

# » *Gaining New Medical Insights through Interactive Visual Exploration*



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DEPARTMENT OF  
**INFORMATION AND KNOWLEDGE ENGINEERING**



# On behalf of...



Danube University Krems, Austria  
Department of Information and Knowledge Engineering



# Danube University Krems, Austria

## University of Continuing Education

Postgraduate

For Executives

About 3500 Students

## Established in 1994

2004 – Federal Law:  
Equated with other  
Austrian Universities

## 15 Departments

## Applied Research

## New Campus opened 2005

Situated in the Wachau (UNESCO World Cultural Heritage area)

80 km west of Vienna





Univ of Maryland College Park

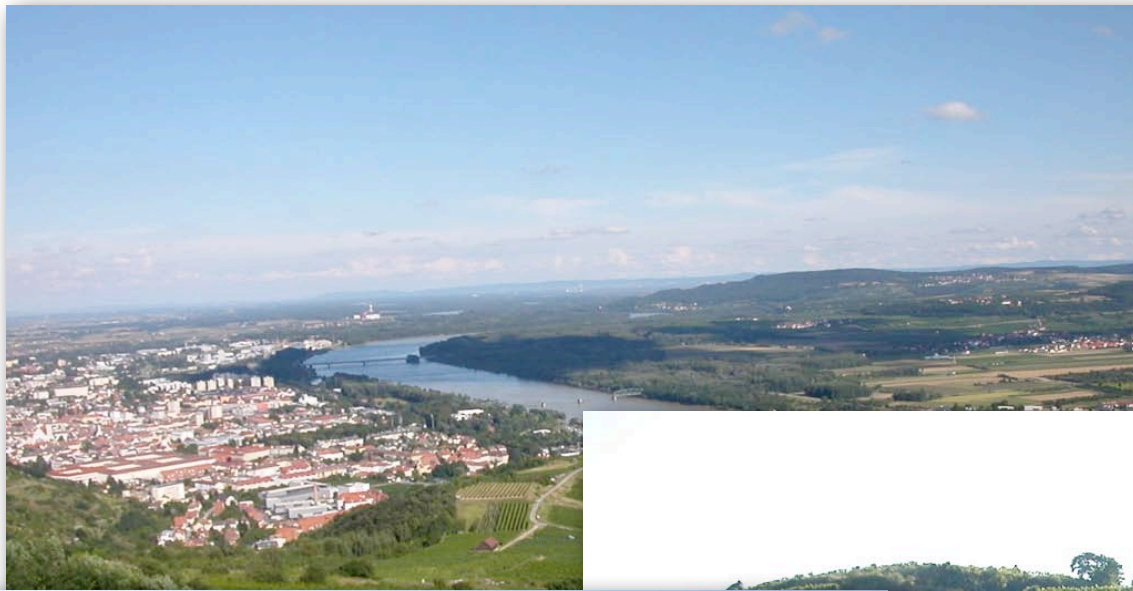
2007 Europa Technologies

Google

Pointer 38° 59' 39.23" N 76° 56' 52.32" W

Streaming 100%

Eye alt 2.80 km



VIE-Nmed

VIE-VENT

ViCo: Metric for the Complexity of InfoVis

VIE-PNN



GOT



**Medical Knowledge-Based Systems**

**TimeViz**  
Visualizing

**Visual Analytics & Information Visualization**

Patient Advocate

in **2**vis

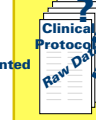
V & V

Protocolre

Asgaard/Asbru

Plan Verification Data Validation

INPUT  
Time-Oriented



**Plan Management**

LASSIE



**DeltA**



SDOF





Interactive Visual Exploration

# Electronic Health Records



Image credits: Paul Bodea, <http://www.sxc.hu>, Photo #920911



BUT...



[Wired Magazine, February 2008]

# Data Explosion



# Data Explosion



„Doctors in developed countries seem to be overwhelmed by the information provided to them and the amount of information is enormous and disorganized.“

[Smith, 1996]

„Industry studies show that a paper medical record is missing up to 30 percent of the time for an office visit and paper medical records are almost never available for patient care in an emergency room.“

Kaiser Permanente, KP HealthConnect, Retrieved at: May 22, 2008.

„Physicians in hospitals spend up to a quarter of their work time searching for patient-related information.“

Wolfgang Dorda, Zukunftsforum vom 7.6.3006, Conect  
Eventmanagement



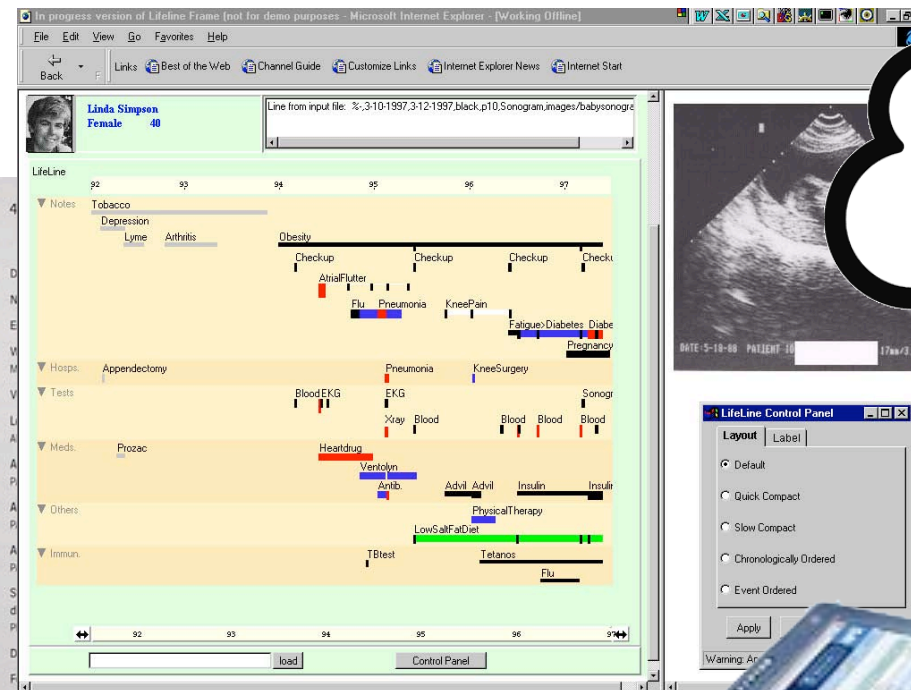
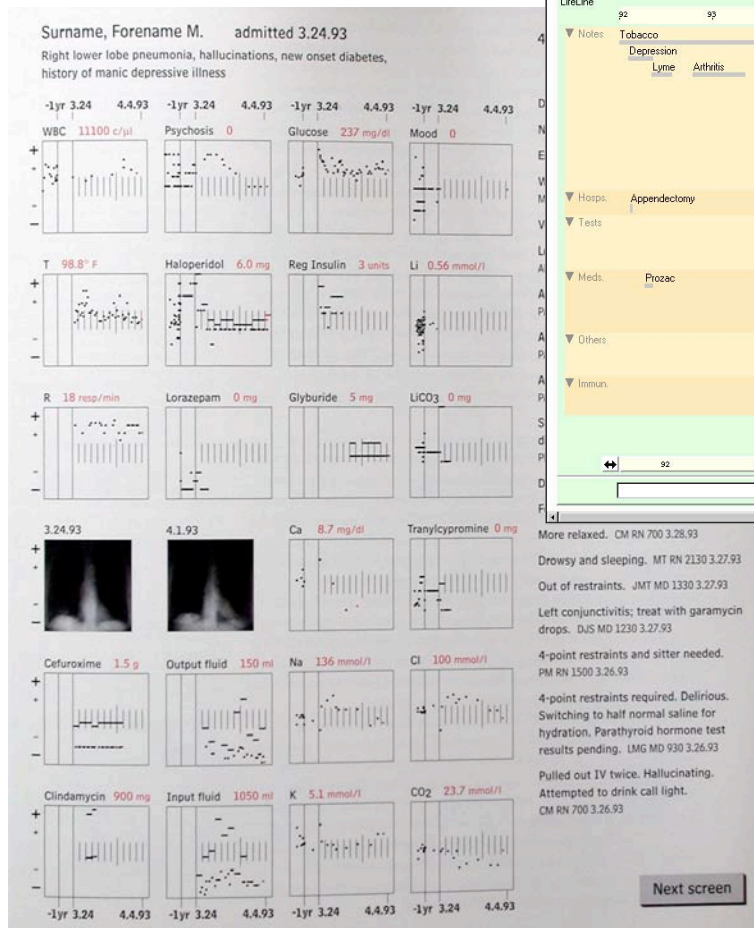
## Electronic Health Record

„A repository of electronically maintained information about an individual's lifetime health status and health care, stored such that it can serve the multiple legitimate users of the record.“

Frédéric Loeurng, Glossary - Information Society Technology, 2001.  
<http://cordis.europa.eu/ist/ka1/administrations/publications/glossary.htm>

# Data Dumps → Insights

[Powsner & Tufte, 1994]



[Plaisant et al., 1998]

