



Emerging Technologies and the OR of the Future...

The Who? What? When? Where? ...of Surgical Services

Kevin Fickenscher, M.D.

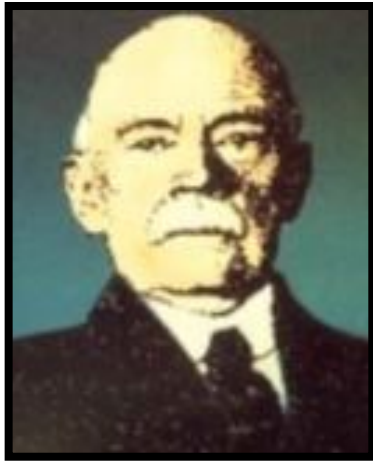
Executive Vice President, Healthcare Transformation

Perot Systems Corporation

*“Vision...
is the art
of seeing
things
invisible.”*

*Jonathon Swift
1711*





Charles Duell, 1887

*“Everything that can be invented,
has been invented.”*

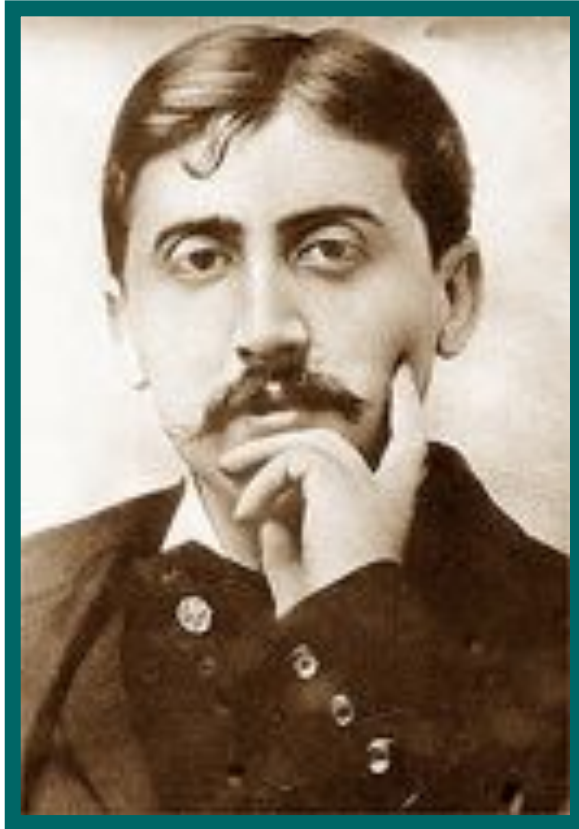
Harry Warner, 1927

*“Who the hell wants to hear actors talk,
anyway.”*



Bill Gates, 1981

*“640K ought to be enough for
anybody.”*



"The real voyage of discovery consists not of finding new lands but of seeing the territory with new eyes."

津波



Forces Precipitating Change...

律
波

- Society is demanding...
 - Quality ↑
 - Service ↑
 - Cost ↓
- Technology – in all forms – is an underlying force for significant change over the next decade
- Moving from professionally dominated information theocracy to an information democracy
 - = Intellectual capital of medicine
 - = Focal point for health care change
 - = Appropriate management of information required
 - = Empowers both physicians and consumers

Forces Precipitating Change...

