

Seeing blindspots

Harold Thimbleby

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Coating Factor Concentrate Infusion

DO NOT SWITCH OFF OR ALTER RATE
without contacting the Haemophilia Centre

Nurses: Ext 4248 (bleep 328 Sat/Sun 9am-1pm)
SpR: Bleep 811

Denise Melanson

22 August 2006



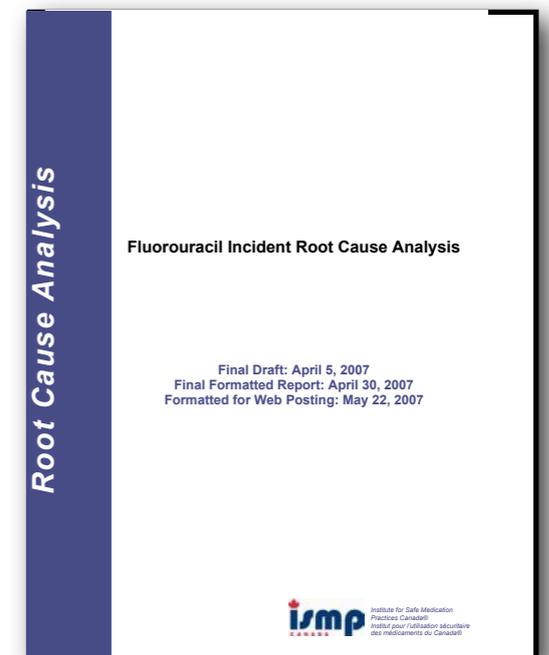


\$799
second hand

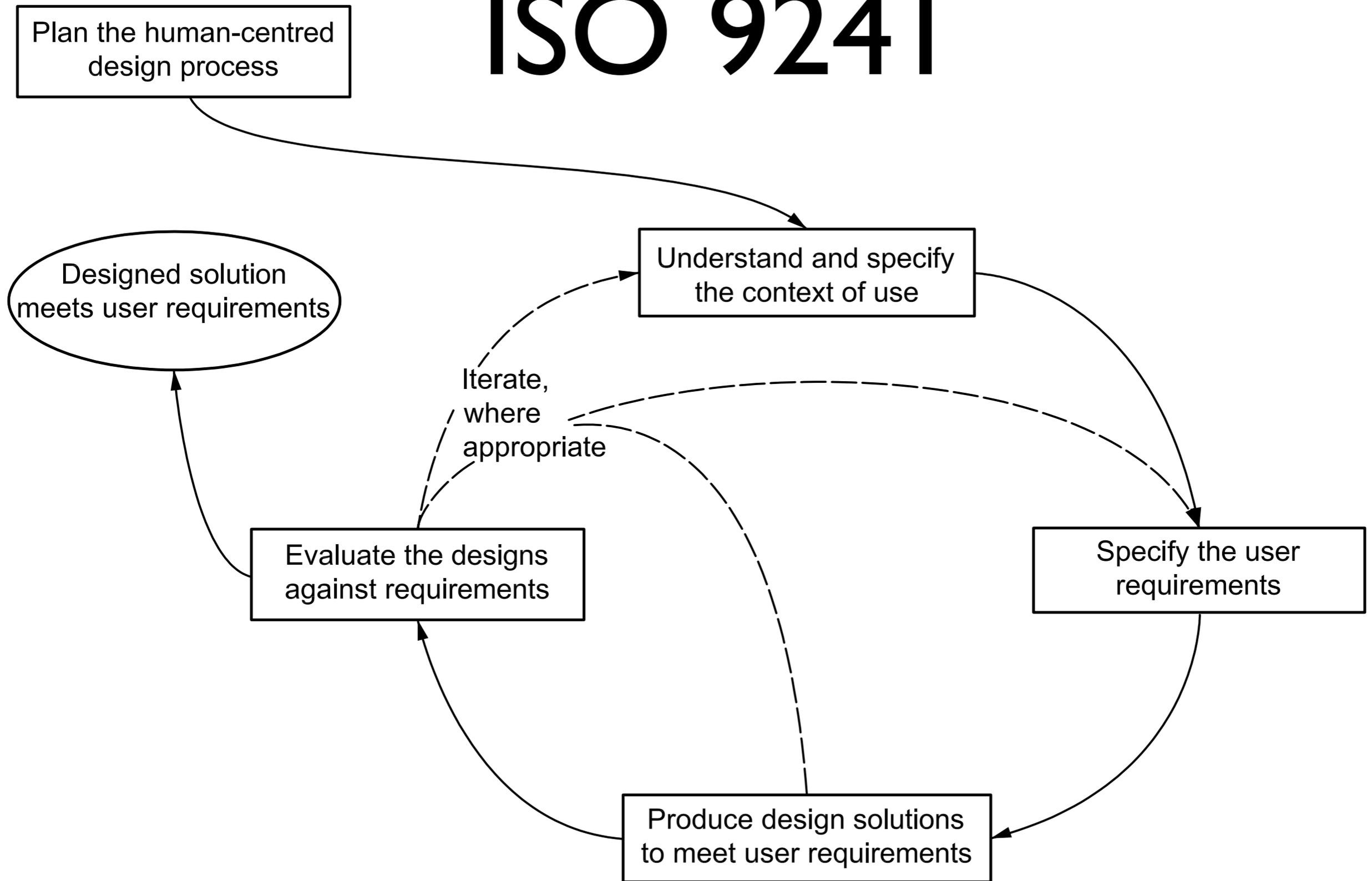


A two-hour study

- 3 out of 5 nurses enter incorrect data
- All 5 confused by setup or selection of mL/hr
- 2 out of 5 confused by programming
- 3 out of 5 confused by decimal point



ISO 9241



Unexpected Increased Mortality After Implementation of a Commercially Sold Computerized Physician Order Entry System

Yong Y. Han, MD*‡; Joseph A. Carcillo, MD*‡§; Shekhar T. Venkataraman, MD*‡§;
Robert S.B. Clark, MD*‡§; R. Scott Watson, MD, MPH*‡§||; Trung C. Nguyen, MD*‡; Hülya Bayir, MD*‡;
and Richard A. Orr, MD*‡§

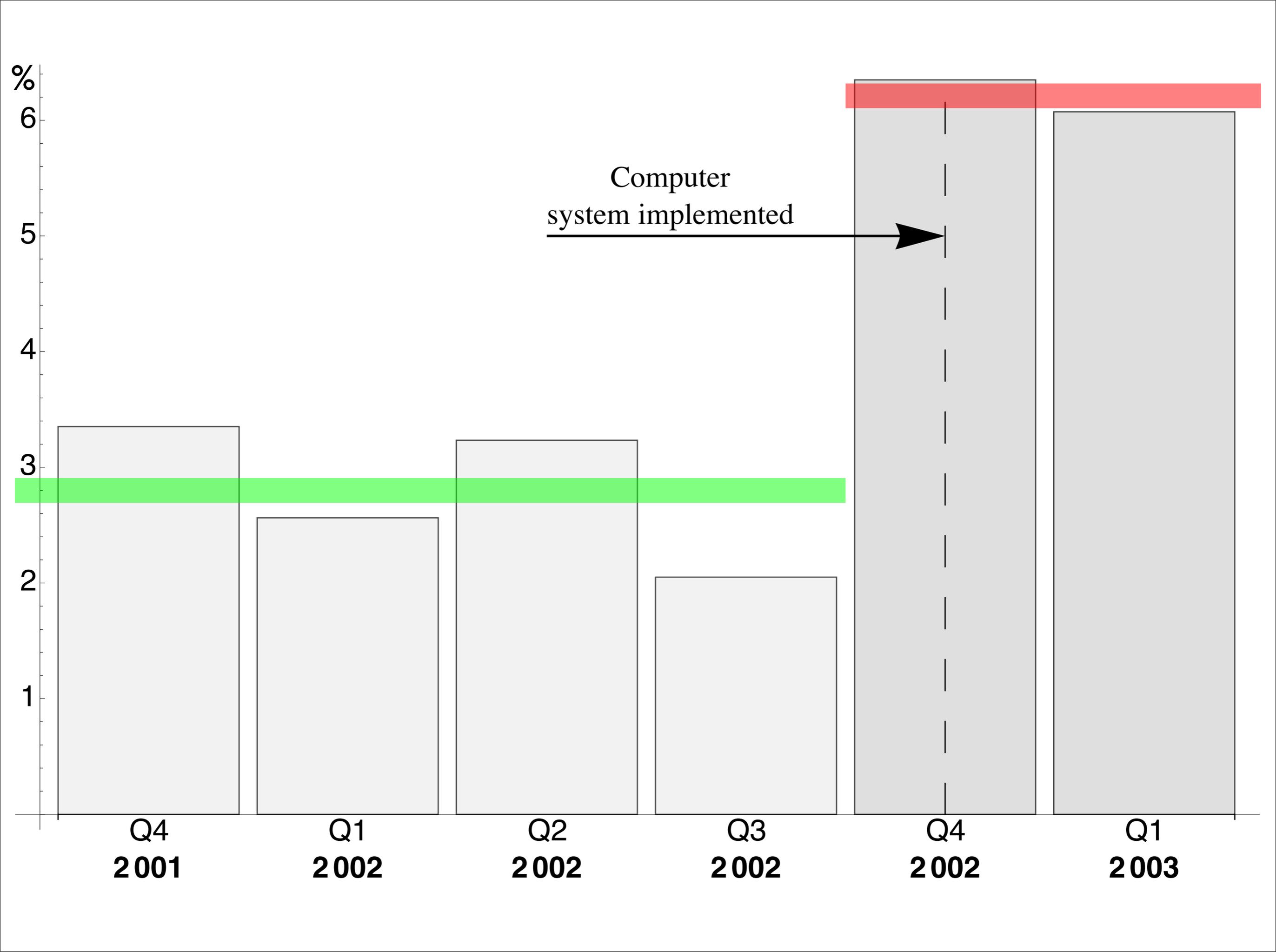
ABSTRACT. *Objective.* In response to the landmark 1999 report by the Institute of Medicine and safety initiatives promoted by the Leapfrog Group, our institution implemented a commercially sold computerized physician order entry (CPOE) system in an effort to reduce medical errors and mortality. We sought to test the hypothesis that CPOE implementation results in reduced mortality among children who are transported for specialized care.

Methods. Demographic, clinical, and mortality data were collected of all children who were admitted via interfacility transport to our regional, academic, tertiary-care level children's hospital during an 18-month period. A commercially sold CPOE program that operated within the framework of a general, medical-surgical clinical application platform was rapidly implemented hospital-wide during this period. Retrospective analysis was conducted during the 18-month period before and after CPOE implementation.

computer software, health care delivery/access, interhospital transport, outcome.

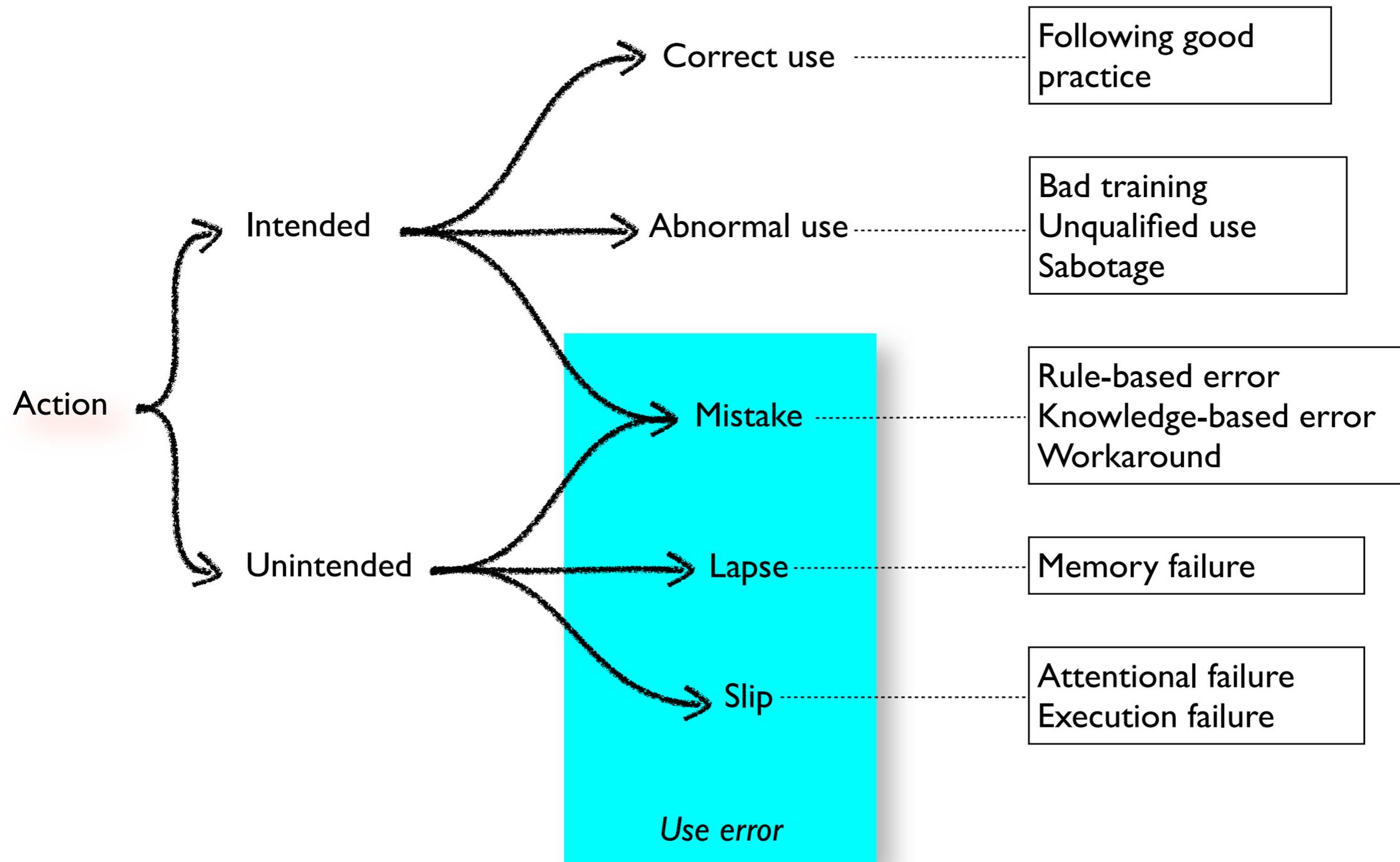
ABBREVIATIONS. CPOE, computerized physician order entry; CHP, Children's Hospital of Pittsburgh; ADE, adverse drug event; PRISM, Pediatric Risk of Mortality; OR, odds ratio; CI, confidence interval.