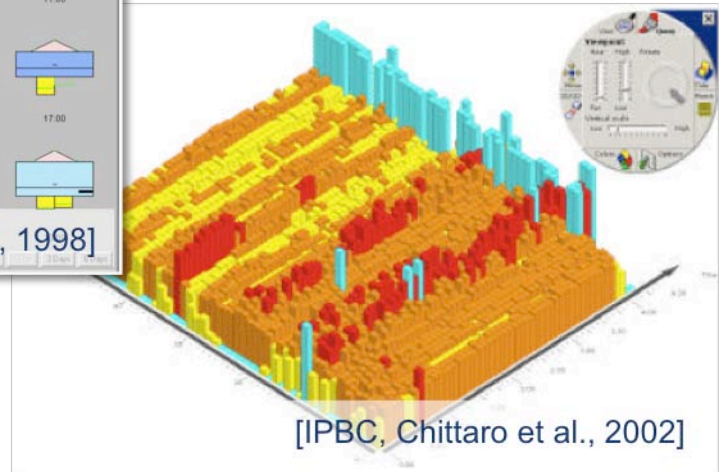
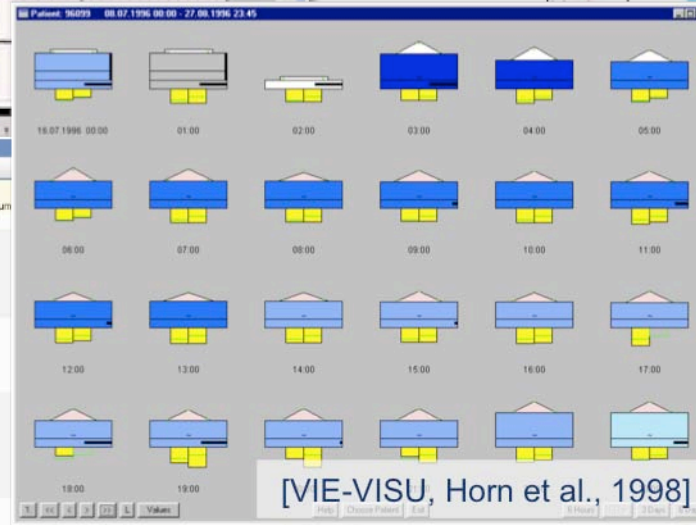
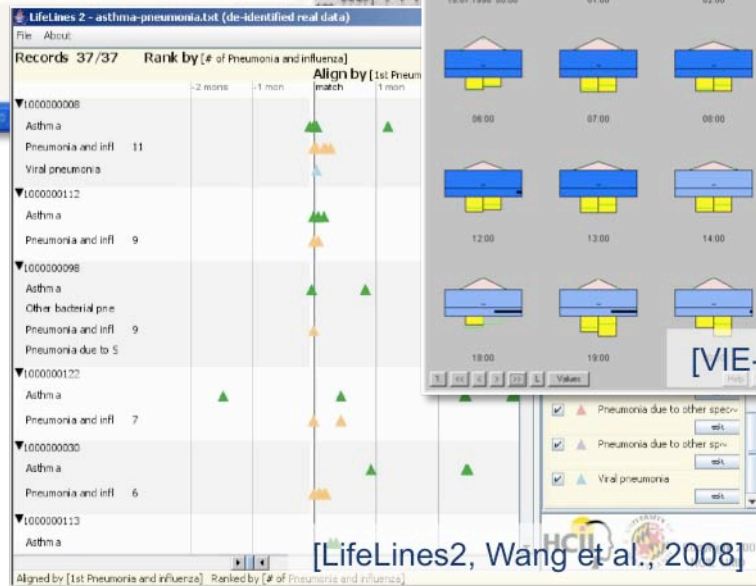
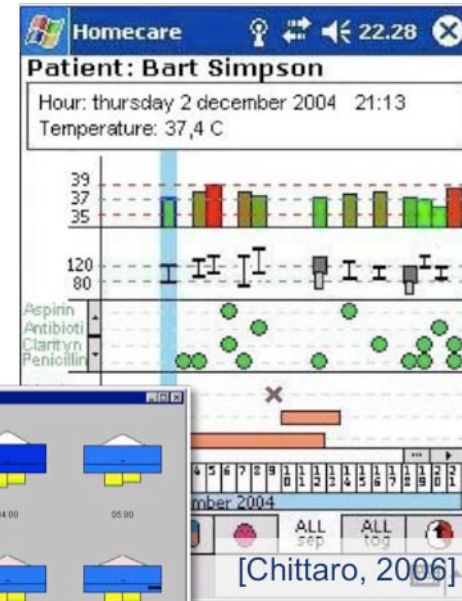


[Lorenzo, 2008]





# Where are we now?



# Where are we now?

**Philips CareVue Chart** - [MICU - 102 - Frank Jones | Lifetime ID: 47387347 | Age (ADT): 77 years | Attending: Michael M. McDonough Dr. | DRR Status: Full Code]

102 - Frank Jones - MICU

Admission Documents | Summary | Forms/Checklists | Orders | Notes | Flowcharts | Lab Data | Discharge Documents | Other | Work Folder

**Lab Results (last 24 hours)**

WBC (x1000/mc)	15.00
Hgb	11
Hct	29
Platelets	200
RBC	3
PT	12.4
PTT	21.3
BNR	1.1

**Chemistry** 1/2/2006 3:00 AM

Sodium (mEq/L)	143
Potassium (mEq/L)	3.3
Chloride	111
CO2	20
Venous HCO3 (mEq/L)	20
BN	30
Creatinine	1.2
Glucose	165
Calcium	8.8
Magnesium	2.1
Phosphorus	3.3
Total Bilirubin	1
Direct Bilirubin	1
Total protein	8.8
Albumin	3.3
LDH	7.30
Alkaline Phosphatase	56
ALT (SGPT)	70
AST (SGOT)	18
Other Labs	88
Finger Stick Blood Glucose	172
Lactic Acid	172

**Clinical Synopsis** 1/4/2006 11:00 AM

Hospital Course  
Allergies: Sulfas  
Attending Physician: Michael M. McDonough Dr.  
Health Care Proxy: Filed in pt chart; Unable to...

**Problems**

Description	Code	Stat
Chronic obstructive asthma, with acute exacerbation	493.22	Act
Acute upper respiratory infections of unspecified site	465.9	Act

**Current Medications**

Order	Order
Acetaminophen 625 mg PO Continuous PRN	
Albuterol 2 mg Inh BID	
Hydrocortisone succinate (Solu-Cortef) 80 mg IV q8hr	
Lorazepam 2 mg IV BID	
Piperacillin/Tazobactam (Zosyn) 3.375 gm IV q8hr	

**Respiratory** 1/4/2006

8:00 AM	4:00 PM	8:00 AM	4:00 PM
O2 Delivery Method	Nasal cannula, 5L	Temperature (C)	37.9, 38.0
Ventilator Mode		Heart Rate	113, 94
Ventilator Rate		Non-Invasive BP	84 / 50 (116 / 58 (75))
FiO2	50, 50	Arterial BP	
SpO2	87, 87	SpO2	87, 87
Tidal Volume (Set)		Cardiac Rhythm	AFb, AFb
Tidal Volume (Spontaneous)		Respiration Rate	32, 29
Tidal Volume (Actual)		CVP	
PEEP		FAP	
Pressure Support		PCWP	
Respiration Rate	32, 29	Cardiac Output	
Arterial pH	7.30	Systemic Vascular Resistance	
Arterial pCO2	56	<b>Fluid Status</b>	
Arterial pO2	70	Total In (24hr)	
Arterial HCO3	18	Total Out (24hr)	
Arterial SaO2	88	Urine Output 24hr	
Base Excess		Blood Infusion	
End-Tidal CO2		GI Output 24hr	
Peak Inspiratory Pressure		CT Output 24hr	
I:E Ratio		Drain Output 24hr	
Inspiratory Time			

[Philips CareVue]

Bed 14 Miller, Frank

Bed 12 Dee, Joanna Ped 16:20 Other Bed+

Temp LOW

Sinus Rhythm HR 120 80

ABP 150 ABP 117/78 (94)

SpO2 99

CVP Mean (12) Pulse 80

Temp 39.0 36.8 PVC 10

NBP 124/80 (90)

HR 60

PVC 0

zSpO2 95

Philips IntelliVue

[Systema mpa]

iSOFT Lorenzo

Standard Lorenzo | My work | Patients | NHS

Adam Joseph 00008870 26-Apr-1970 34 years, 1 month Male

Allergies: aspirin Alerts: history of violent behaviour

Current Baseline

Timeline: Vital signs | Base | 1 Year | From 27/05/2003 To 26/05/2004

Summary

History

Batch Reports

Enrollment Methods

Tasks

Labels

iSOFT Lorenzo

[iSOFT Lorenzo]

Dräger medical

167 200

69

Dräger medical

[Dräger medical]



