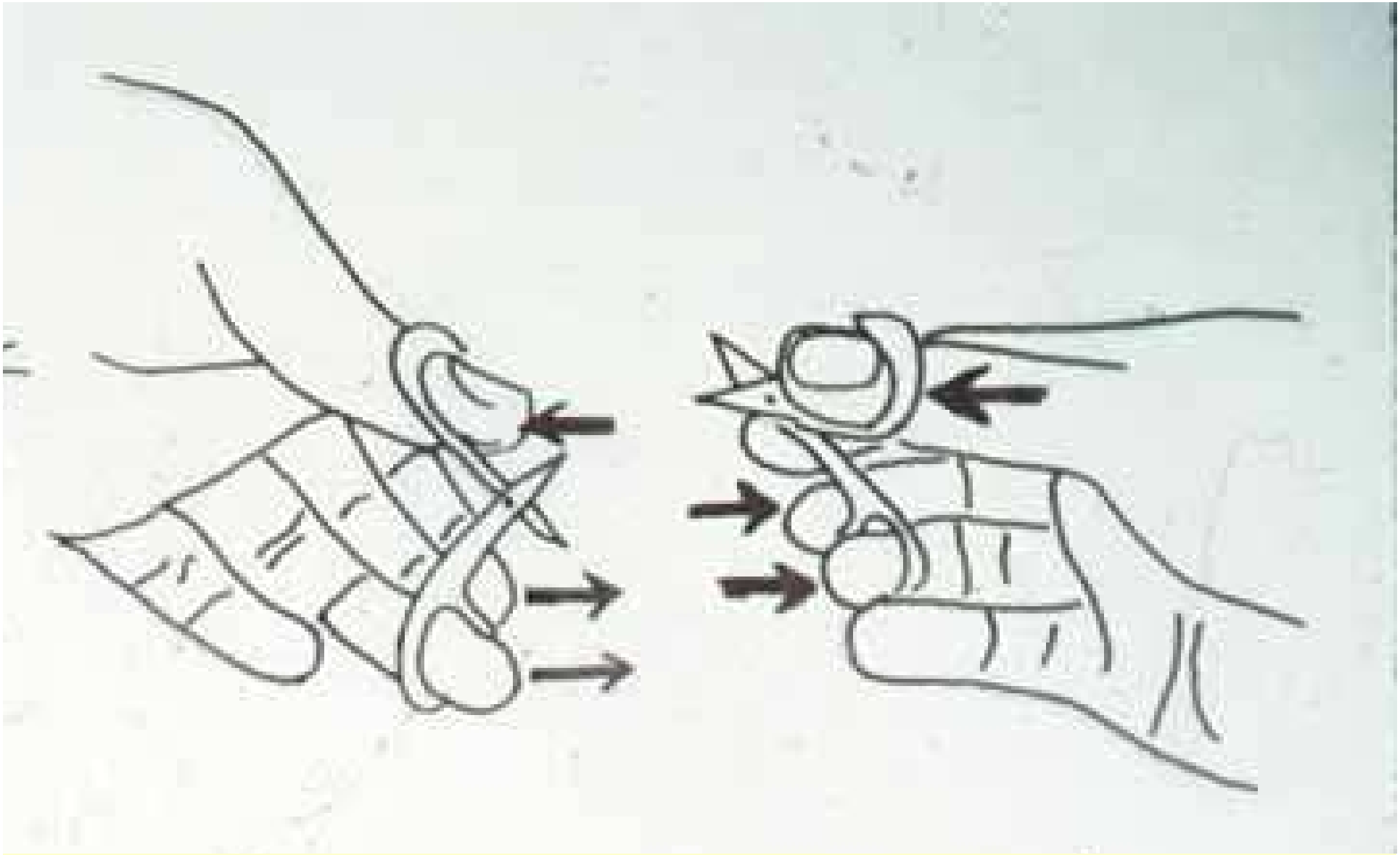

Direction of finger and thumb forces for cutting with loose scissors

But first …. for something completely different

Para-professional skills

- Self-management – fitness, alcohol
- Info mgt,communicating - speaking, ppts,,
- Interpersonal relations - ethics & values
- Technical - drawing, photography, computing
- Forces exerted in surgery

- AND … Ergonomics!!