In their landmark report *To Err is Human: Building a Safer Health System*, members of the Institute of Medicine estimated that medical errors contributed to between 44 000 and 98 000 deaths annually in the United States.¹ As a result of this report, subsequent congressional hearings, and extensive media exposure, the issue of patient safety has quickly risen to a position of highest priority among many health care organizations. Sparked by this "safety initiative," many hospitals have looked toward emerging medical information technologies, specifically computerized physician order entry (CPOE) systems, to reduce human error during h



ISO 62366

Medical devices— Application of usability engineering to medical devices



DO ME

Designing Out Medical Error

A research collaboration between the Helen Hamlyn Centre for Design at the Royal College of Art, the Department of Surgery and Cancer, Imperial College London, and Imperial College Business School. DOME is funded by the Engineering and Physical Sciences Research Council.

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**helen
hamlyn
centre for
design**

**Imperial College
London**

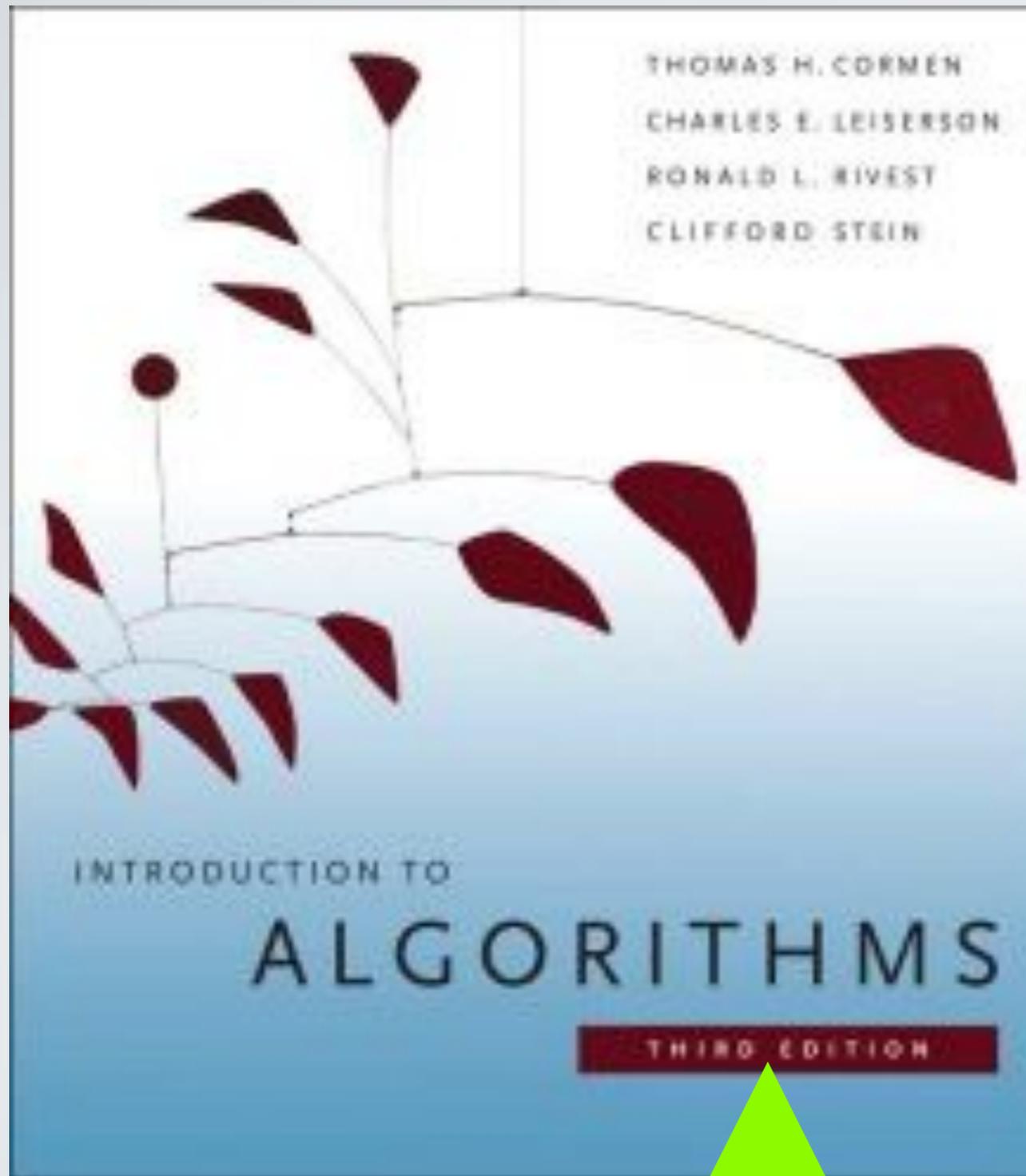
**Imperial College
London
BUSINESS SCHOOL**

DOME

Designing Out Medical Error

Computerized approaches are ideal for **eliminating error** because reliability can approach 100%

D W Bates *et al*, "Incidence of ADEs and potential ADEs," *JAMA*, 274:29–34, 1995.



1292 pages

“beautifully written introduction to design of algorithms”

“the bible of the field”

“best textbook ever seen”

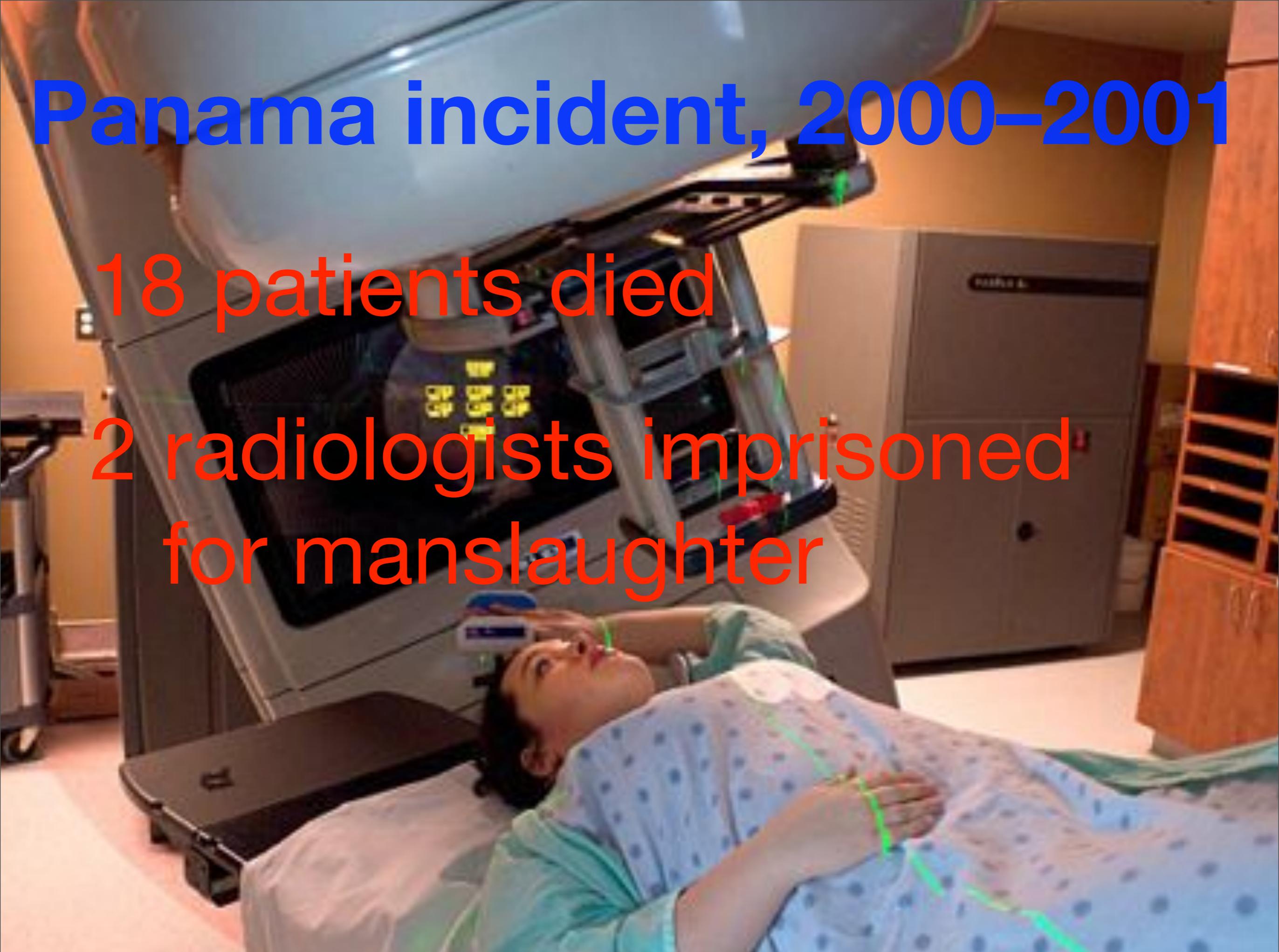
“We do not address error-handling”



Panama incident, 2000–2001

18 patients died

2 radiologists imprisoned
for manslaughter



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Olivia Saldana

Sociology...

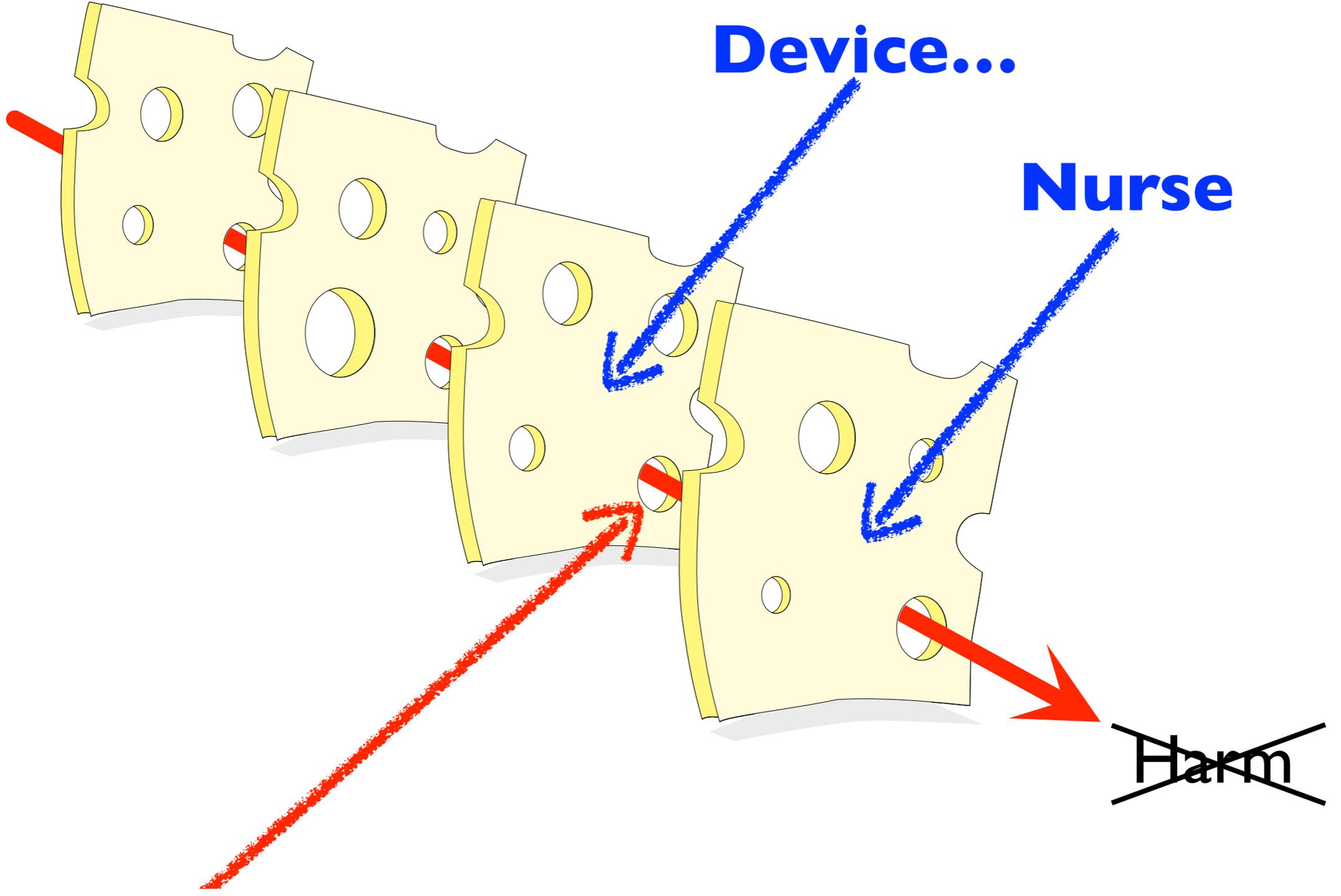
- delay & deny
- bad apple
- stories & statistics
- impossible error
- swiss cheese

... *but what can we do?*





Hazards



Device...