# Challenges

Image credits: Sanja Gjenero, <http://www.sxc.hu>, Photo #886254



Challenge #1

**Interaction is key**

Image credits: Jenny W., <http://www.sxc.hu>, Photo #209336

# Interactive Information Visualization: Exploring & Supporting Human Reasoning Processes



Interactive Information Visualization  
of Highly Structured Temporal Data



Wiener Wissenschafts-, Forschungs- und Technologiefonds

Klaus Hinum, Silvia Miksch, Wolfgang Aigner

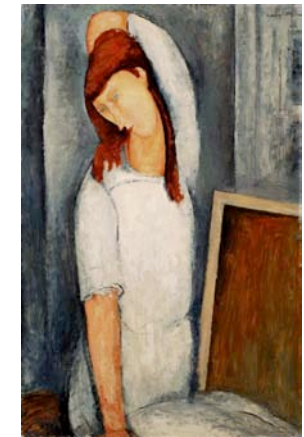


Margit Pohl, Markus Rester

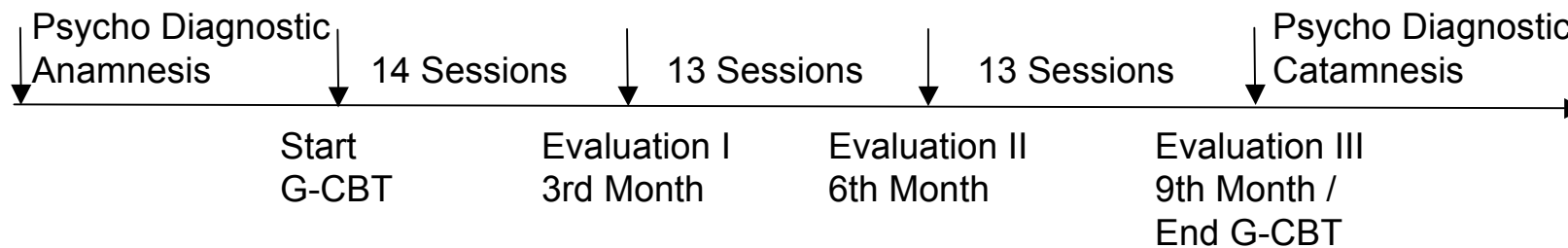


Susanne Ohmann, Christian Popow





## Therapeutic Management of Anorectic Girls (Cognitive Behavioural Therapy (G-CBT))



**Users:** therapists

**Data:** complex, highly structured, time-oriented

**Task:** finding predictors

# Gravi++: Demo



The screenshot displays the Gravi++ software interface. The main window shows a 3D simulation of a person sitting in a chair, surrounded by several circular force fields. The interface includes a menu bar (File, Questions, Persons, Windows, Help), a ListVis panel on the left, a Time Control panel at the bottom, and a Toolbar panel on the right. The ListVis panel lists 23 persons and 15 questions. The Time Control panel shows a timeline from 1.1.2004 to 1.1.2004. The Toolbar panel has sections for Questions, Persons, and General, with various checkboxes and buttons.

**ListVis**

**Persons**

- Person:1C
- Person:2C
- Person:3C
- Person:4C
- Person:5C
- Person:6C
- Person:7C
- Person:8C
- Person:9C
- Person:10C
- Person:14C
- Person:15C
- Person:16C
- Person:18C
- Person:22C
- Person:23C

**Questions**

- Question:f(x)ASW
- Question:f(x)BDI
- Question:f(x)BMI
- Question:f(x)CBCL Treffen Fr
- Question:f(x)CBCL Zahl Fr
- Question:f(x)MR EVA
- Question:f(x)MRSOC
- Question:f(x)Restraint
- Question:f(x)SD
- Question:f(x)SPS
- Question:f(x)YSR Treffen Fr
- Question:f(x)YSR Zahl Fr

**Time Control**

3/5: 1.1.2004 - 1.1.2004

**Toolbar**

**Questions**

- Attraction Field
- Label
- Circular Placemen
- Evenly Distribute
- Show Question

Send to Top

**Persons**

- Show Traces
- Show Whole Traces
- Show Persons

Send to Top

**General**

- Star Glyph
- Show Gric
- Show Tooltips

Open

Save



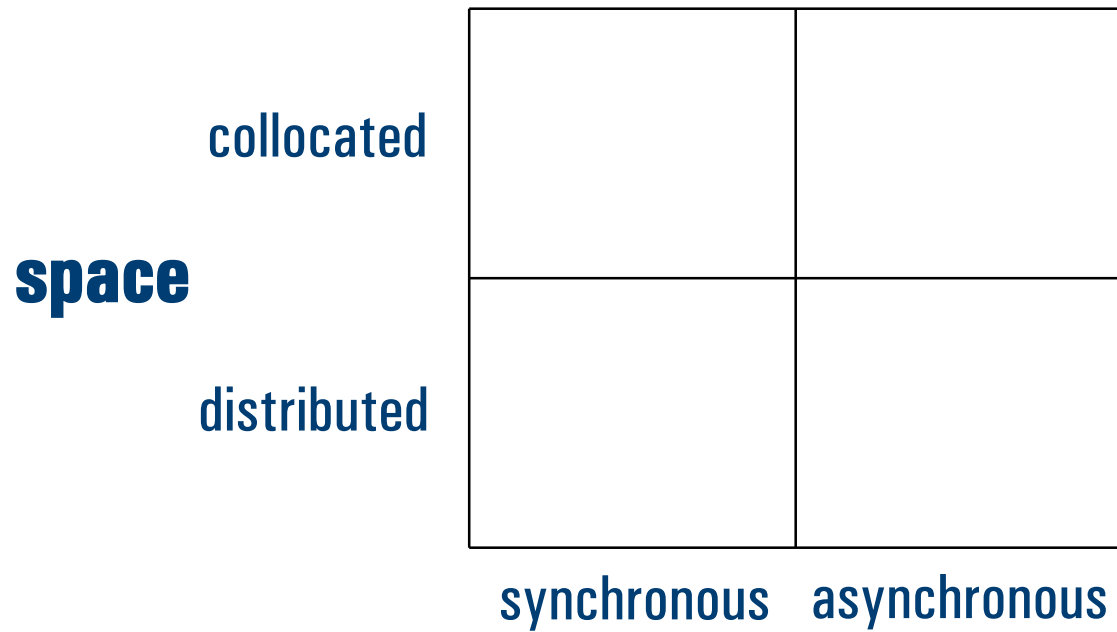
Challenge #2

# Support collaboration

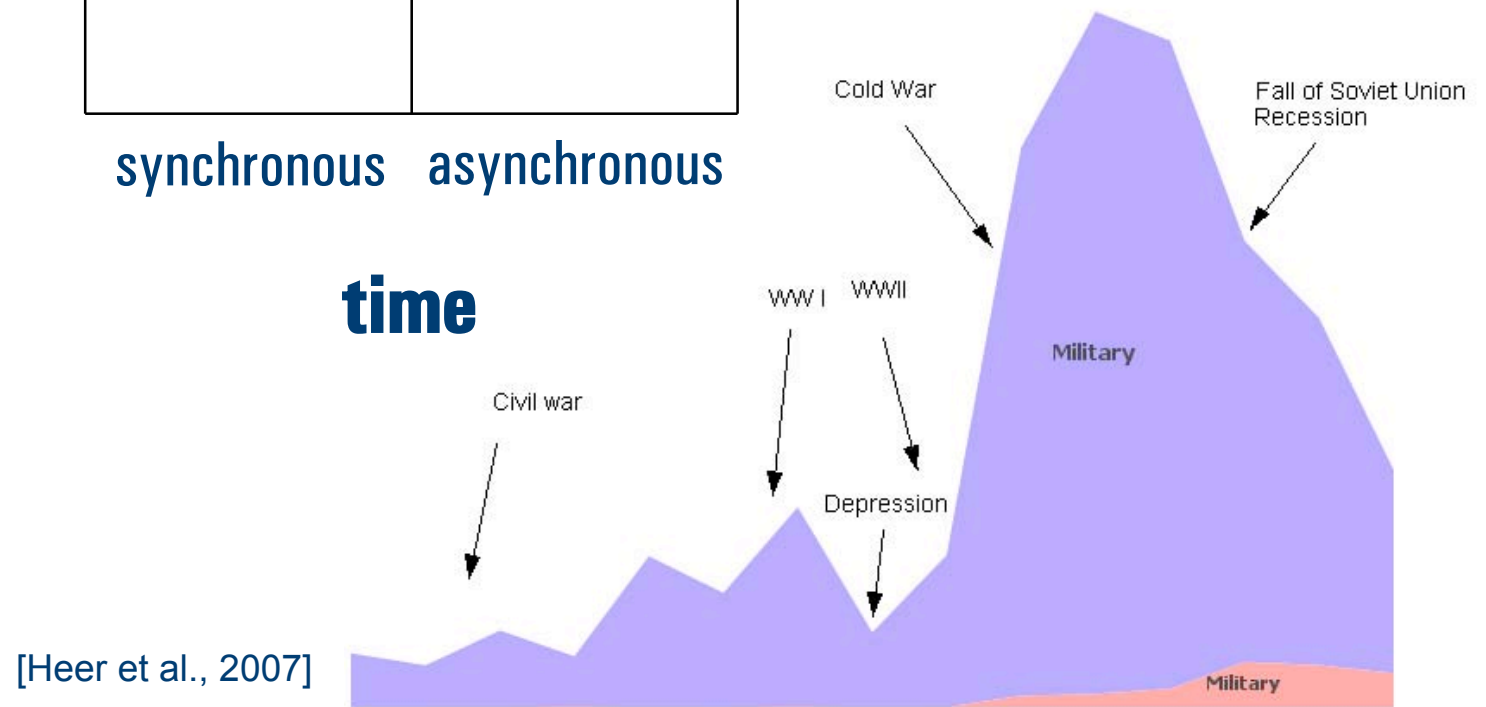
Image credits: iofoto, <http://www.sxc.hu>