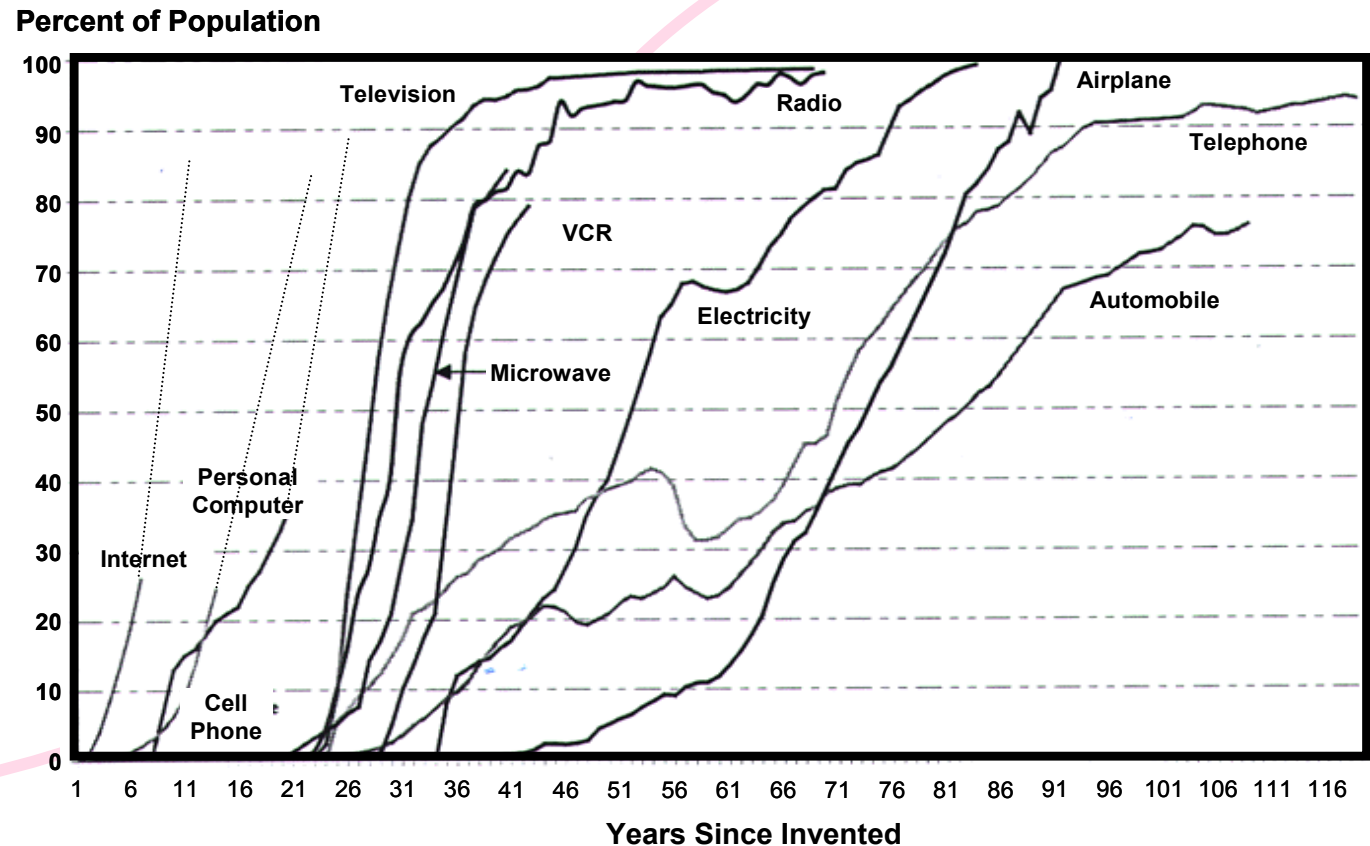
津波

- Information technology as a central enabler ties together all of the disparate functions of health care by...
 - Empowering consumers as active participants and decision-makers in their personal care process
 - Enhancing communication between and among patients and providers that drive changes in health
 - Integrating disruptive technologies over the next decade through medical devices, pharmaceuticals (new drug delivery devices and patient monitoring) and biotechnology
 - Reinforcing cost (↓), quality (↑) and service (↑) through data mining and appropriate refocusing of resources

A Few Caveats...An Explosion of Change

津波

Changes in the delivery of healthcare are exploding and precipitating non-linear change that will radically change the market place...and, projections related to physician and clinical services



30 Classes of Medical Technologies

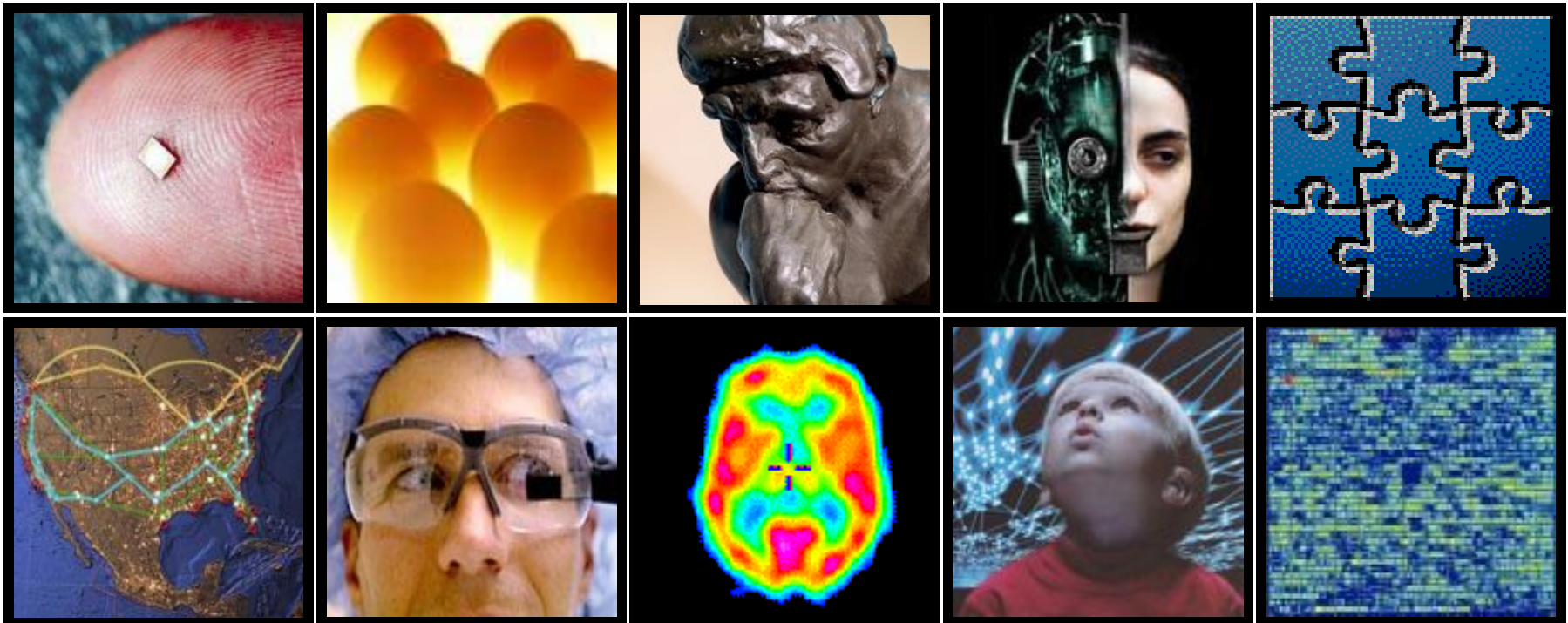
- Diagnostic Laboratory Tests
- Drug Delivery Systems
- Imaging—Non-invasive
- Multiple Modality
 - Functional Imaging
 - Molecular Imaging
 - Image Guidance (for Therapy)
 - Imaging –Invasive/Internal
- Nano Devices
- Neurostimulators
- Organ Assistance and Prosthetics
- Sensors—Monitoring
- Surgery—Robotics
- Surgery—Minimally Invasive
- Tissue and Fluid Replacement
- Information Systems
 - Connectivity
 - Bandwidth
 - Wireless
 - Security
 - Networks