Nurse

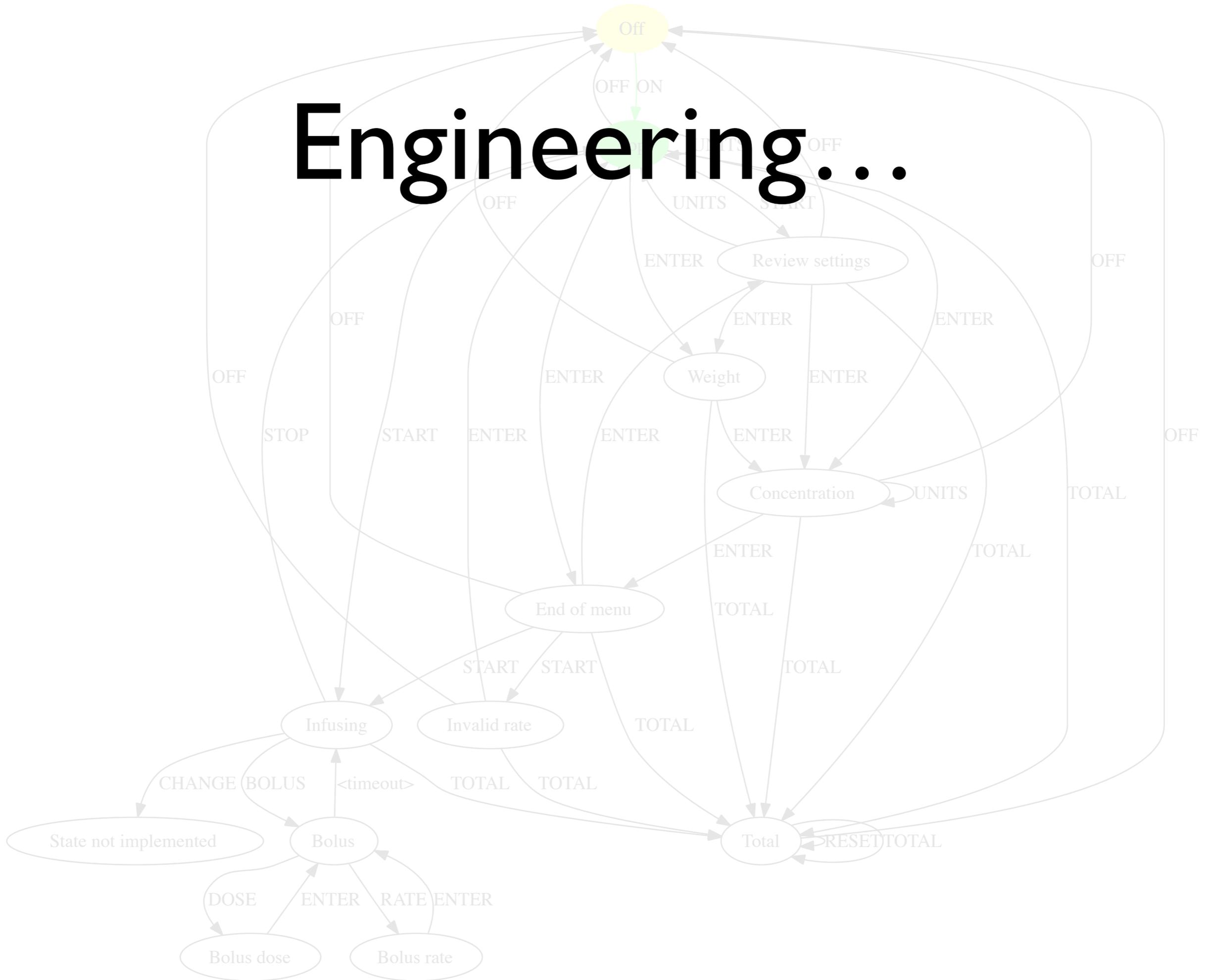
Bugs...

Swiss Cheese

~~Harm~~



Engineering...



errors

preventable errors

errors

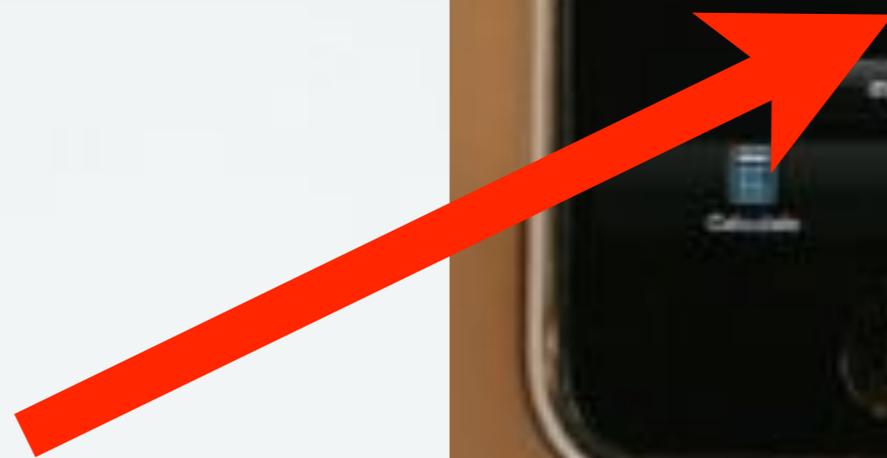
noticed errors

managed errors

user slip



*unnoticed
bad result*



harm

noticed harm

managed harm

hazard
noticed hazard
managed hazard



Seeing blindspots

"Safety in numbers"

















EMERGENCY USE ONLY

9999





999 EMERGENCY TELEPHONE

This service provided by the CCG Water Safety Section (01792 635421)

Lift receiver and press any button once

Ask for COASTGUARD

EMERGENCY USE ONLY

9
9
9



ON THIS

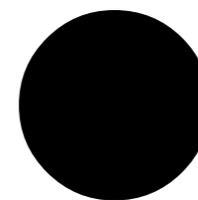
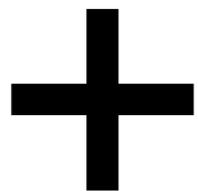
CE MAY

STGUARD
ND OF CAR PARK

: (01792) 635421

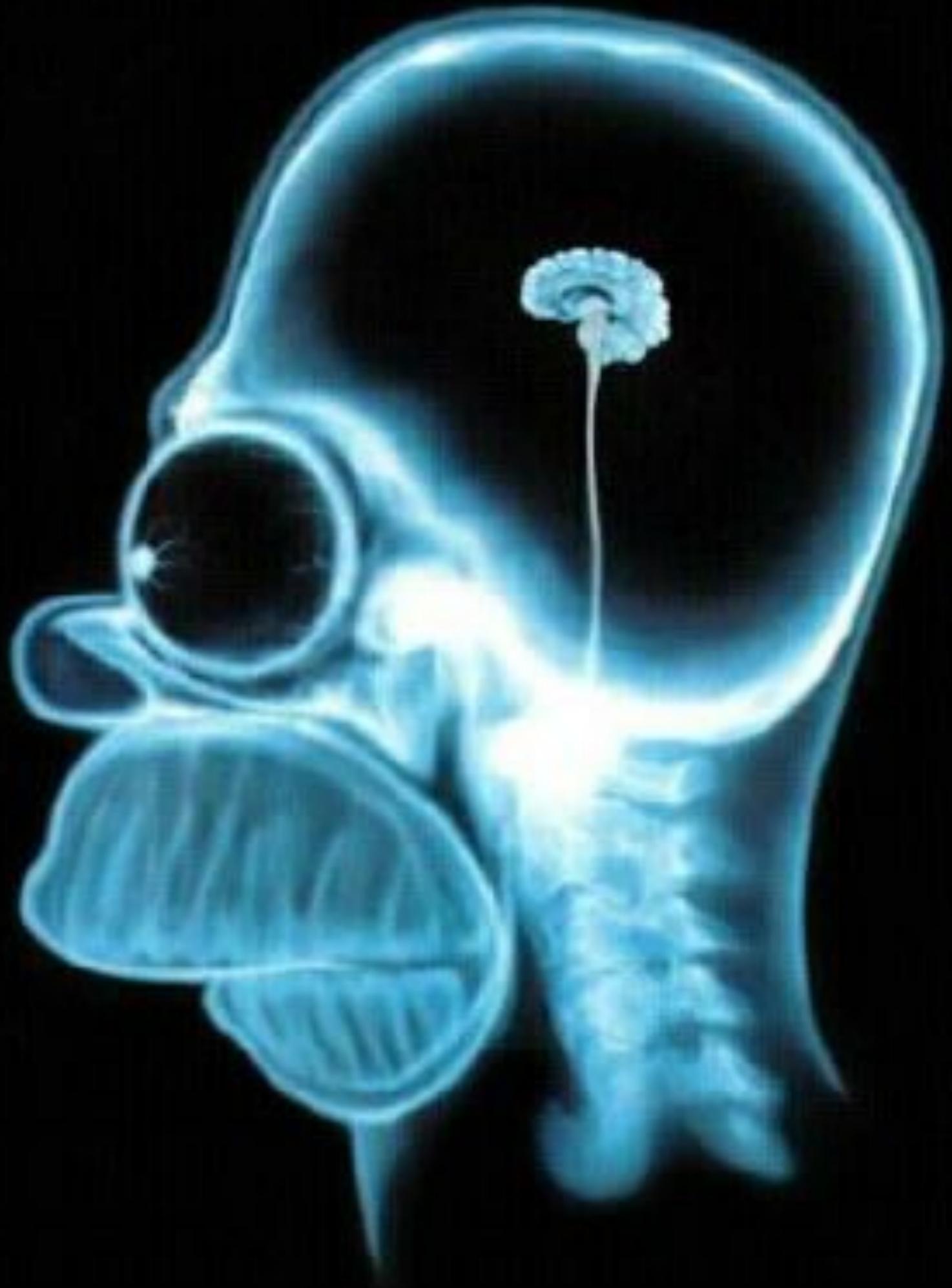
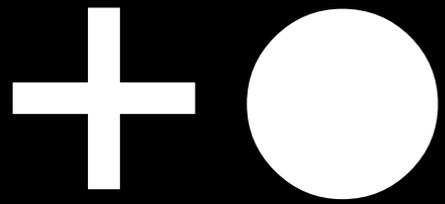
Seeing blindspots

"Safety in numbers"



4° visual angle

- ignores
- fills in
- accommodates
- unaware



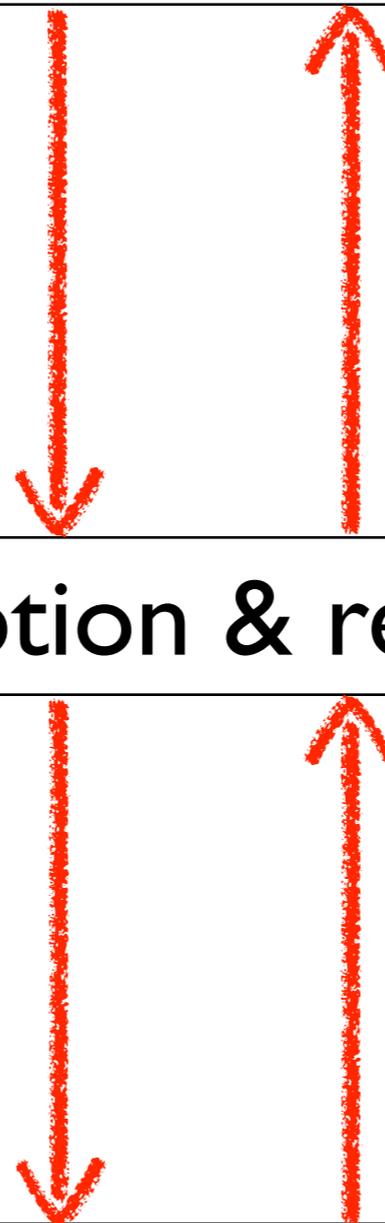
World

Perception & response

Conscious thinking
planning, reflection

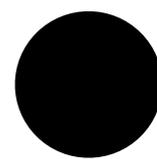
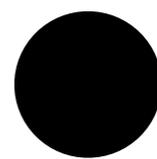
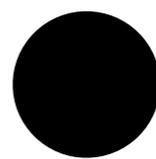
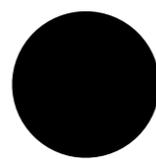
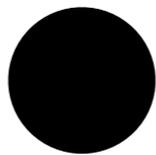
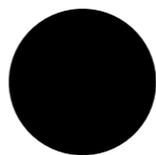
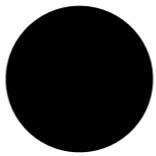
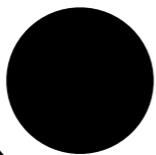
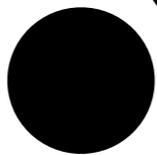
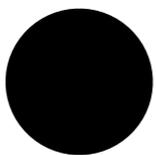
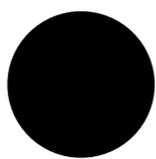
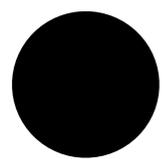
System 1

System 2



Finished scientific
papers follow
years of fascinating fundamental
scientific research.