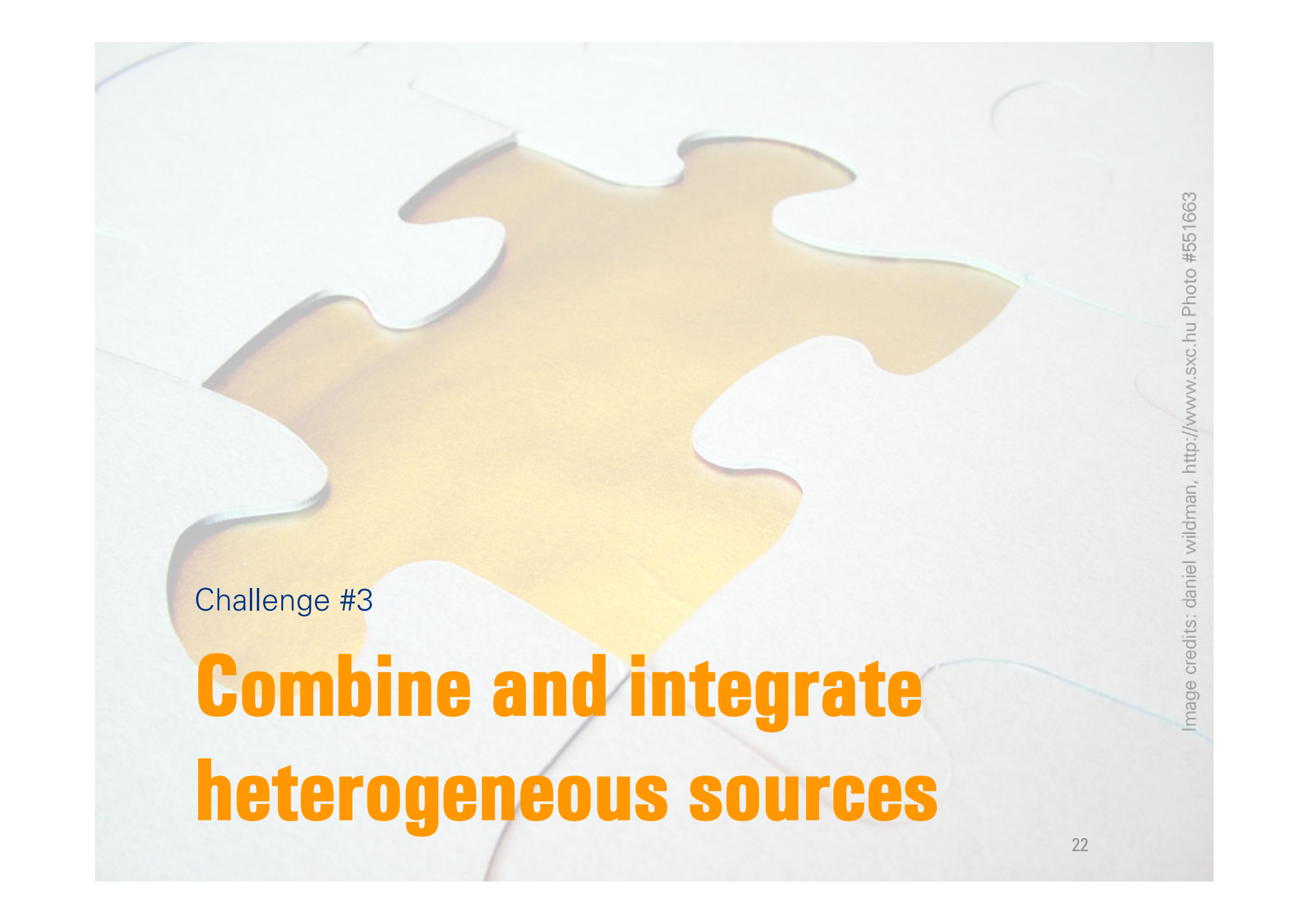


# Collaboration



[Bafoutsou & Mentzas, 2002]



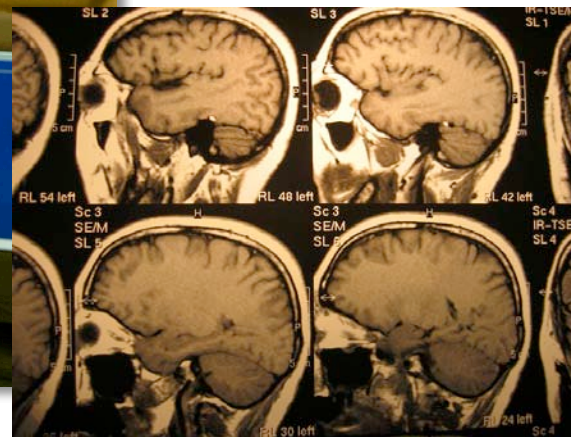
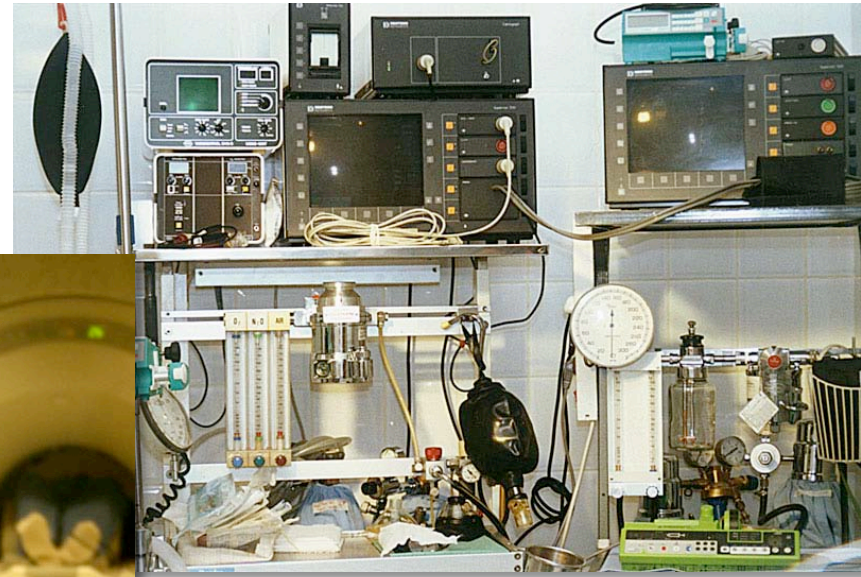
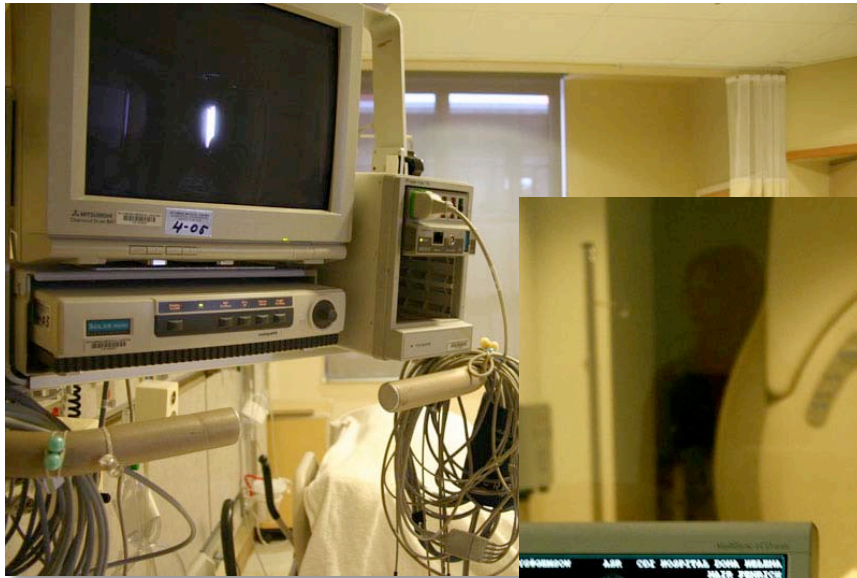


Challenge #3

# Combine and integrate heterogeneous sources

Image credits: daniel wildman, <http://www.sxc.hu> Photo #551663

# Heterogeneous Sources

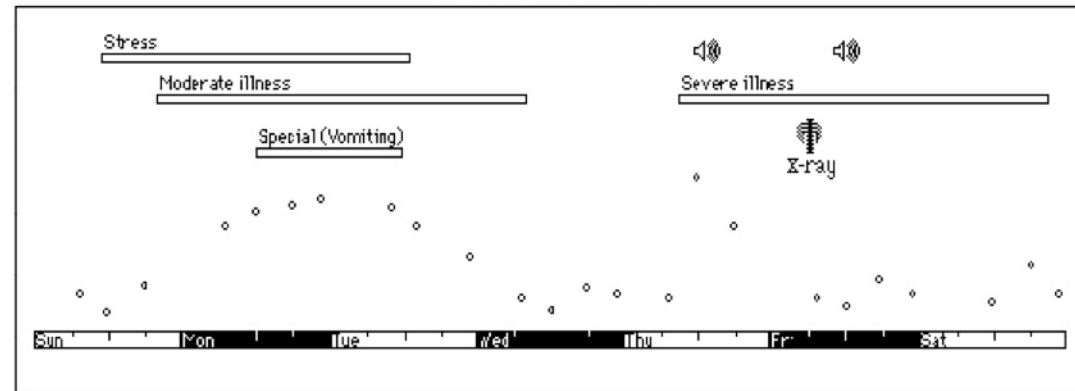


# Heterogeneous Sources



[Plaisant et al., 1998]

Patient: Joe Patient



[Cousins and Kahn, 1991]