- Biotechnology
 - Cell-Based Therapy
 - Genetic Testing
 - Genetic and Protein Therapy
 - Immunotherapy
 - Stem Cell Technology
 - Transplant Technologies
- Pharmaceuticals
 - Pharmacogenomics
 - Rational Drug Design
 - Vaccines
 - Oncology
 - Cardiology
- Information Storage, Retrieval, and Transmission
 - PACS
 - Electronic Prescriptions
- Information Systems and Systems Integration
 - EMR's
 - Health Systems Management
 - Computer-Assisted Decision Making
- Remote Management Systems
 - Remote Patient Management
 - Population Health and Disease Management
 - Telemedicine

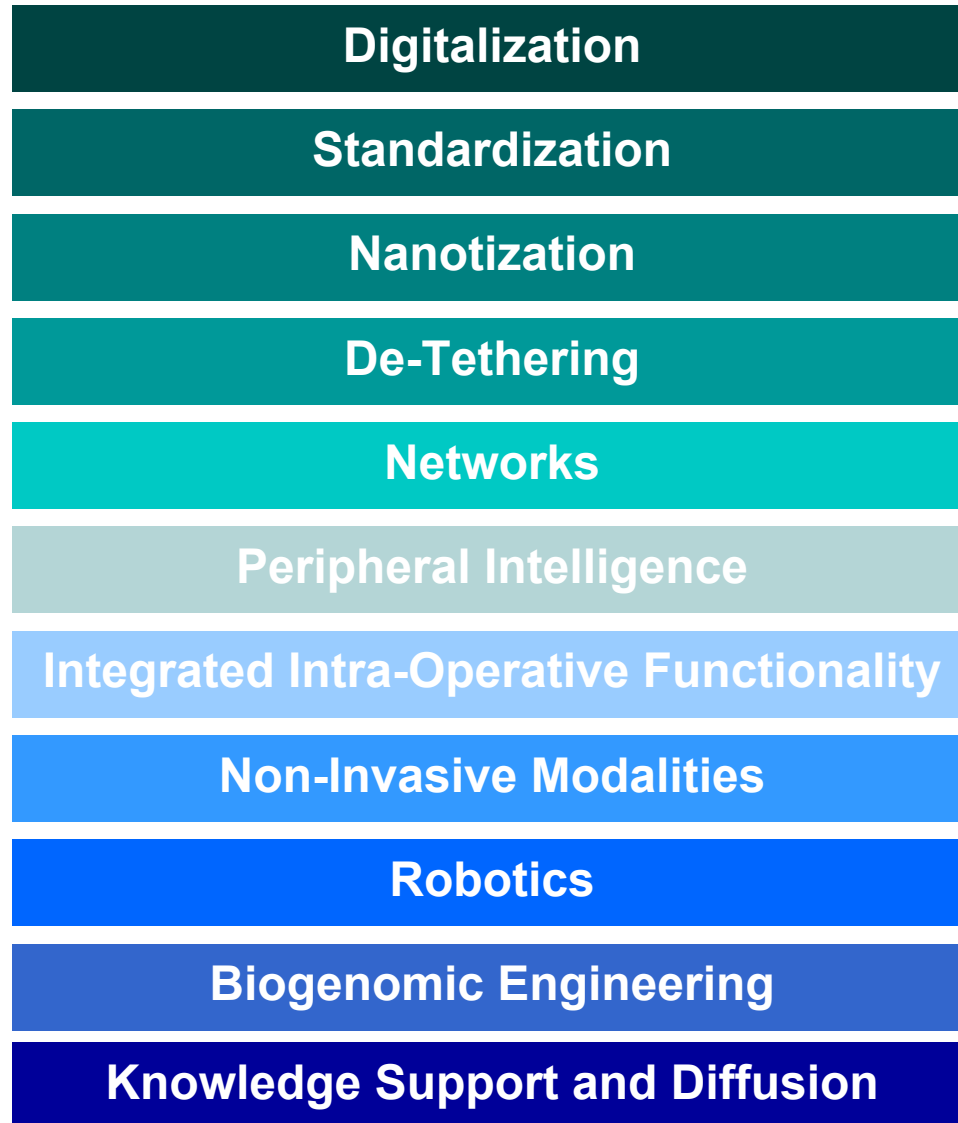
Framing the Technology Change...

Ten technology areas dominate the new, new thing for the operating room...