Finished scientific
papers follow
years of fascinating fundamental
scientific research.





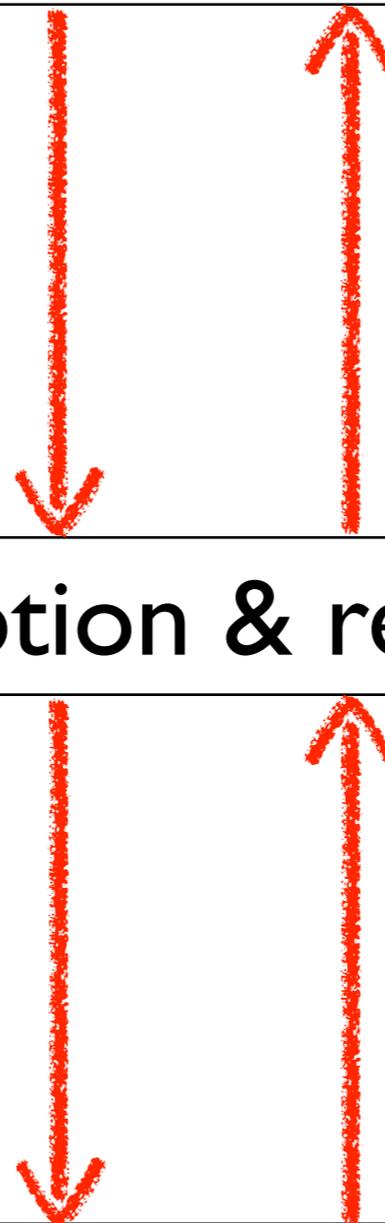
World

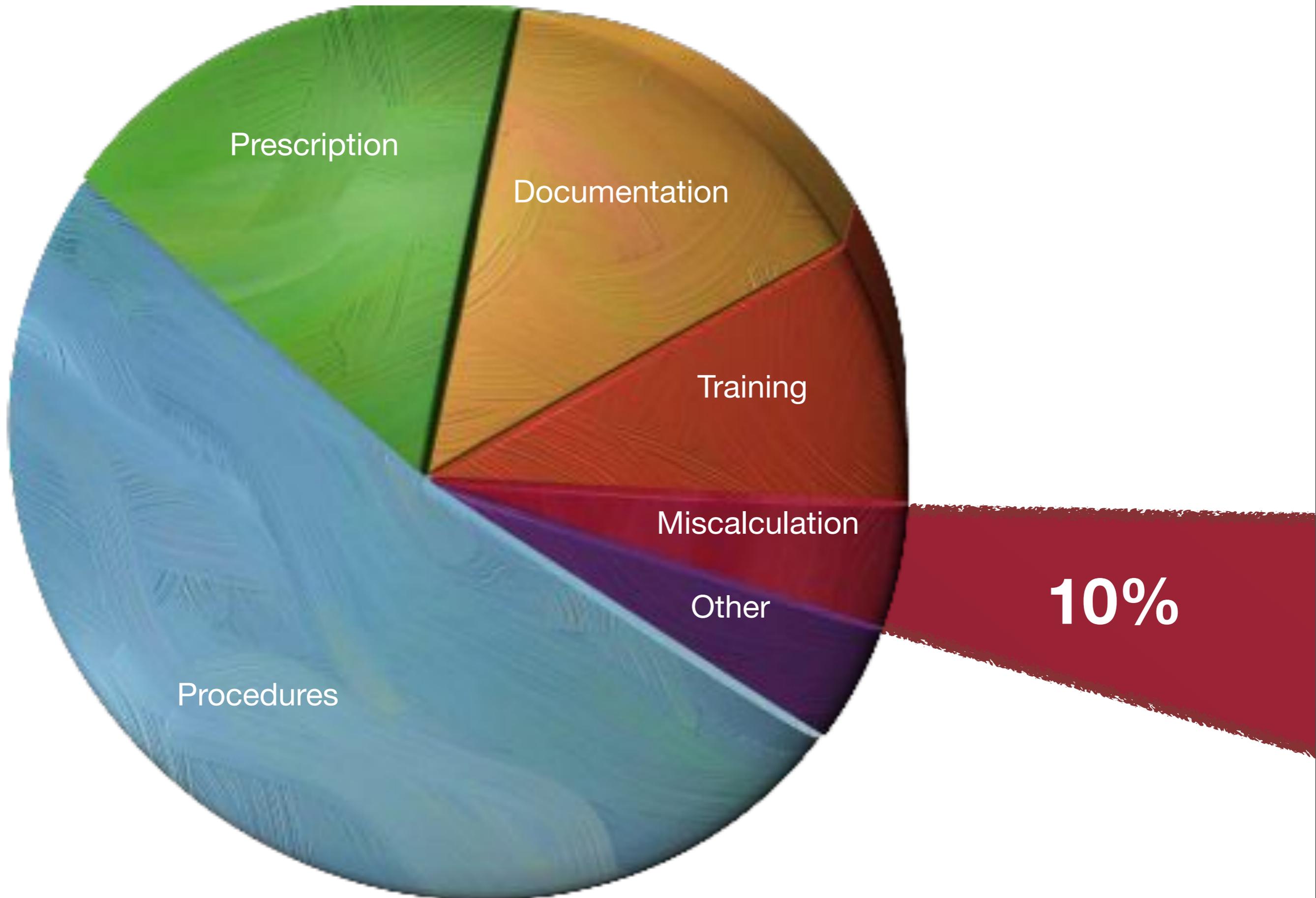
Perception & response

Conscious thinking
planning, reflection

System 1

System 2





10% \approx 35,000 US people pa*





Chinese population
1,338,299,500

World population
6,840,507,000

$$\text{AC } 1340000000 \div 6840000000 = 0.19590643$$



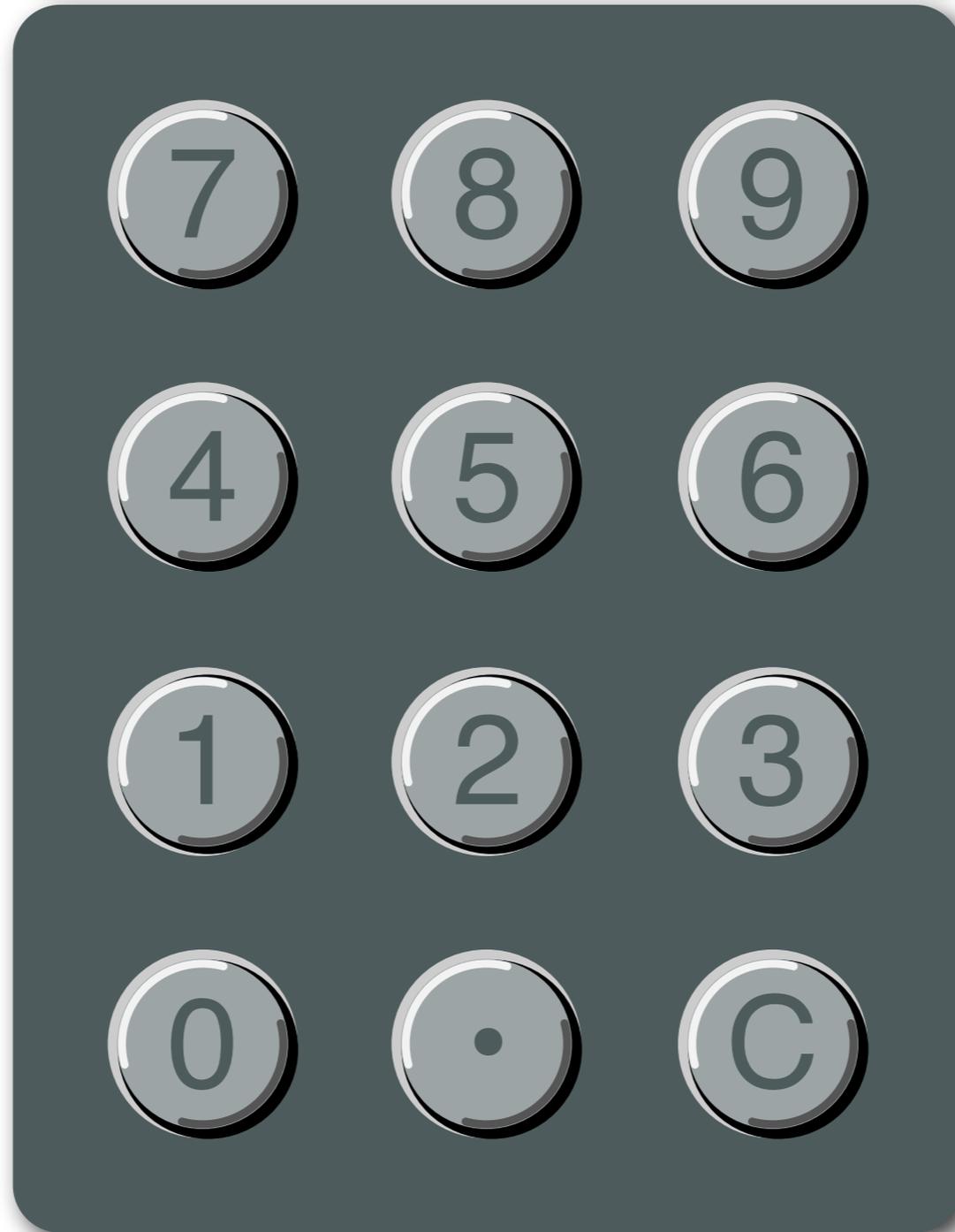
US population
307,006,550

World population
6,840,507,000

AC 307000000 ÷ 6840000000 = ~~0.44883041~~



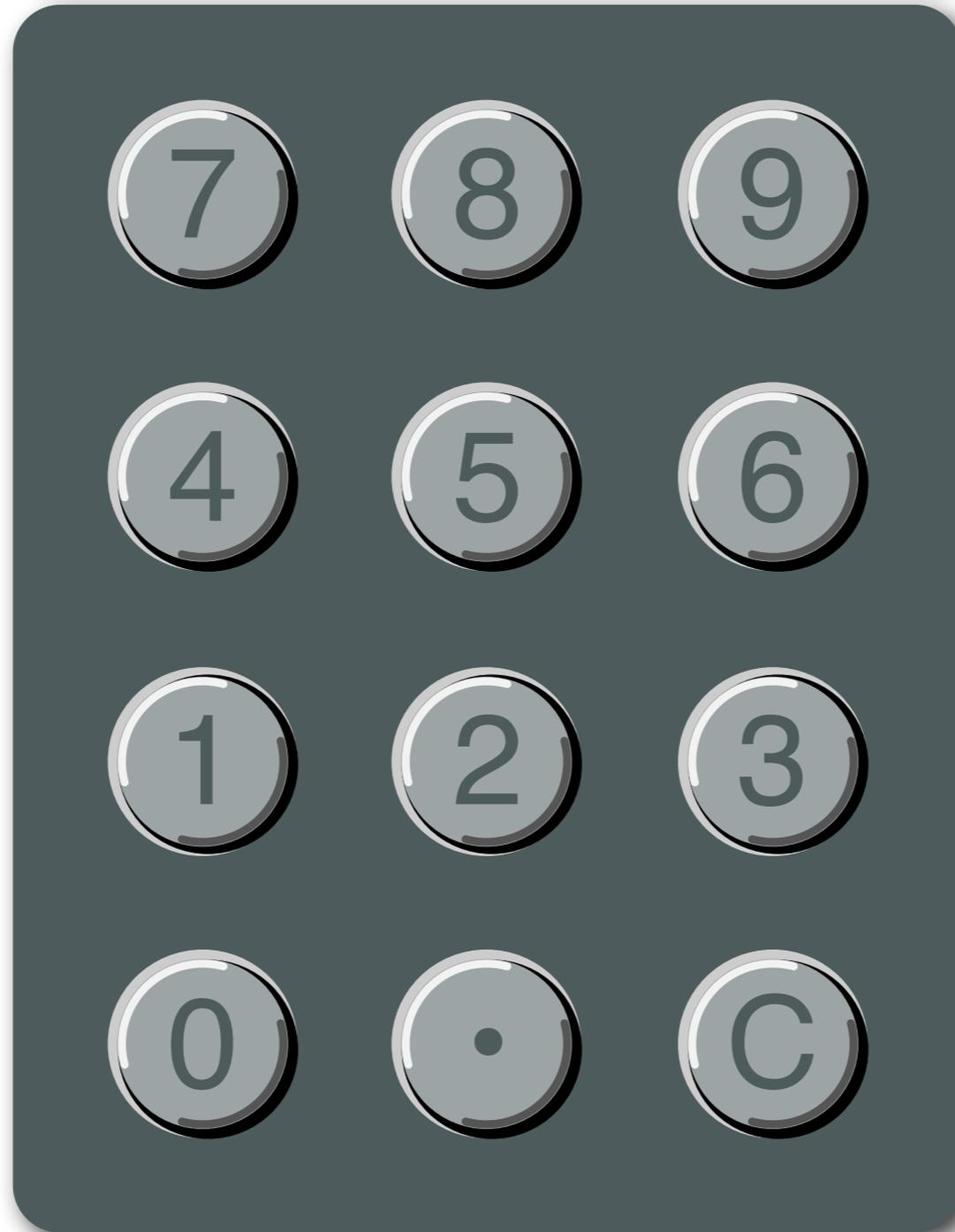
0.