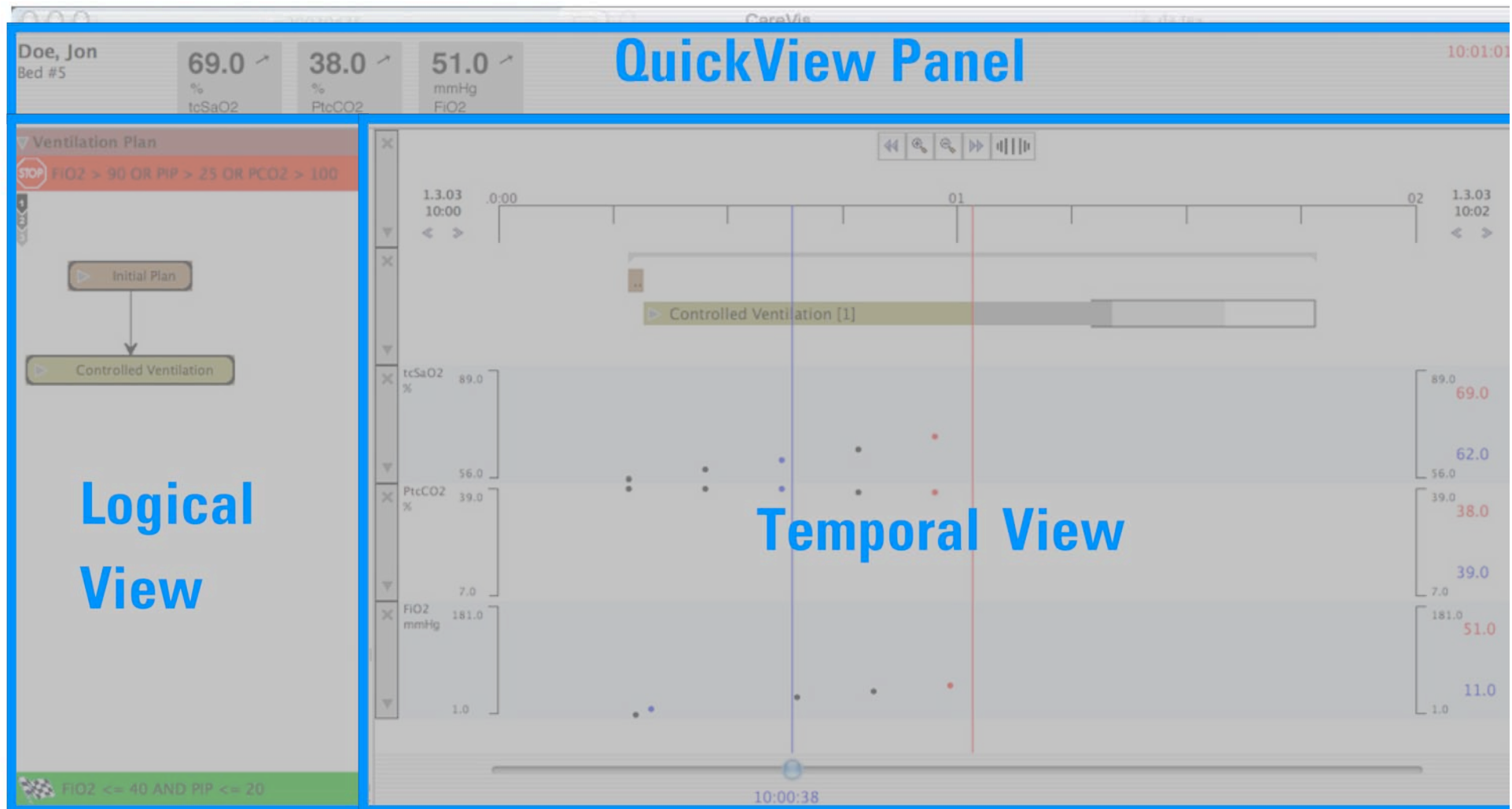
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## Interactive Visualization Methods to Support Protocol-Based Care

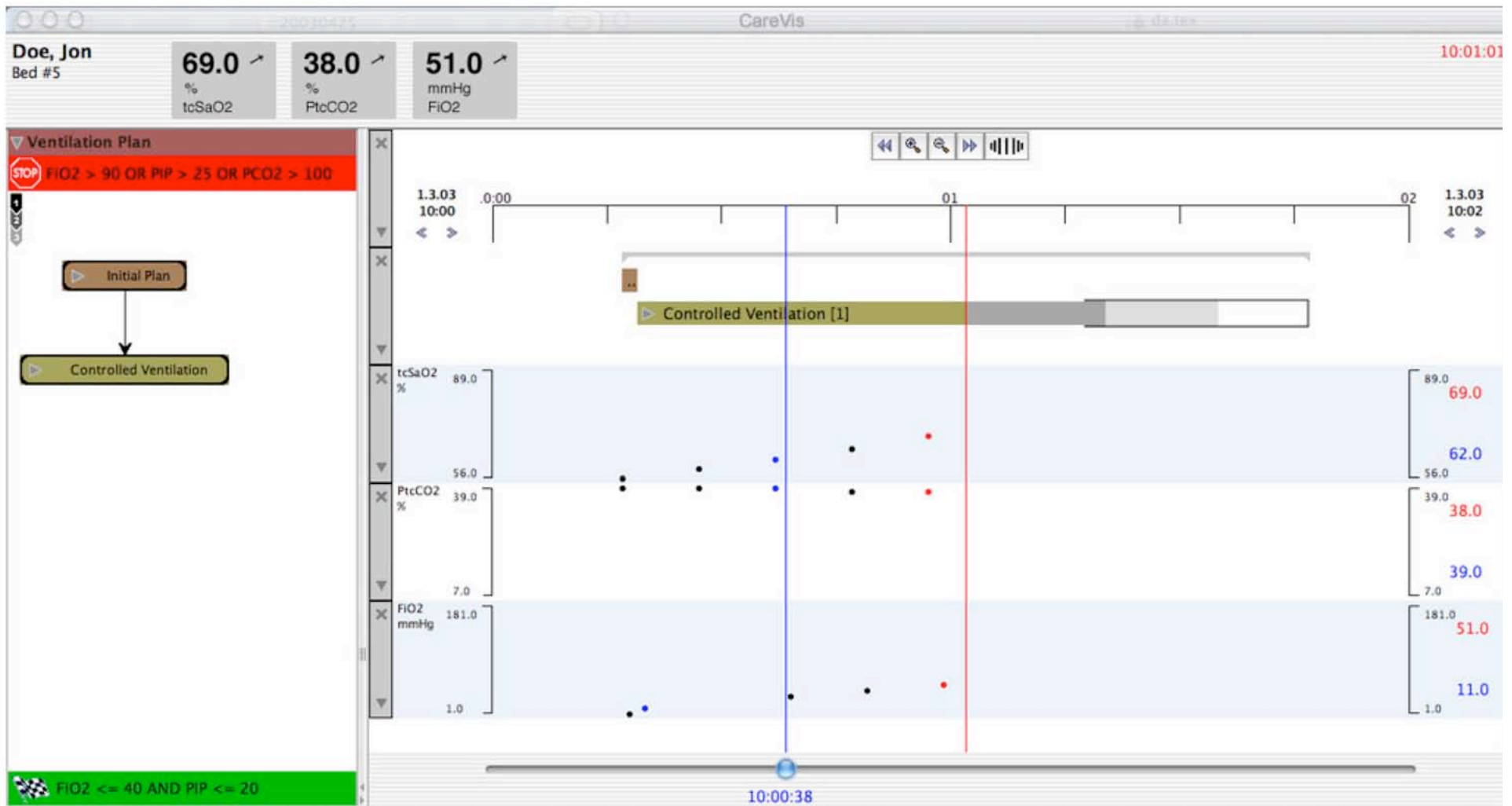
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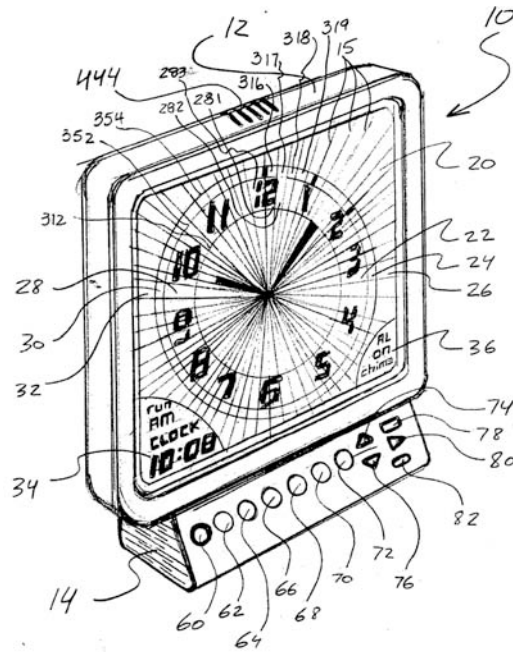