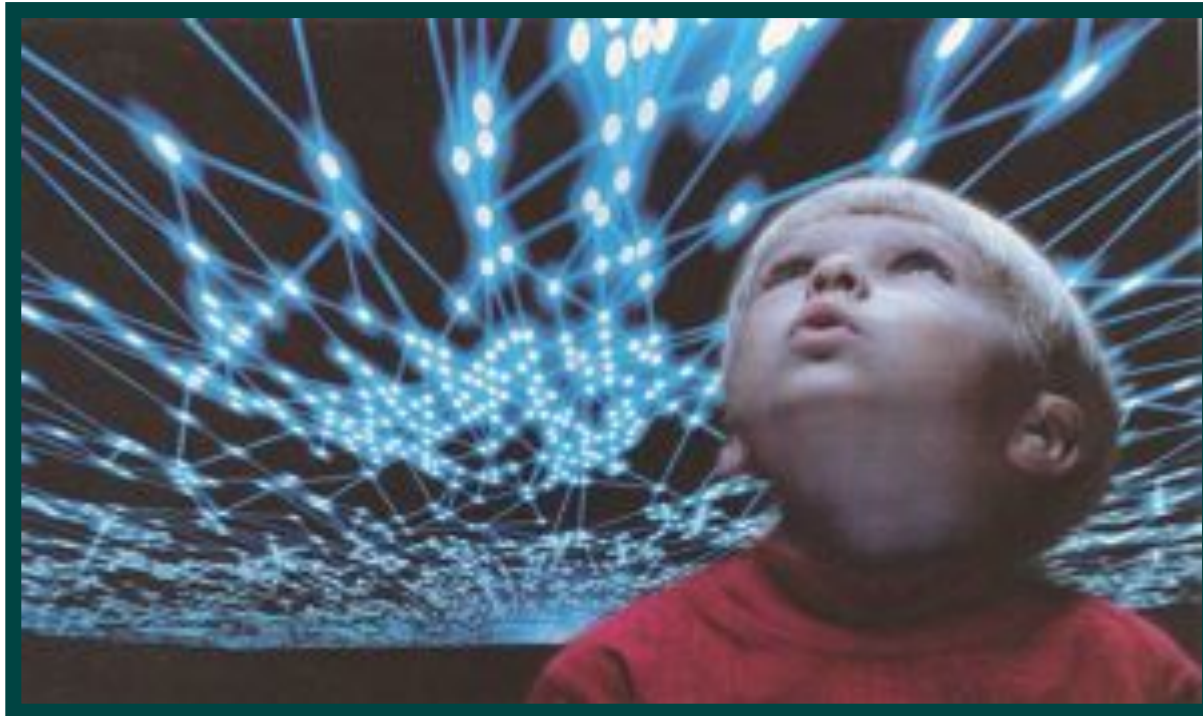


Framing the Technology Change...

Ten categories dominate the new, new things...



Digitalization



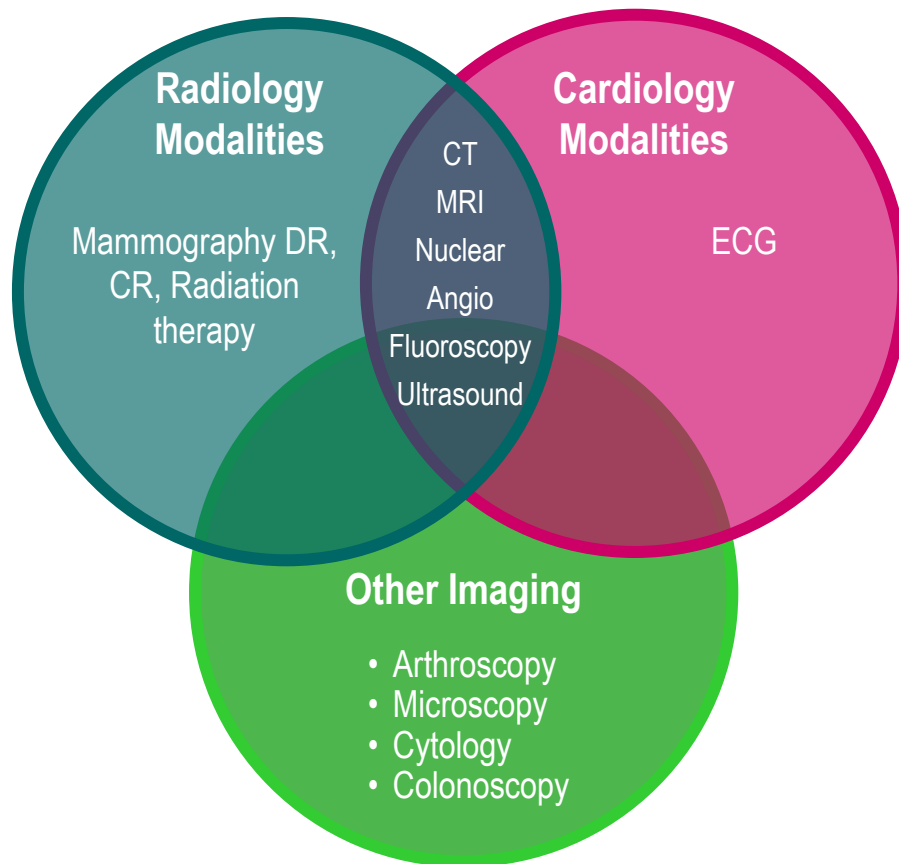
**Imaging
PACS
Data Management
...all things transmitted and shared...**

Digitalization
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Nanotization
De-Tethering
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Digitalization

*Integrating a Picture Archive and Communication System (PACS)
Within the Healthcare Enterprise*

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Standardization

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Standardization: Universal Protocol—Time-Out

For Preventing Wrong Site, Wrong Procedure, Wrong Person Surgery

- Pre-operative verification process
 - Ongoing process of information gathering and verification
 - Determination to do the procedure
 - Verification though all settings and interventions involved in preoperative preparation of the patient
 - “Time out” before start of procedure
- Marking the operative site
 - Right/left distinction
 - Multiple structures (e.g. specific operative sites) or multiple levels (e.g. spinal procedures)
 - Mark visible after prepping and draping



Nanotization

Microelectronics...