5.

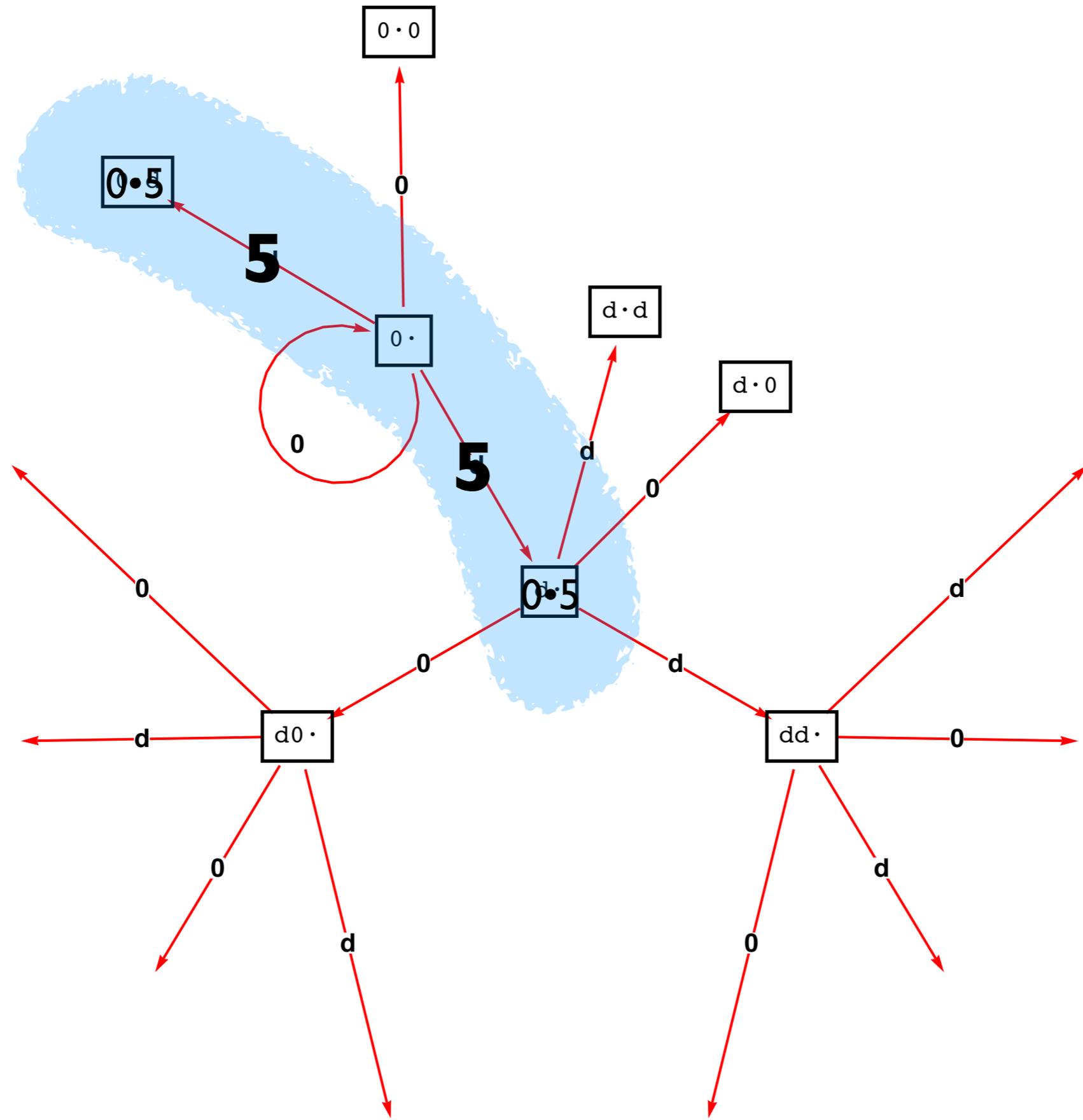


0.



0.5







Patient arrests

Log shows 55 mg/hr

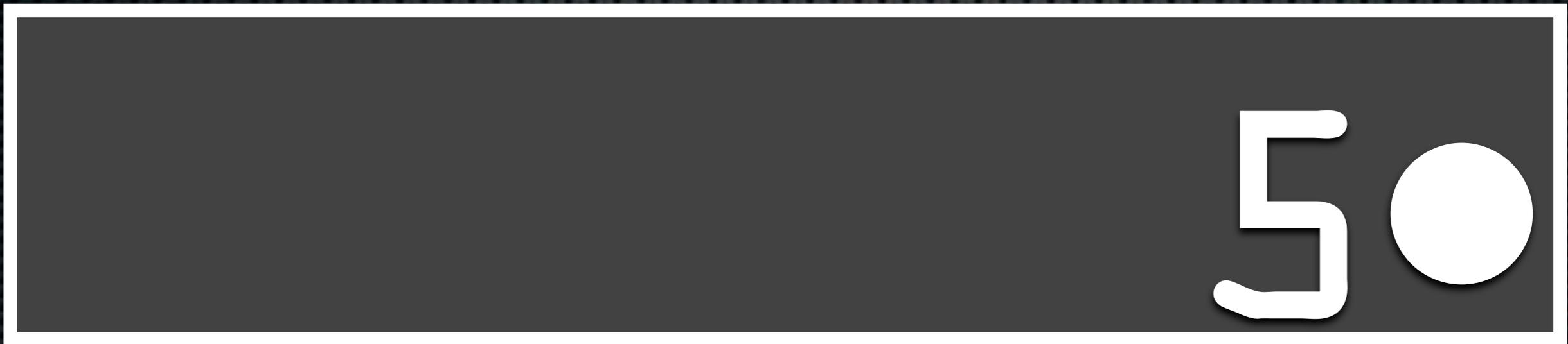
Should be 5.5 mg/hr

Nurse at fault



Task — enter **5.5** mg/hr

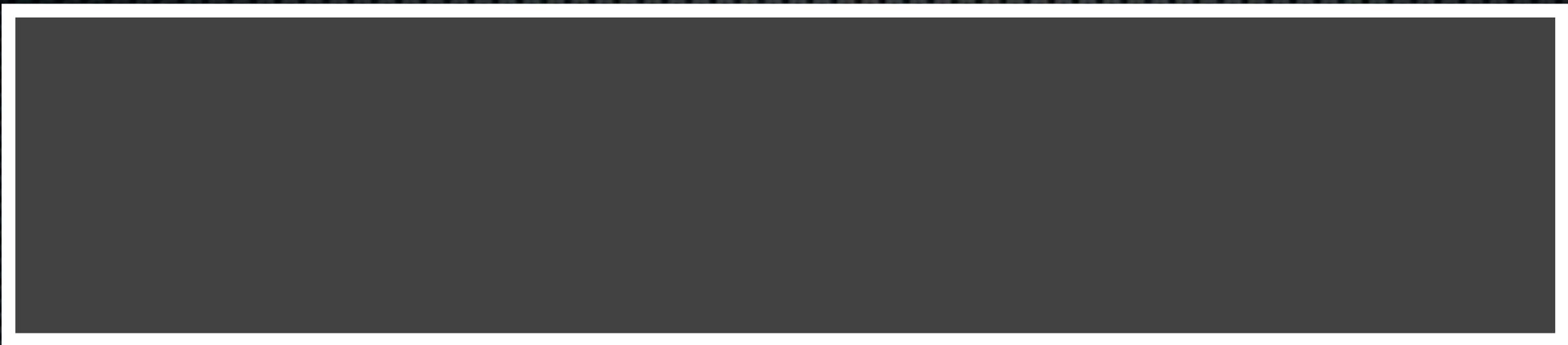
5



500

50

505



5

50

50

5

55

Nurse thinks 5.5

Log shows 55

EXTERNAL BEAM PLANNING: Norm Point Off-axis Distances and Off-axis Ratios for OMP Plans

Name:
 ID:
 Prep:
 Date: 17-Jun-12

Orientation of Patient: **HES Head First Supine**
 HFP Head First Prone
 FFS Feet First Prone
 FFP Feet First Prone

Modality: **6MV X-ray**

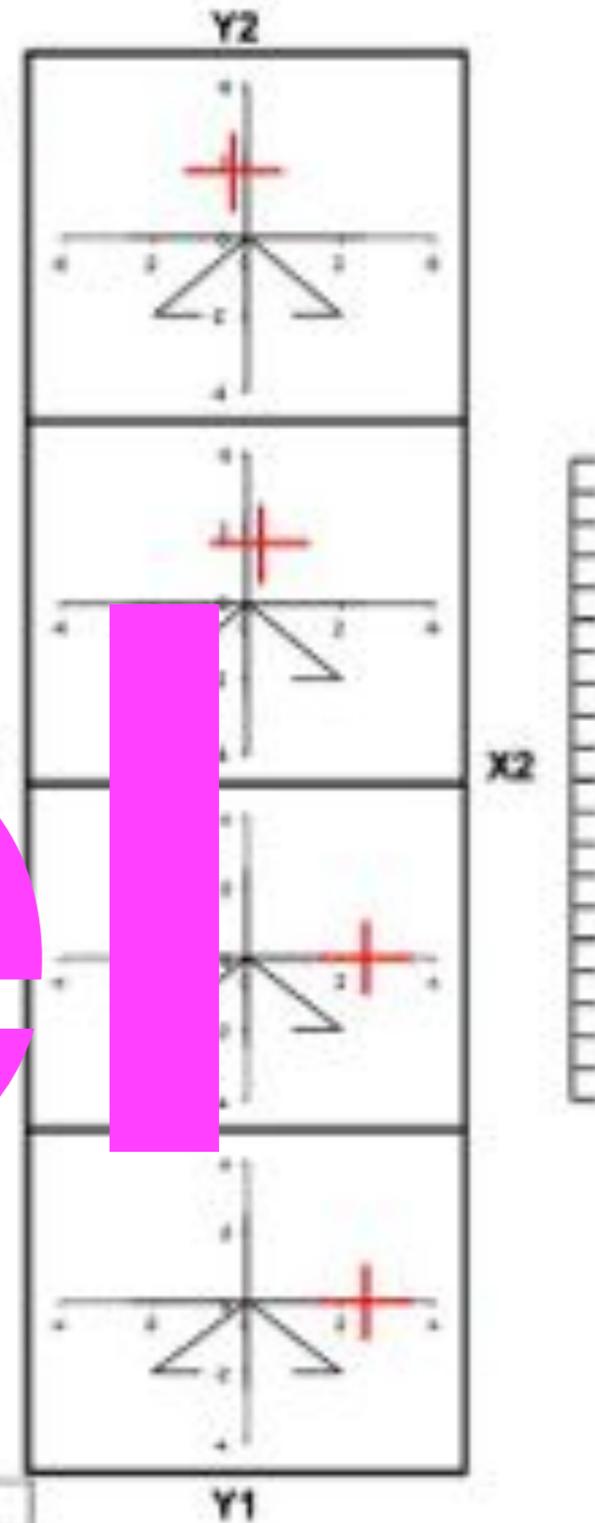
Chkd:
 Date:

Coordinates of Isocentre: **9.3 -0.3 -1.7** cm
 Coordinates of Norm Point: **11.9 -0.3 -5.5** cm

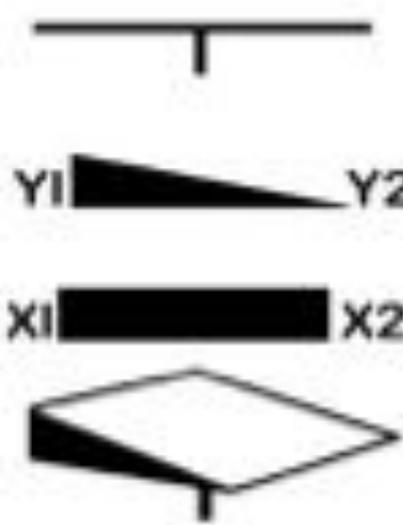
	Field 1	Field 2	Field 3	Field 4	
Gantry Angle:	302	126	0	0	degree
Collimator Angle:	80	280	0	0	degree
Rotatable Angle:	0	0	0	0	degree
Point Depth:	5.0	5.0	5.0	5.0	cm

	Field 1	Field 2	Field 3	Field 4	
SSD for Norm Point:	90.7	90.7	98.8	98.8	cm
Open Field Radial Distance:	1.8	1.6	2.5	2.5	cm
In-plane Wedge OAR _{in}	1.183	1.168	1.014	1.014	
OAD in Y1-Y2 direction:	0.0	0.0	0.0	0.0	cm
Wedge Factor:	1.000	1.000	1.014	1.014	
OAD in X1-X2 direction:	-0.3	0.3	2.5	2.5	cm
Combined Wedge OAR _{ca}	1.184	1.168	1.014	1.014	
Radial Distance:	1.8	1.6	2.5	2.5	cm