## Integrated Visualization of Computerized Protocols and Temporal Patient Data



## Integrated Visualization of Computerized Protocols and Temporal Patient Data

# Time has a complex structure





Challenge #4

# Care about semantics



Image credits: Raphael Caram, <http://www.sxc.hu> Photo #687116

# Midgaard

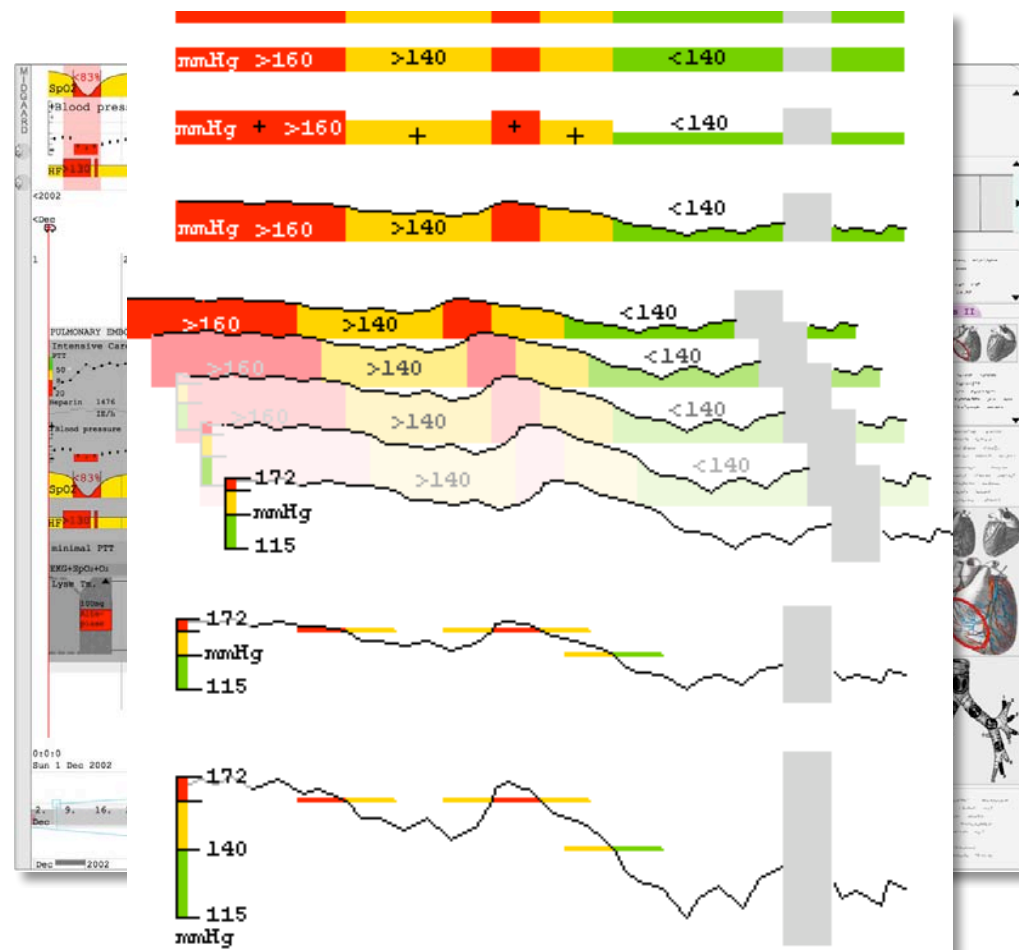
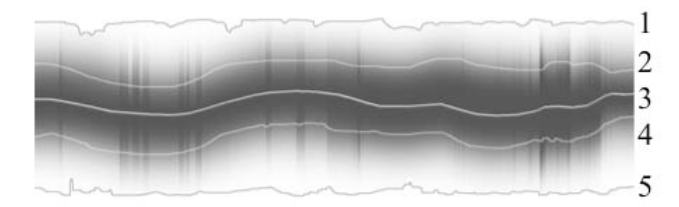
[Bade et al., 2004]

visualization of medical intensive care data

- qualitative scales
- quantitative scales
- qualitative / quantitative hybrids
- hybrids

semantic zoom

smoothly integrated





Challenge #5

**Don't forget about the  
hardware**

Image credits: Brano Hudak, <http://www.sxc.hu> Photo #875772

# Hardware + Software





Challenge #6

**Users first!**

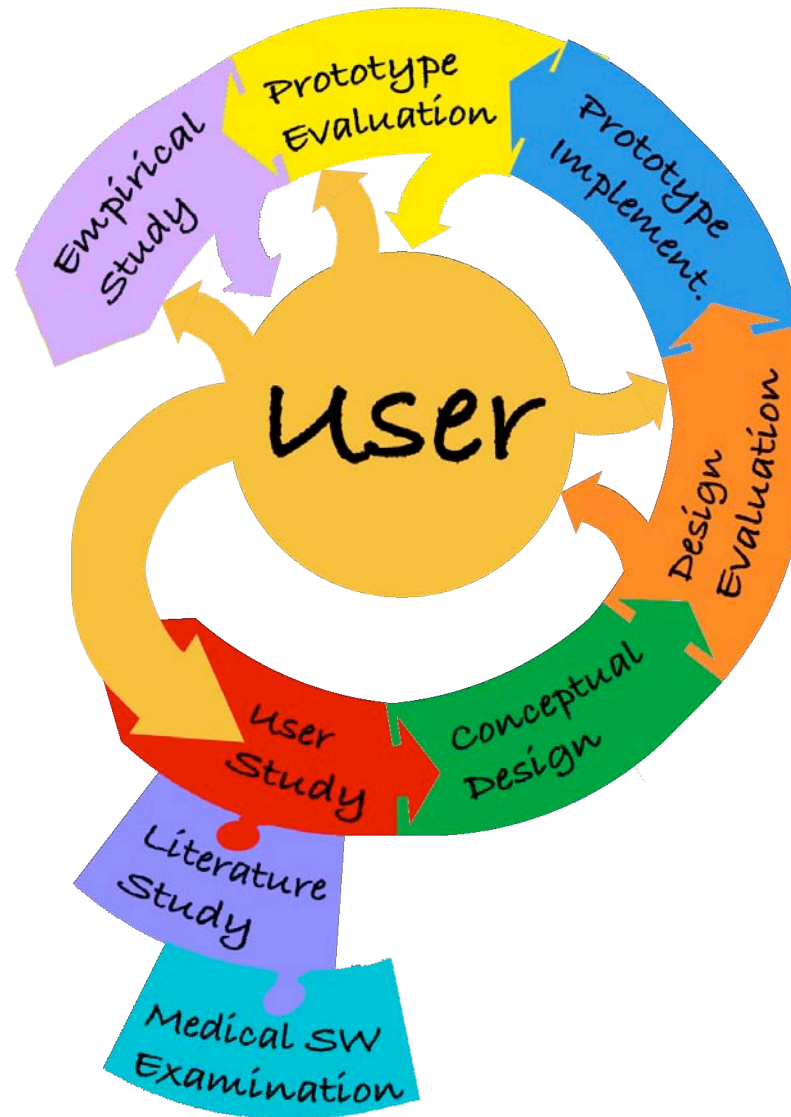
Image credits: Penny Mathews, <http://www.sxc.hu> Photo #985603

# One does not fit all



Image credits: Ju e Marcinho Castro Porto, <http://www.sxc.hu> Photo #684744

# User-Centered Development



A photograph of a curved wooden boardwalk on a grassy area. The boardwalk is made of light-colored wooden planks and is bordered by a concrete curb. Several concrete pillars are visible in the background. The scene is brightly lit, suggesting a sunny day.