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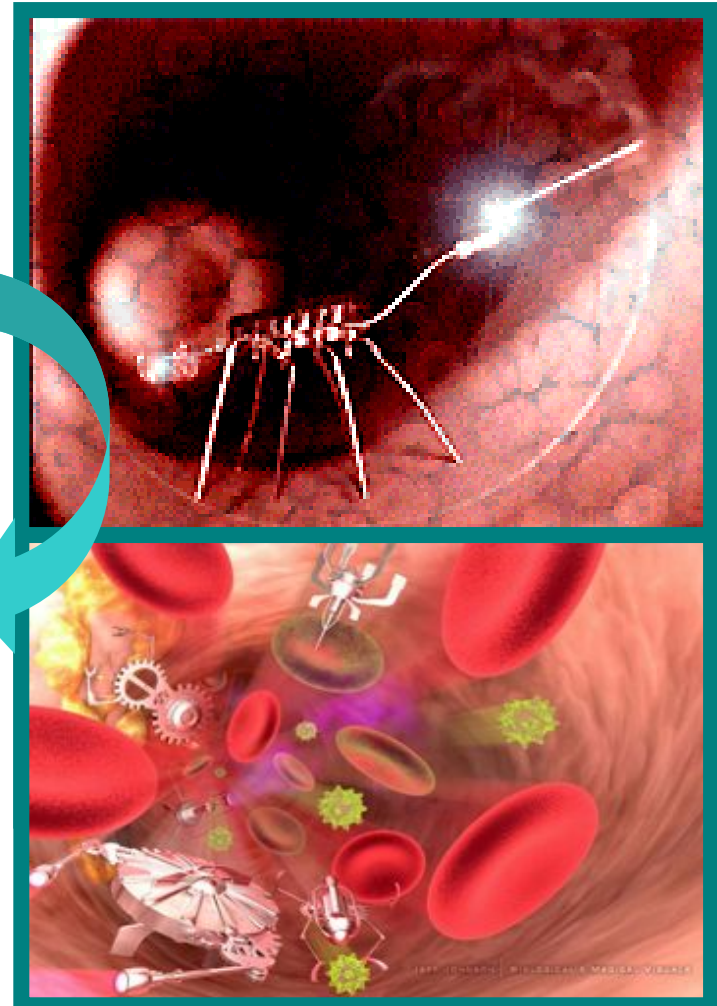
MicroElectroMechanical Systems (MEMS)

Silicon wafers packed with kinetic, three-dimensional gizmos: laboratories, laser-guided mirrors, canals flowing with chemicals. In the future, they are projected to be networked and practical (e.g. disposable blood-pressure gauges, wearable pollution sensors)

September, 1999—First Self-Propelled Nanobiot Devised

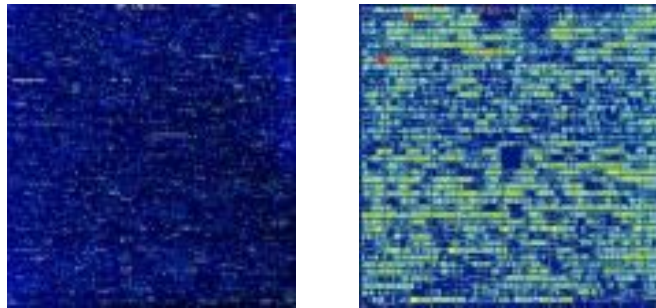
Cornell researchers created a nanobot 100,000X smaller than a grain of sand with a small propeller. attached to an ATP segment, creating a self-propelled devise to which bio-substances could be attached. For example, the device could be attached to antibiotics or anti-cancer drugs

Source: Wired, January 2000



Nanotization

*“The future's already arrived; it's just not evenly distributed yet”
—William Gibson*



Dateline: February 7, 2005 – Institute of NanoTechnology [www.nano.org.uk] “...In 5-8 years [biochips] will be available that will map an individual's entire genetic code from a drop of blood, almost instantaneously. Understanding the [information] ...using DNA chips, the response can be gauged 100 to 1000 times faster than before, allowing treatment to be tailored to the individual...*What silicon chips did for computing, DNA chips may do for biomedical research.*”

“...Doctors will soon be able to order a test to find out whether patients have unusual gene variations that predict whether they'll suffer bad reactions to certain drugs...
In 2006, Affymetrix released a new set of chips that have 6.5 million DNA types.”