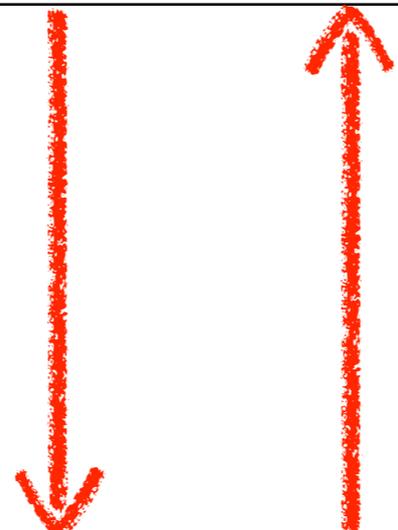
	Field 1		Field 2		Field 3		Field 4	
	Y	X	Y	X	Y	X	Y	X
Norm Point at Isocentre Level	1.7	-0.3	1.6	0.3	0.0	2.5	0.0	2.5
Off-axis Ratio	1.184	1.018	1.168	1.017	1.014	1.026	1.014	1.026



Excel

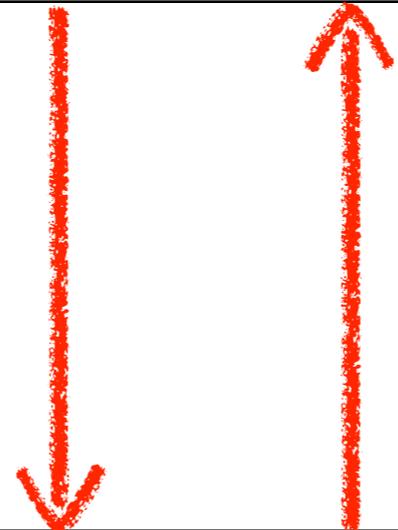


Environment



System 1

Perception & intuition

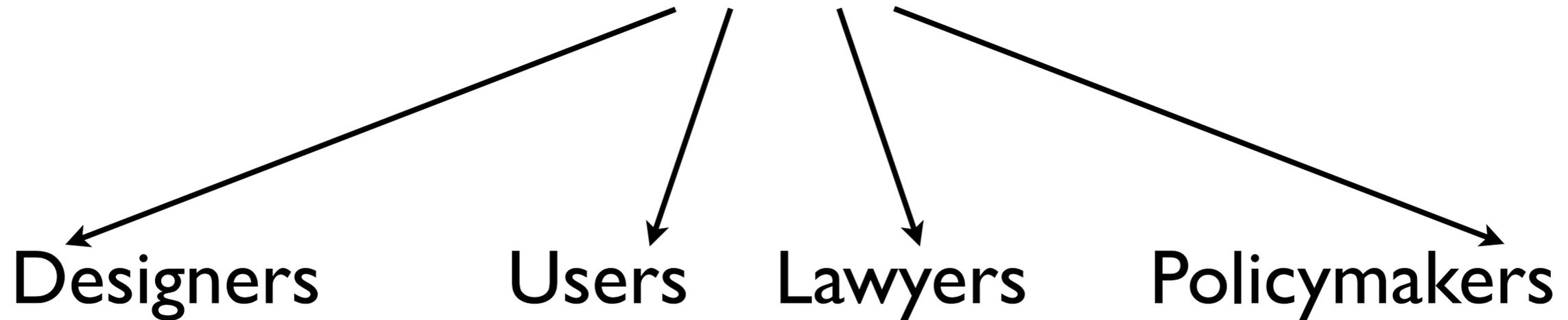


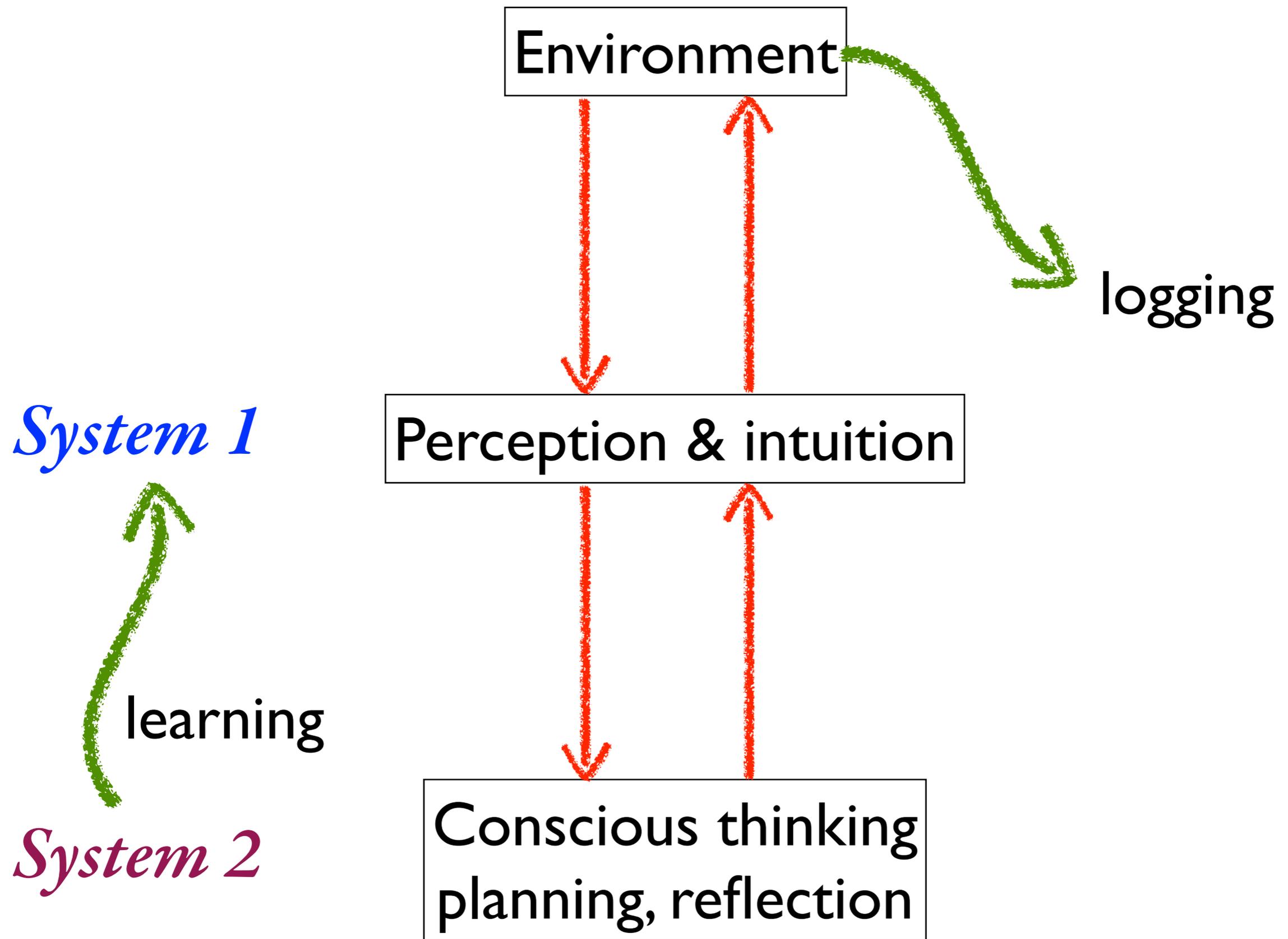
System 2

Conscious thinking
planning, reflection

**System 1
thinks these
things work**

**System 2
has a blindspot**





blocks **35** types
of hazard





makes hazard visible

is it any good?

Reducing number entry errors: solving a widespread, serious problem

Harold Thimbleby^{1,*} and Paul Cairns²

¹*Future Interaction Technology Laboratory, Swansea University, Swansea SA2 8PP, UK*

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Number entry is ubiquitous: it is required in many fields including science, healthcare, education, government, mathematics and finance. People entering numbers are to be expected to make errors, but shockingly few systems make any effort to detect, block or otherwise manage errors. Worse, errors may be ignored but processed in arbitrary ways, with unintended results. A standard class of error (defined in the paper) is an ‘out by 10 error’, which is easily made by miskeying a decimal point or a zero. In safety-critical domains, such as drug delivery, out by 10 errors generally have adverse consequences. Here, we expose the extent of the problem of numeric errors in a very wide range of systems. An analysis of better error management is presented: under reasonable assumptions, we show that the probability of out by 10 errors can be halved by better user interface design. We provide a demonstration user interface to show that the approach is practical.

To kill an error is as good a service as, and sometimes even better than, the establishing of a new truth or fact.

(Charles Darwin 1879 [2008], p. 229)

Keywords: number entry; human error; dependable systems; user interfaces

Safer “5-key” number entry user interfaces using Differential Formal Analysis

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Differential formal analysis is a new user interface analytic evaluation method based on stochastic user simulation. The method is particularly valuable for evaluating safety critical user interfaces, which often have subtle programming issues. The approach starts with the identification of operational design features that define the design space to be explored. Two or more analysts are required to analyse all combinations of design features by simulating keystroke sequences containing keying slip errors. Each simulation produces numerical values that rank the design combinations on the basis of their sensitivity to keying slip errors. A systematic discussion of the simulation results is performed for assessing the causes of any discrepancy, either in numerical values or rankings. The process is iterated until outcomes are agreed upon. In short, the approach combines rigorous simulation of user slip errors with diversity in modelling and analysis methods.

Although the method can be applied to other types of user interface, it is demonstrated through a case study of 5-key number entry systems, which are a common safety critical user interface style found in many medical infusion pumps and elsewhere. The results uncover critical design issues, and are an important contribution of this paper since the results provide device manufacturers guidelines to update their device firmware to make their devices safer.

Number entry, stochastic simulation, medical devices, interactive systems, blocking errors.

1. INTRODUCTION

Best practice for designing effective and safe interactive systems uses methodologies that were developed primarily in office and consumer domains: iterative design, user evaluation (using both laboratory and field experiments), and so forth; international standards, e.g., ISO 9241, summarise current best practice. However, safety critical and dependable applications should be designed not just to be usable, but to be safe; design should reduce risk to be As Low As Reasonably Practical, ALARP, which is a legal requirement under the UK Health & Safety At Work Act (1974) and under similar legislation in other countries.

Dependable interactive applications, we argue in this paper, require different methodologies than conventional usability approaches. For example, a standard laboratory experiment may find that users prefer one system to another, or that they make fewer errors or are faster. This is certainly useful

information, but (except for very simple systems) a lab study cannot cover all features (let alone all states and transitions) of a system. If the interaction design has bugs — actual software bugs or poor boundary cases in the user interface — then human participant-based evaluation may not help enough. For complex systems, and for critical applications, reliance on user testing alone may not be good enough to assure a system has as few design defects as possible.

A common approach to assessing human factors is via empirical studies. With any method, its validity is an important issue. In a typical usability experiment researchers try to achieve validity by managing participant variability. For example, if the only participant was a university student, the results would not be representative of a typical consumer population; in general the smaller (and less representative) the population of participants the less reliable it is to estimate the significance of any results. In addition, running large trials is prohibitively expensive.



- **open source**
- **open access**
- **open verification**



User Friendly Interface

Featuring **the same intuitive user interface** as the Asena® Syringe Pumps, the GP Volumetric Pump requires minimal additional training





MUTE button - Press to silence alarm for (approximately) 2 minutes. The alarm will resound after this time.



PRIME/BOLUS button For future implementation.



OPTION button For future implementation.



PRESSURE button For future implementation.



CHEVRON keys - Double or single for faster / slower increase / decrease of values shown on display.



BLANK SOFTKEYS - Use in conjunction with the prompts shown on the display.