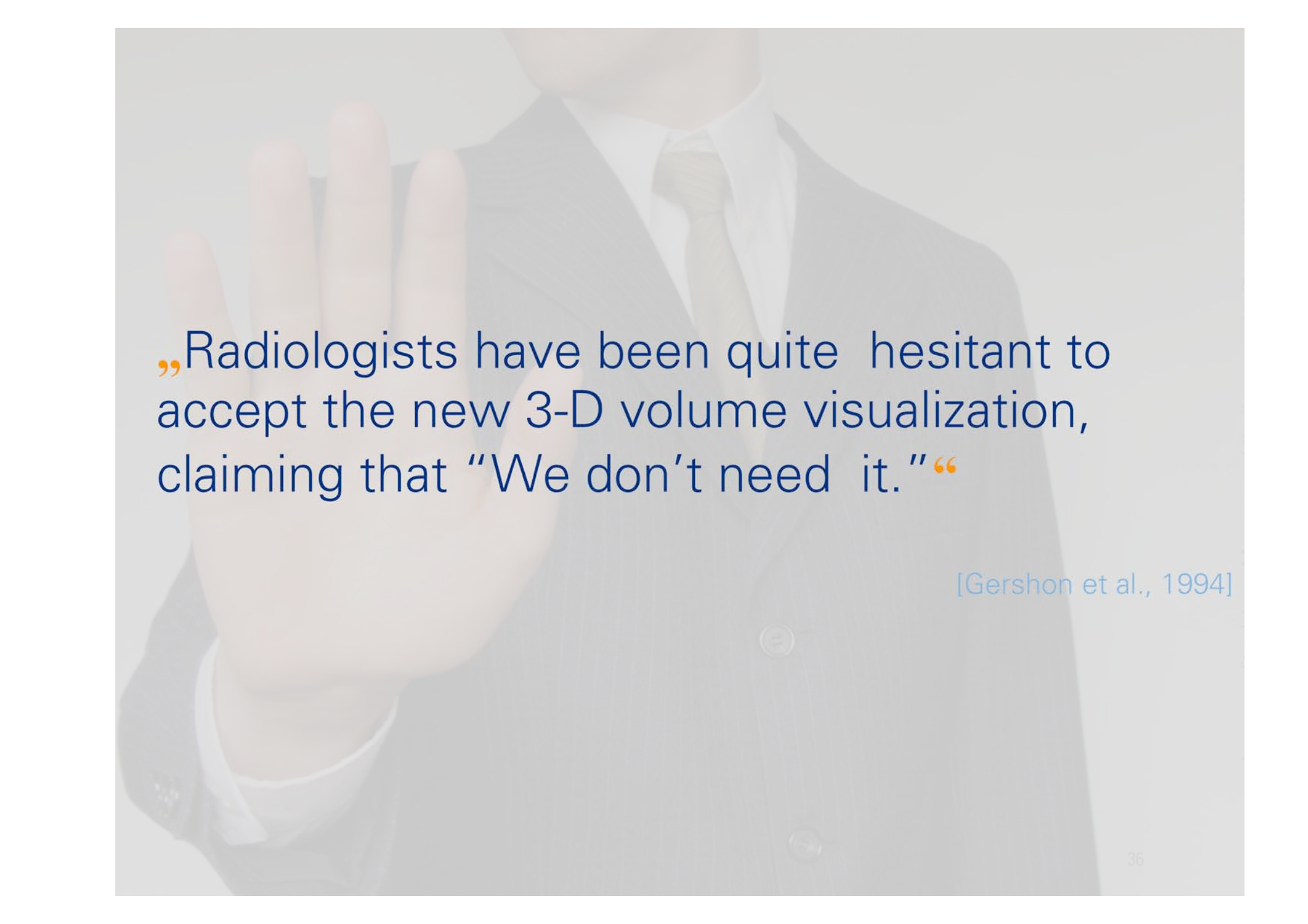
Challenge #7

# Research into practice

Image credits: Alex T., <http://www.sxc.hu> Photo #89658

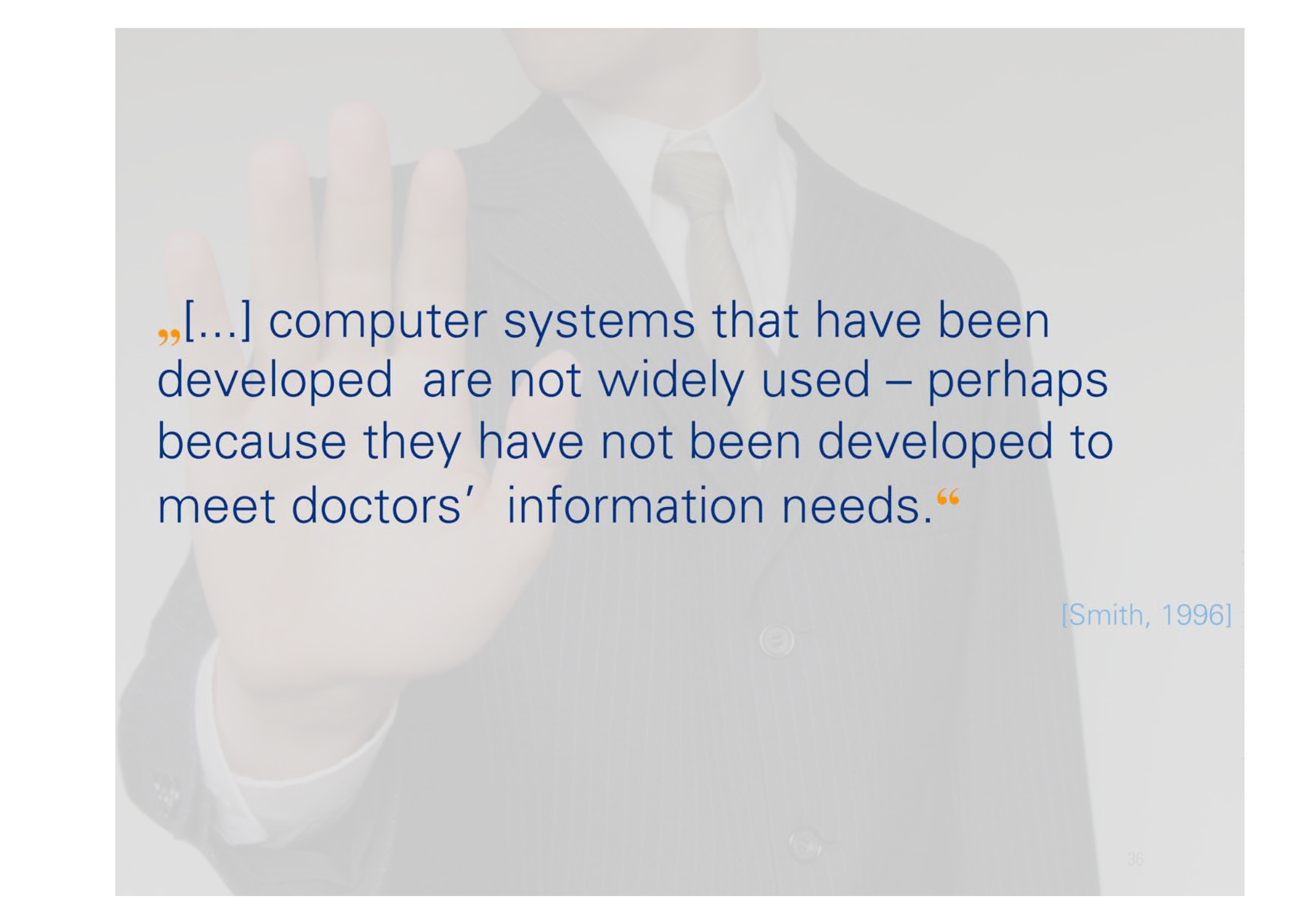






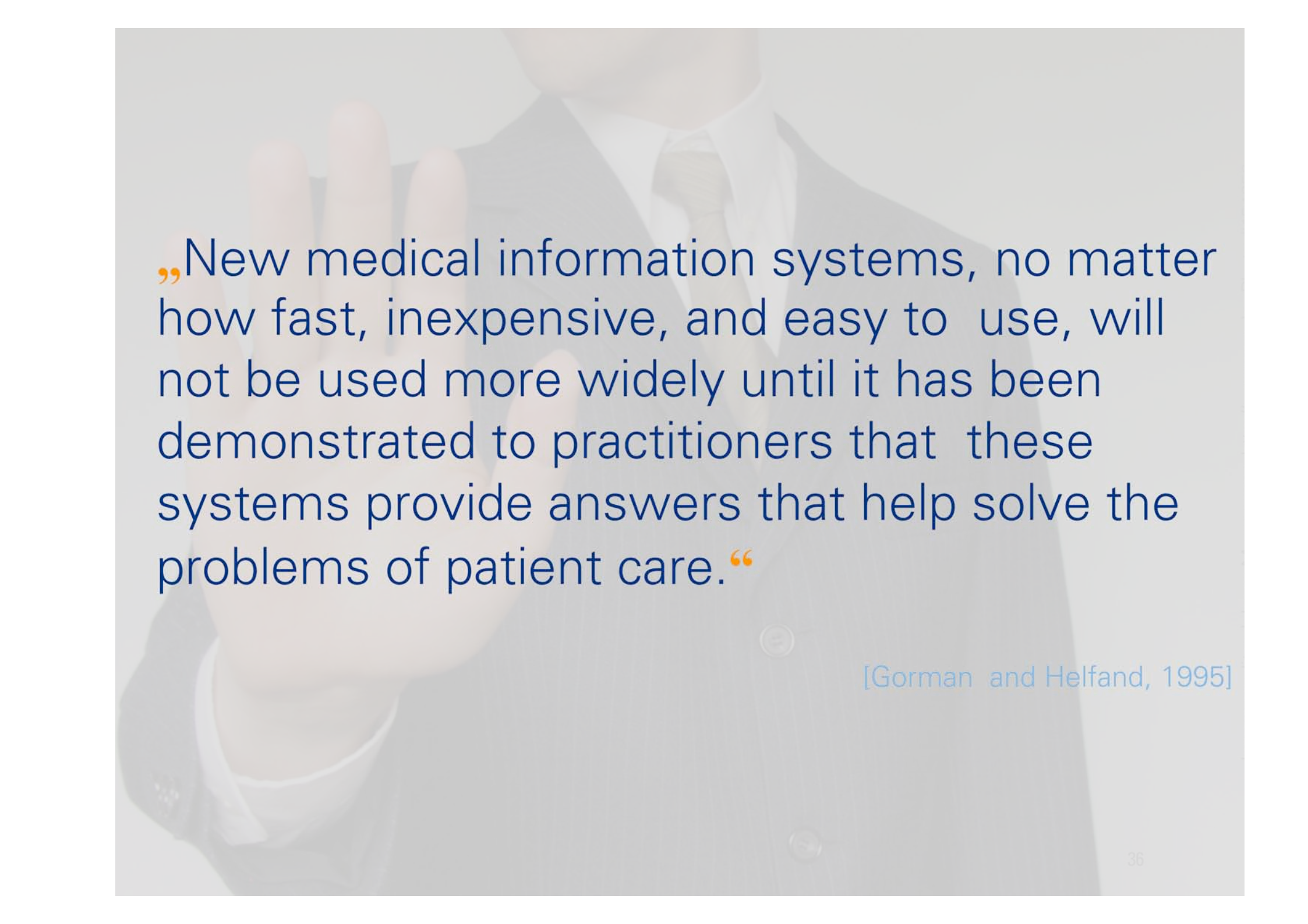
„Radiologists have been quite hesitant to accept the new 3-D volume visualization, claiming that “We don’t need it.”“

[Gershon et al., 1994]

A person in a dark suit, white shirt, and light-colored tie is shown from the chest up. Their right hand is held up, palm facing forward, in a 'stop' gesture. The background is a light, neutral color. Overlaid on the image is a quote in blue text.

„[...] computer systems that have been developed are not widely used – perhaps because they have not been developed to meet doctors’ information needs.“

[Smith, 1996]

A person in a dark suit, white shirt, and tie is shown from the chest up. Their right hand is held up, palm facing forward, in a gesture that suggests a point or a warning. The background is a light, neutral color.