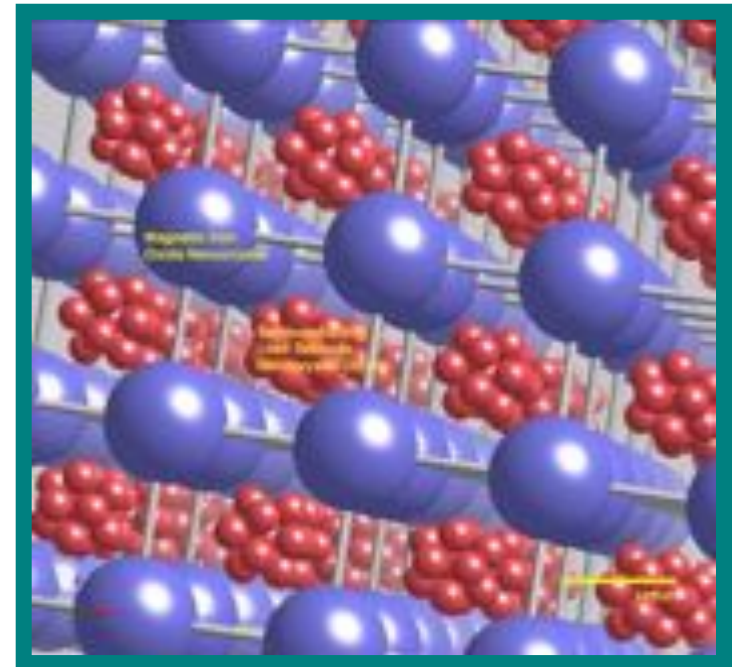


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- New Sensors Give Robots Touch of Humanity
 - Device can feel the shape of a coin down to detail of the letters stamped on it
 - Semiconducting nanoparticles produced out of a solution so sensors can be built to conform to complex shapes
- Next step
 - Potential use of this sensitivity in robots
 - To discern cancer cells from normal cells during surgery
 - By “feeling” tissue with the sensor surgeon may be able to differentiate diseased from healthy cells



De-Tethering

It all started a few years back...

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- Telephones
- Network communication
- Patient Monitors
- Pagers
- Mobile Viewers
- Wireless Laptop
- Allow for flexibility and mobility of many medical technologies
- Perioperative and anesthesia documentation systems



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De-Tethering

Wireless LAN Hot Spots Getting Hot...

- De-tethering creates a whole new experience for the user of information and peripheral technologies
- De-tethering in the consumer world is driving our desires in the professional world
- Networks are becoming more ubiquitous – allowing access to information from public places as well as through private networks or VPN modalities
- 3G Disruption = massive bandwidth meets mobile reality



Source: IDC, Corp. Reports

De-Tethering

RFID Tags Track Surgical Supplies



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- Advantages of RFID Tags
 - Creates a “nothing is left behind” environment = enhanced safety and outcomes
 - Sponges and instruments are tagged
- Barriers to the Use of RFID Tags
 - Needles are too small to tag
 - Wand must be held in correct position and, used consistently correctly

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De-Tethering

...The Consumer

Measure blood pressure with one touch — and track last 90 readings by date.
Simply press a button and new oscillometric technology measures pulse rate and blood pressure in less than a moment. Worn like a regular wristwatch using the adjustable Vilevo™ strap. The large, easy-to-read screen continuously displays the time and date. Stores the last 90 measurements and the date they were taken. Fits on just 1 1/2" x 1 1/2" x 1/2" and comes with a durable case for travel. Runs on a AAA battery (included); 90-day warranty.

Lifescan Blood Pressure Wrist Monitor
MSRP: \$199.99

Quick and easy at-home cholesterol monitor accurately records hundreds of test results. No fasting required!
This compact, portable device is the first at-home test of its kind to be cleared by the FDA. Just place one drop of blood from an easy fingertick onto the disposable test strip, and get an accurate measurement of your total cholesterol level in just minutes. There's no fasting required. The monitor calculates your test result as "desirable," "borderline-high" or "high risk," according to National Cholesterol Education Program classification standards. The Data Converter smart card (included) allows you to store up to 100 test results, calculate average readings and securely provide your data to your doctor or pharmacist. The required test products (sold separately): L5231, \$69.99 for six tests; include a disposable sterile lancet, an alcohol prep swab, single-use test strip and a lancet. Runs on one 9V battery (included) for a minimum of 100 tests. Measures 4" x 4" x 1/2" and weighs only 1 lb. One-year warranty.

Personal Cholesterol Monitor
L5231 \$69.99

Sylin's wristwatch tracks heart rate—and calories, too!—without a chest strap.
Set fitness and weight loss goals and the Mio™ Lifestyle Heart Rate Watch helps you reach them: Place two fingers on sensors for a fast, EKG-accurate heart-rate measurement—without an uncomfortable, unreliable chest strap. Begin by entering personal data (age, gender, weight and resting heart rate), during workouts. Mio calculates how close you come to your minimum heart rate and how quickly your heart returns to its resting rate after exercise — one of the best indicators of fitness. Its memory tracks your calorie intake, then subtracts the estimated calories burned during workouts. Set a daily calorie loss target and Mio tells you how close you came to it. For feedback on your progress, use your personalized code to access Mio's Web site. Comes with a 32-page guidebook for healthy living. Digital LCD watch shows time, calendar and features an alarm setting. Weighs 6 oz. Runs on CR2032 lithium battery (included). One-year warranty.

Mio™ Lifestyle Heart Rate Watch
MSRP: \$199.99

...The Professional



“It’s sort of like Superman.”