- open source
- open access
- open verification
- **open testing**



Clotting Factor Concentrate Infusion

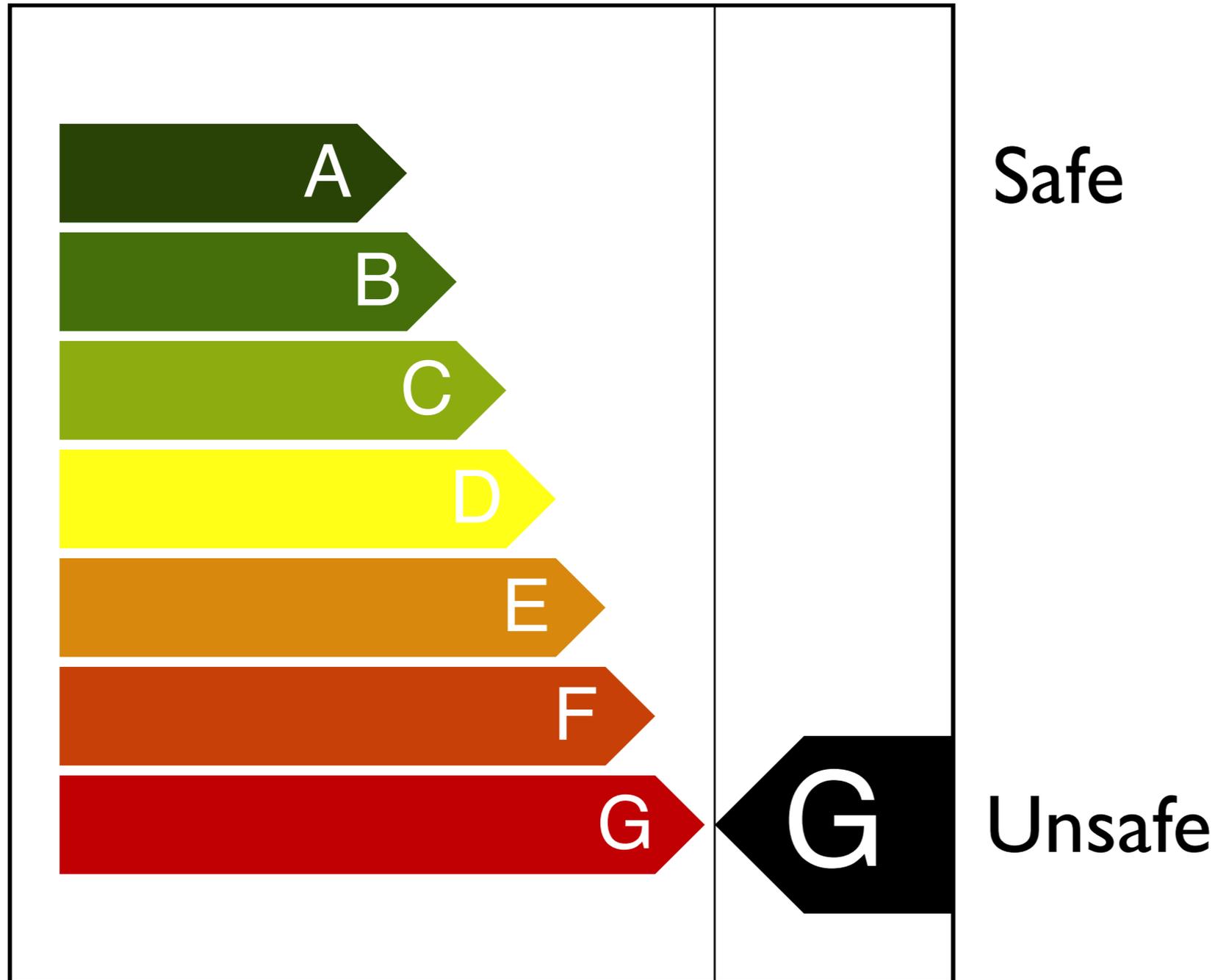
DO NOT SWITCH OFF OR ALTER RATE
without contacting the Haemophilia Centre

Nurses: Ext 4248 (bleep 328 Sat/Sun 9am-1pm)
SpR: Bleep 811

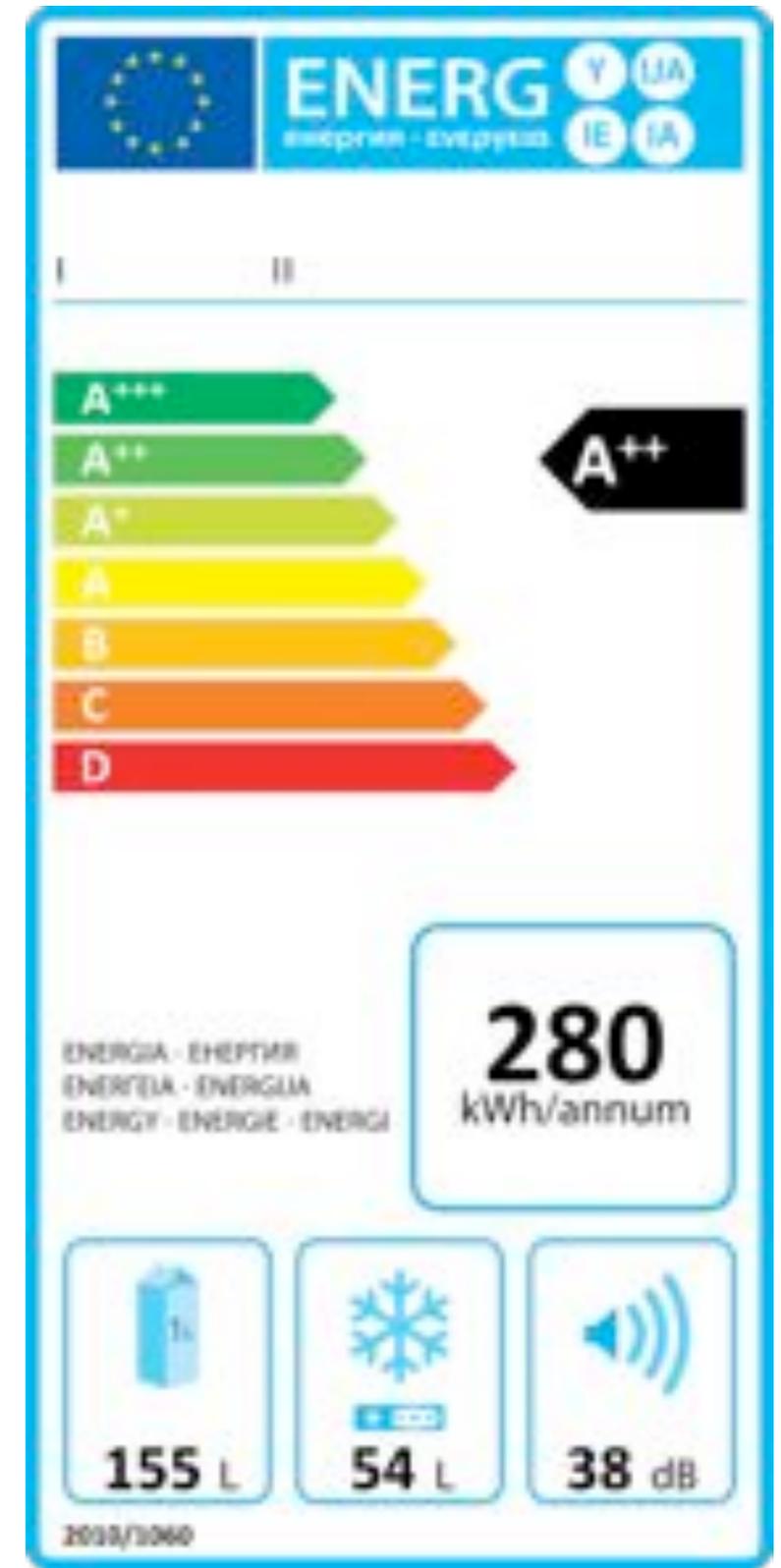


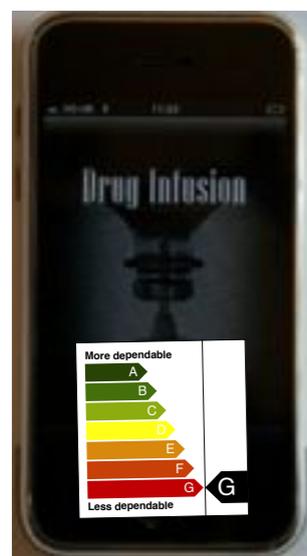
<http://shesnotdown.blogspot.com/2010/10/deja-vu.html>

EU directive 1992



EU directive 210





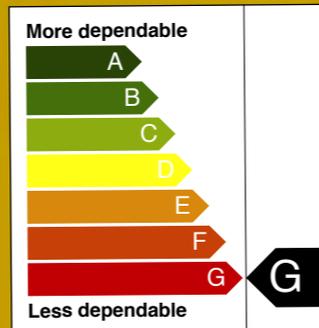
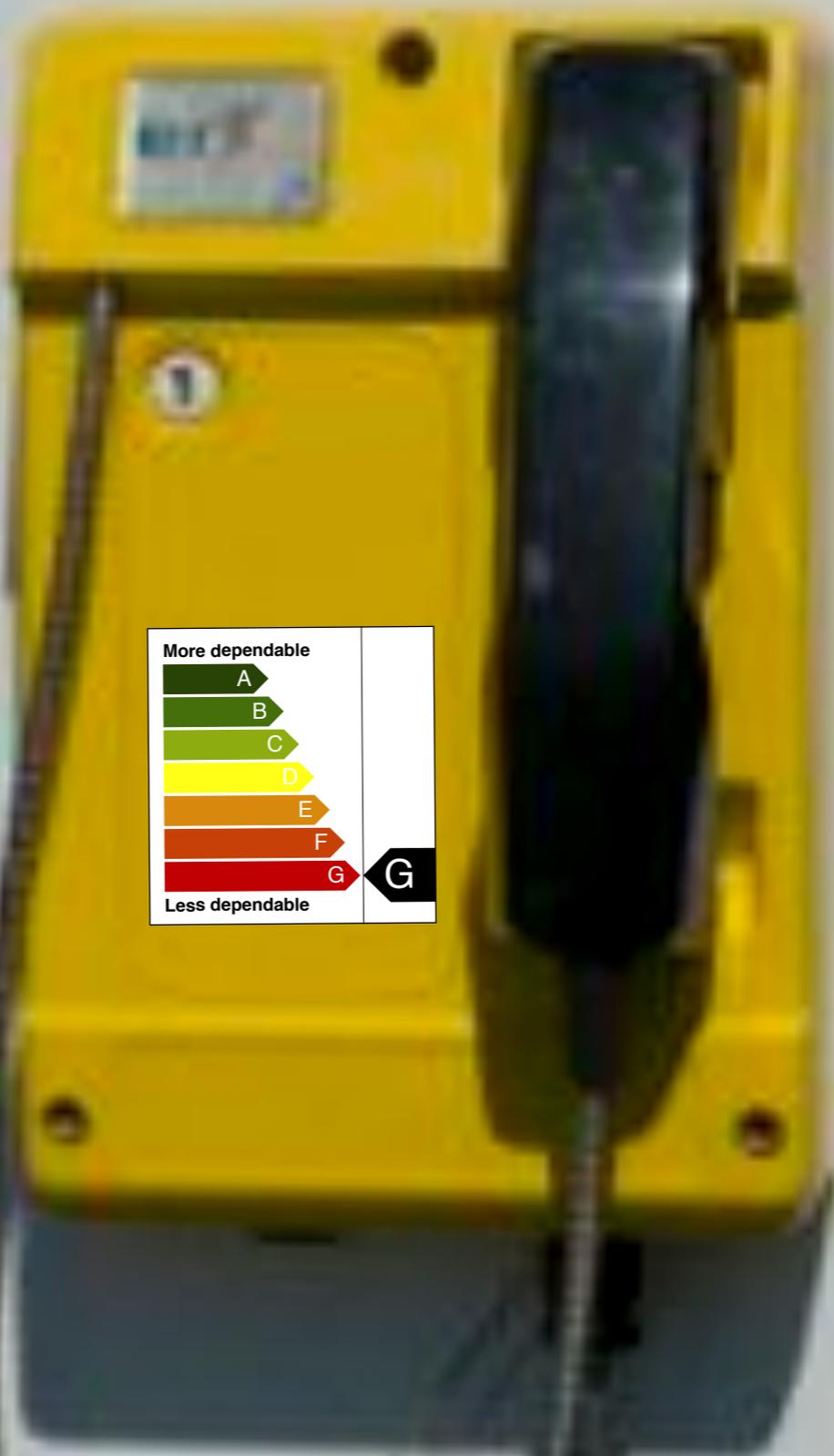
EMERGENCY USE ONLY

ARD
PARK
5421

9

9

9



CEILING



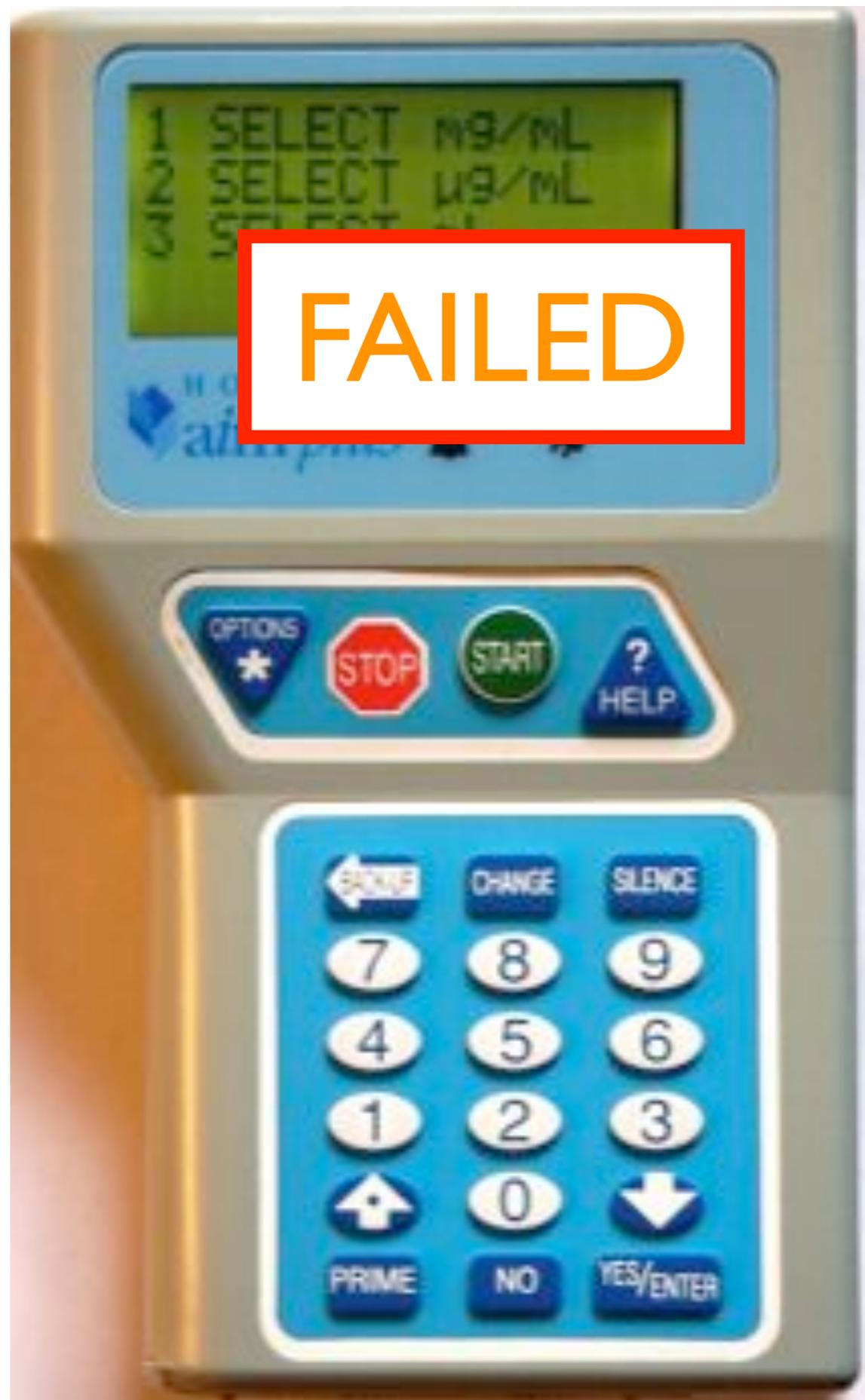


ELECTRICAL SAFETY TEST	
FAILED	
APPLIANCE ID	BY
FAILED DATE	
Able Labels Electricians 0844 371 2423	