„New medical information systems, no matter how fast, inexpensive, and easy to use, will not be used more widely until it has been demonstrated to practitioners that these systems provide answers that help solve the problems of patient care.“

[Gorman and Helfand, 1995]

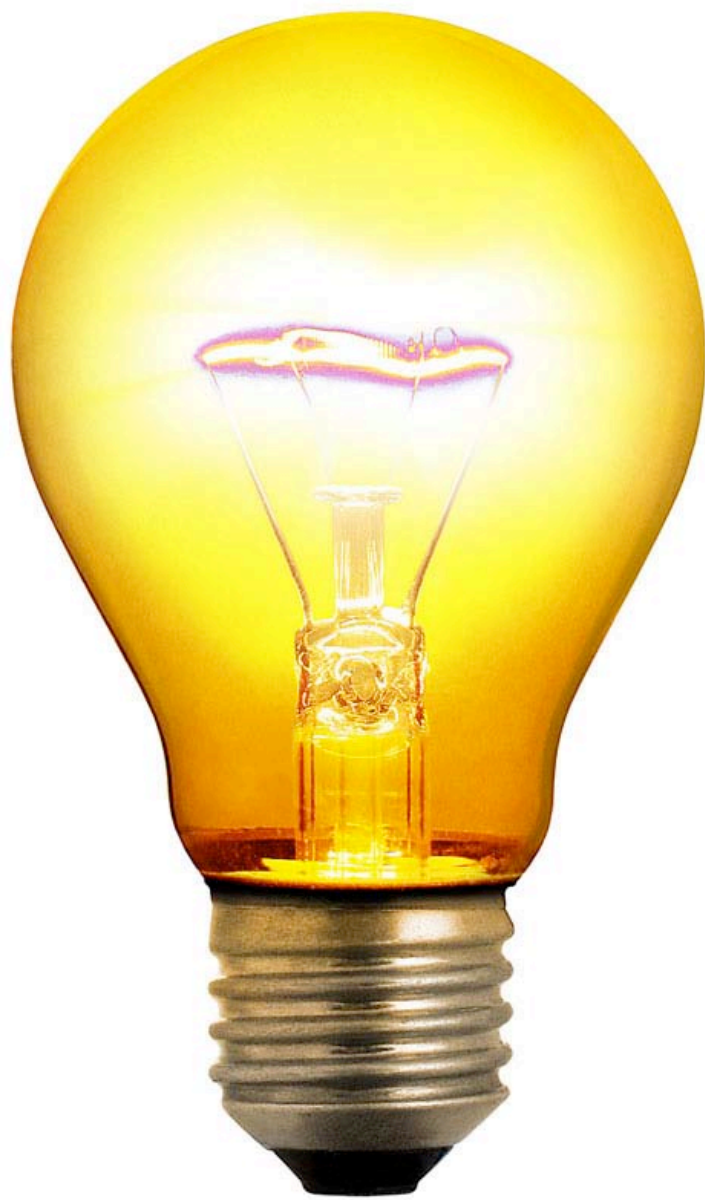
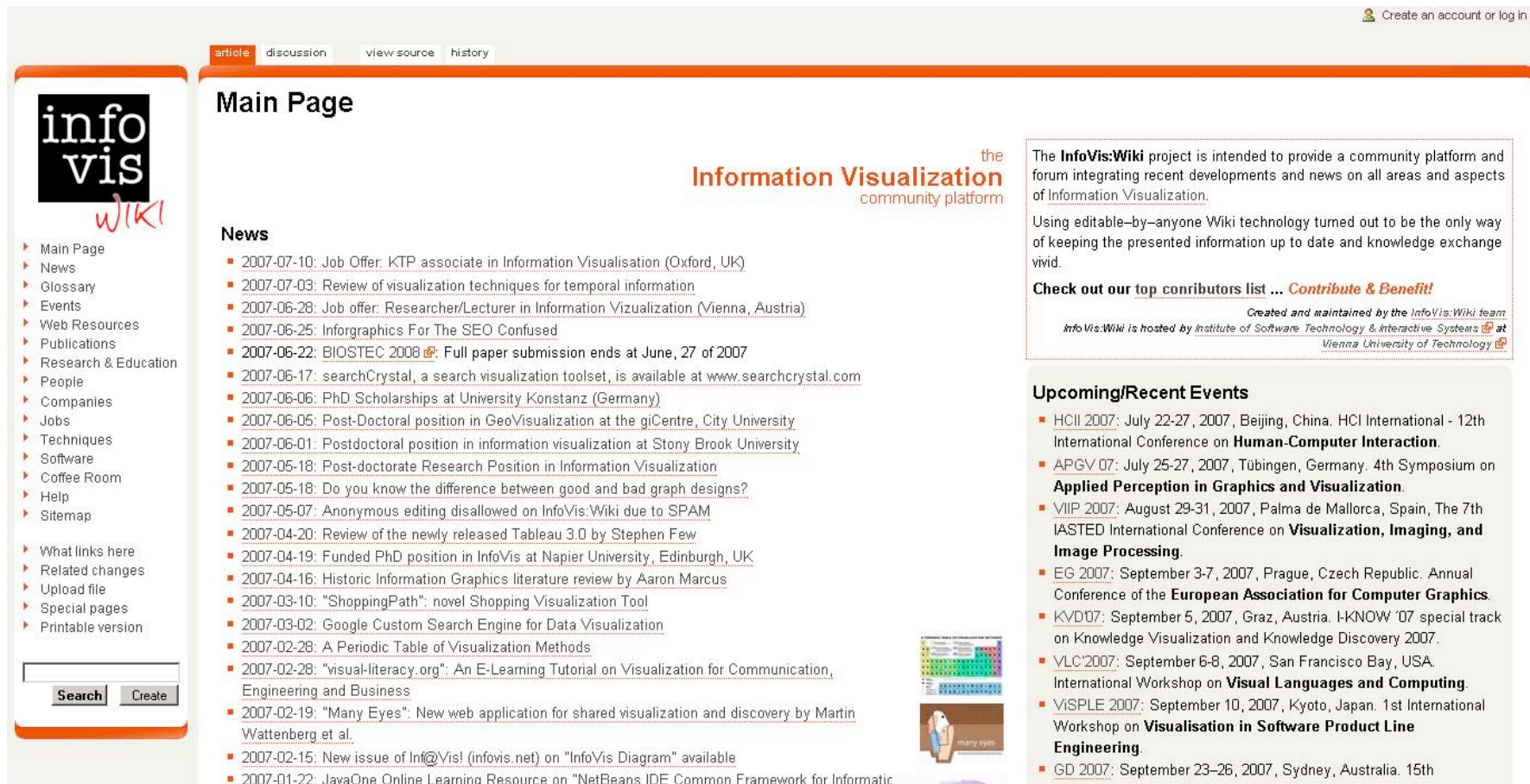


Image credits: Davide Guglielmo, <http://www.sxc.hu> Photo #190593

# Challenges

- ① Interaction is key
- ② Support collaboration
- ③ Combine and integrate heterogeneous sources
- ④ Care about semantics
- ⑤ Don't forget about the hardware
- ⑥ Users first!
- ⑦ Research into practice



The screenshot shows the main page of the InfoVis:Wiki website. At the top right, there is a link to 'Create an account or log in'. Below this, there are navigation tabs for 'article', 'discussion', 'view source', and 'history'. The main content area is titled 'Main Page' and features the 'InfoVis:Wiki' logo on the left, which includes the text 'info vis WIKI'. To the right of the logo is a navigation menu with links to various sections like 'Main Page', 'News', 'Glossary', etc. The central part of the page is titled 'the Information Visualization community platform'. Below this, there is a 'News' section with a list of recent articles, each with a date and a brief description. To the right of the news section, there is a text box explaining the project's purpose and a list of upcoming/recent events. At the bottom of the page, there is a large orange banner with the text 'Contribute & Benefit!'.

**Main Page**

the **Information Visualization** community platform

The **InfoVis:Wiki** project is intended to provide a community platform and forum integrating recent developments and news on all areas and aspects of Information Visualization.

Using editable-by-anyone Wiki technology turned out to be the only way of keeping the presented information up to date and knowledge exchange vivid.

**Check out our top contributors list ... Contribute & Benefit!**

*Created and maintained by the InfoVis:Wiki team  
InfoVis:Wiki is hosted by Institute of Software Technology & Interactive Systems at  
Vienna University of Technology*

**Upcoming/Recent Events**

- HCII 2007: July 22-27, 2007, Beijing, China. HCI International - 12th International Conference on **Human-Computer Interaction**.
- APGV 07: July 25-27, 2007, Tübingen, Germany. 4th Symposium on **Applied Perception in Graphics and Visualization**.
- VIIP 2007: August 29-31, 2007, Palma de Mallorca, Spain. The 7th IASTED International Conference on **Visualization, Imaging, and Image Processing**.
- EG 2007: September 3-7, 2007, Prague, Czech Republic. Annual Conference of the **European Association for Computer Graphics**.
- KVD 07: September 5, 2007, Graz, Austria. I-KNOW '07 special track on Knowledge Visualization and Knowledge Discovery 2007.
- VLC/2007: September 6-8, 2007, San Francisco Bay, USA. International Workshop on **Visual Languages and Computing**.
- VISPLE 2007: September 10, 2007, Kyoto, Japan. 1st International Workshop on **Visualisation in Software Product Line Engineering**.
- GD 2007: September 23-26, 2007, Sydney, Australia. 15th International Conference on **Graphical User Interfaces**.

# Contribute & Benefit!

# Contact

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The purpose of computing is insight, not numbers.

Richard Hamming (1981)

# Interactive Visualization and Data Analysis



Postgraduate Master Program, Master of Science – MSc  
5 semesters, part-time

**Danube University Krems**

[www.donau-uni.ac.at/ike/visual-analytics](http://www.donau-uni.ac.at/ike/visual-analytics)