Michael S. Higgins, MD
Surgeon
Vanderbilt University

Source: San Francisco Chronicle Magazine, April 20, 2003
The Tennessean, May 27, 2004

Networks

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Source: San Francisco Chronicle Magazine, April 20, 2003
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- Immediate access to Communities of Practice and “real time” expertise...
- Telemedicine
 - Diagnosis
 - Robotic participation
 - Monitoring
 - “Digital Hospital” with capabilities to assess vital functions, medications, and device settings
 - eICU > eER > eOR
 - From remote locations
 - Disease management



Peripheral Intelligence

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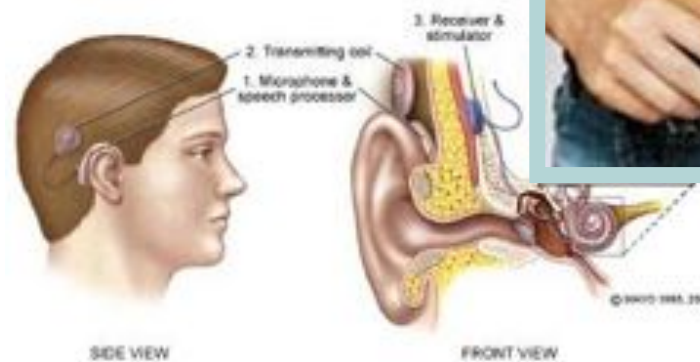
- Plasma Glucose Monitoring

- Maintaining plasma glucose between 80 and 120 mg/dL benefits admitted to the SICU, but requires frequent glucose monitoring to ensure adequacy of treatment / detection of hypoglycemia.
- Technical performance and accuracy of continuous glucose sensors needs improvement but technical issues are being resolved...



- Other Examples of Uses

- Brain metabolism
- Arterial blood oxygenation
- Dynamic blood pressure monitoring
- Glucose
- Electrolytes
- Drug levels (e.g. Heparin)



Integrated Intra-Operative Functionality

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- The OR = chaotic, complicated, and stressful place where human capabilities can fall short (*)
 - Limited memory capacity – we hold 5-7 pieces of information in short-term memory
 - Stress and fatigue increase error rates
 - Communication failures – the leading root cause of sentinel events, 1995 – 2004 (JCAHO)
- Need to systematically improve OR team communication, information synthesis, and situational awareness to reduce errors and near misses:
 - Foreign body retention
 - Wrong site / wrong side / wrong patient surgery
 - Allergic reactions and adverse drug events
- To improve OR team communication, information synthesis, and situational awareness, the organization must support...
 - OR team “on the same page”
 - Enhance team communication, hand-offs and reports:
 - Enhance training – archive, search and recall

* Source: Discussions with Kaiser Permanente patient safety leaders, Dr. Michael Leonard and Suzanne Graham, LiveData OR of the Future Workshop, San Francisco, November 17, 2005.

Integrated Intra-Operative Functionality

Real-Time OR Data Integration and Display

- Digitalization
- Standardization
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- Knowledge Support and Diffusion



Integrated Intra-Operative Functionality

Benefits are becoming clearer...

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- Improve OR scheduling to reduce delays
- Reduce infections through improved antibiotic use
- Leverages across multiple IT platforms
- Improve staff satisfaction, reduce turnover
- Improve asset utilization – find it faster, track it better

Non-Invasive Modalities

Ratio of Endovascular to “Surgical” Cardiac Procedures Over Time

Year	Total Coronary Artery Procedures	Endovascular* : “Surgical”**
1996	900,000	3 : 2
2001	1,250,000	5 : 2
2006	1,700,000	5 : 1

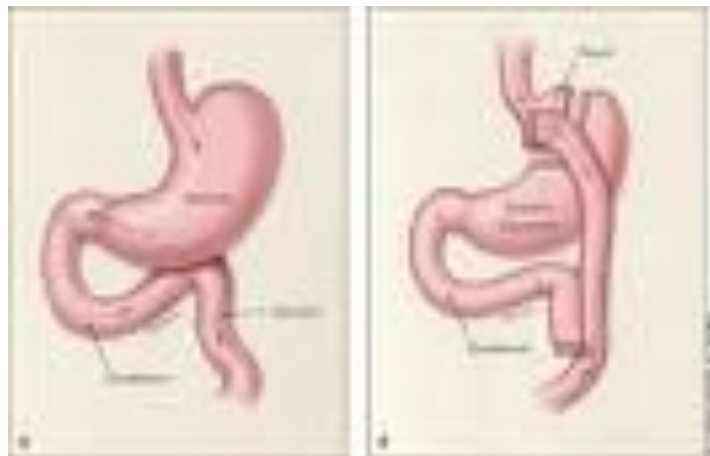
Cost per procedure	*PTCA/Stent	**CABG Surgery
Total Charges	\$21,000	\$32,000
Total cost over 8-yrs	\$69,000	\$73,000

Non-Invasive Modalities

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- The types and number of minimally invasive or laparoscopic procedures increases each year
 - Minimally invasive techniques will replace 2/3rds of open surgical procedures
- Bariatric surgery reverses diabetes (72%), eliminates hypertension (62%) and reduces cholesterol (70%)
- Electron beam tomography (EBT) scanner
 - Used to perform “virtual colonoscopies”
 - Used to detect asymptomatic cardiovascular disease and other potentially life-threatening disorders



Non-Invasive Modalities

Technology...Changing How We Do Our Work...