- 30 people die per year from shock (in UK)
- ~150 in the US

ELECTRICAL SAFETY TEST	
PASSED	
APPLIANCE ID	BY
PASSED DATE	NEXT TEST DUE
Able Labels Electricians 0844 371 2423	





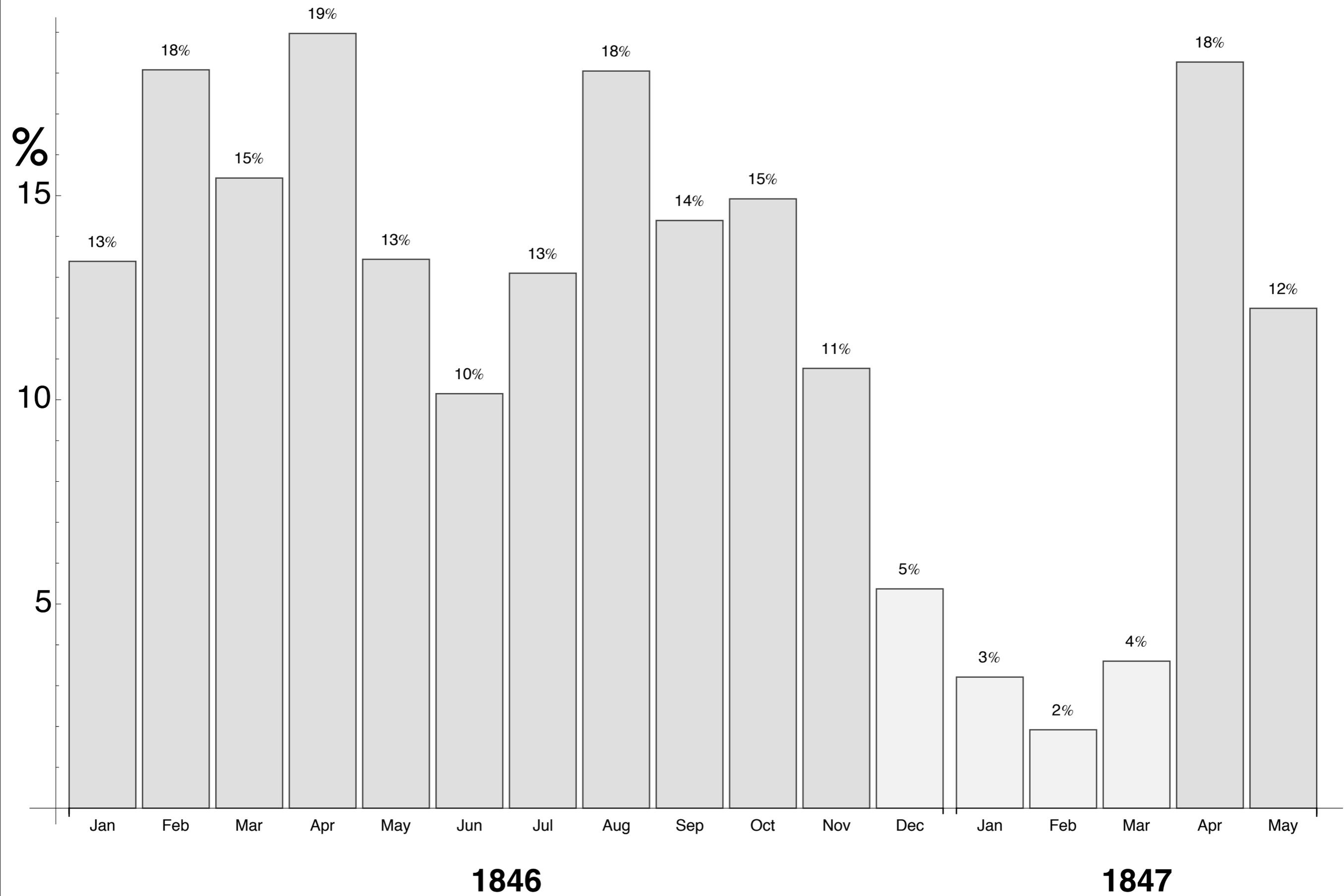
Seeing blindspots

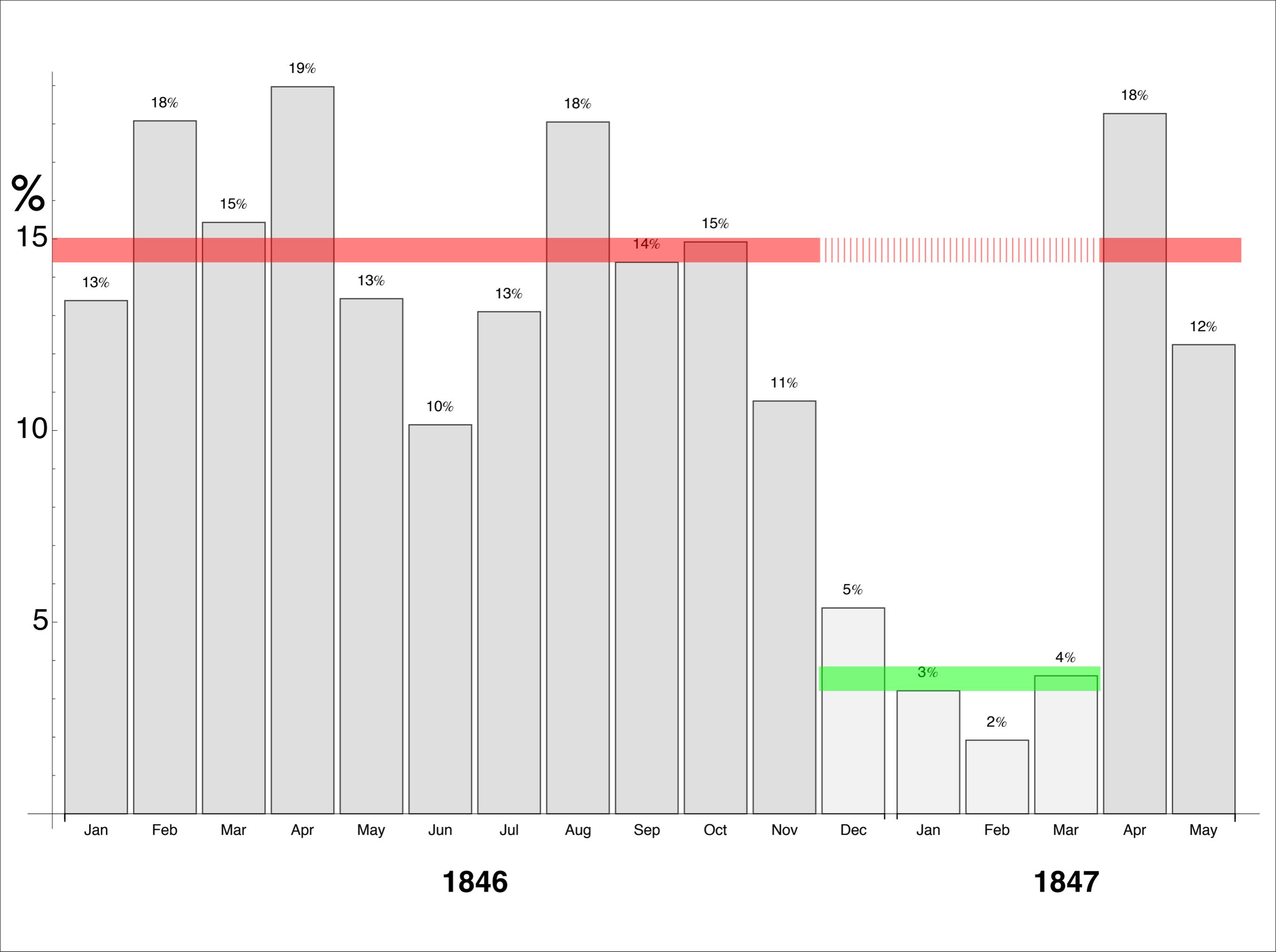
- Visual check
- Differential leakage
- Substitute leakage
- Protective earth resistance

Seeing blindspots

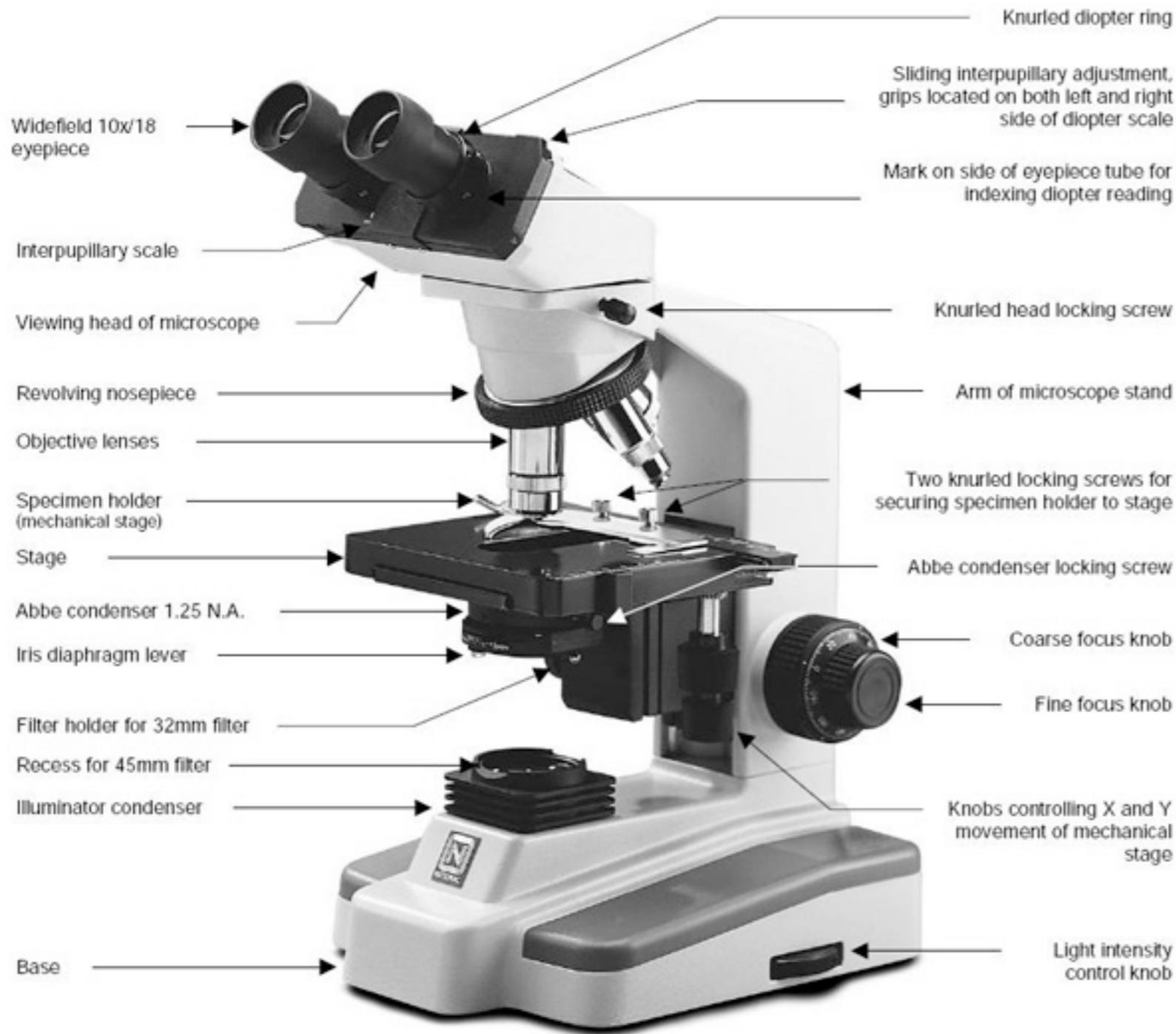
- Visual check
- Unnoticed error rate
- Error blocking
- Eye tracking











Seeing blindspots

"Safety in numbers"