- >20 million asthmatics (@ 14M adults + 6M children)
- Lack of asthma control creates excess cost of care per year
 - >10.4M unscheduled MD visits
 - >1,8M ER visits
 - >0.5M hospitalizations
 - >5,000 deaths
- Bronchial thermoplasty offers a more permanent treatment modality
 - Procedure takes @ 30 minutes under conscious sedation
 - Offers “permanent” treatment for chronic asthma
 - Unclear at this time whether or not thermoplasty will replace pharmacotherapy but safety parameters are under investigation



Societal economic + morbidity/mortality implications are HUGE...

Robotics

Tele-presence and tele-manipulation

- Patients receive benefits of a minimally invasive procedure
- Robotics decrease physician fatigue
- Fewer staff required in the perioperative suite
- Currently used for prostatectomies, hysterectomies and myomectomies
- Used in some cardiovascular procedures

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Robotics

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- Use of Robotics
 - Allows surgeons to operate on patients at another location – tele-surgery and tele-medicine
 - Remote presence replaces real presence due to shrinking number of healthcare professionals
- Robots of the Future
 - Johns Hopkins developing flexible, “snakelike” robot for procedures where space is minimal (e.g. esophagus)
 - Creates “steady-hand system” to control tremors of the hands = better results on microsurgery



Robotics Nurse Specialist Role

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- The Robotics Nurse Specialist
 - Transforms and enhances the OR by providing valuable nuggets of information that increases every ones knowledge about robotics and the delivery of care associated with robotic use
 - Ensures patient and staff safety by educating others and acting as a subject matter expert in the area of robotics
 - Works with physicians, OR staff and patients to boost acceptance of the use of robotics and to explain robotic equipment and associated instrumentation



Source: *The Evolution of Robotics in Surgery and Implementing a Peri-operative Robotics Nurse Specialist Role*, AORN Journal, Vol 83. Issue 3, p 629-632, March 2006

Robotics: Mathematical Models from Robotic Medical Tools

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- Johns Hopkins developing “language of surgery”
 - Adopting techniques from speech recognition (e.g. NLP) and physio monitoring technologies (e.g. athletic motion studies)
 - Applying them to motion recognition and skills assessment for surgical procedures
- Complicated surgical procedures broken down into component steps = processes
 - Use data to define the tasks
 - Evaluate efficiency of surgical movements
 - Eliminate components that reduce quality or disrupt outcomes
- Create models of effective surgical procedures and “teach” proper approach



Goal: To objectively evaluate a surgeon's work and help physicians improve their operating room skills

Biogenomic Engineering

Cytograft (Novato, CA) – Growing Blood Vessels through Biotechnology

- Fibroblast cells (backbone of blood vessels) extracted from postage stamp size biopsy
- Tissue placed in culture and cells grow into tissue sheets, which are manipulated into 3D structures
- Tissue = graft available in 6+ months – as an autologous match to the patient
- Uses:
 - Coronary Artery Grafts
 - Peripheral Grafts
 - AV Shunts



Example:

- 300,000 Americans have End Stage Renal Disease and vast majority treated w/ hemodialysis
- Treatment via fistula / shunt between an artery and a neighboring vein so blood can be rapidly exchanged through the dialysis filtration system
- Complications of AV shunts = leakage, clotting, infection, and collapse
- Synthetic AV grafts exhibit very low patency rate of 60% at one year and typical ESRD patient receives 2-3 shunts over the course of treatment.

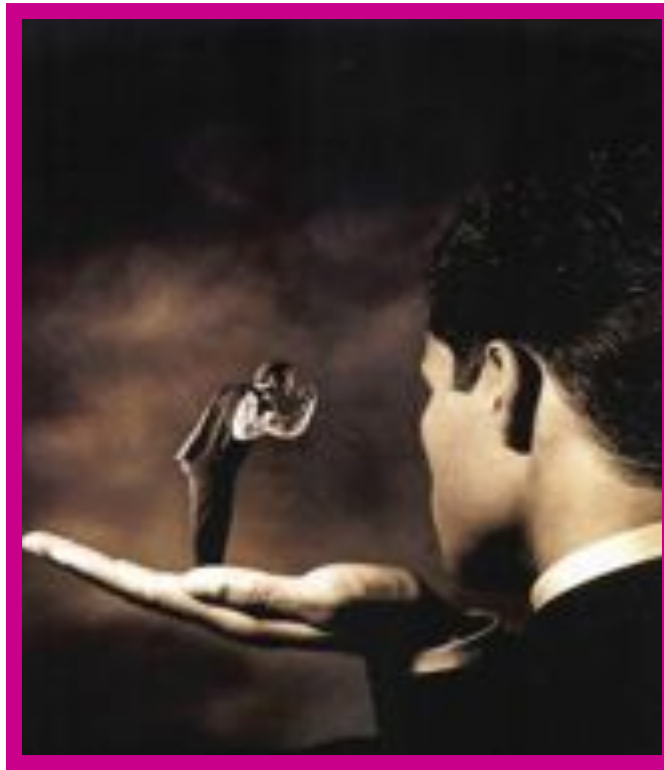
• **Cost = \$8000 per procedure**
\$25,000 with infection } **Medicare = \$4 – 5 Billion / year**

Plus...
a couple of
other ideas...

Knowledge Support and Diffusion

Decision Support...

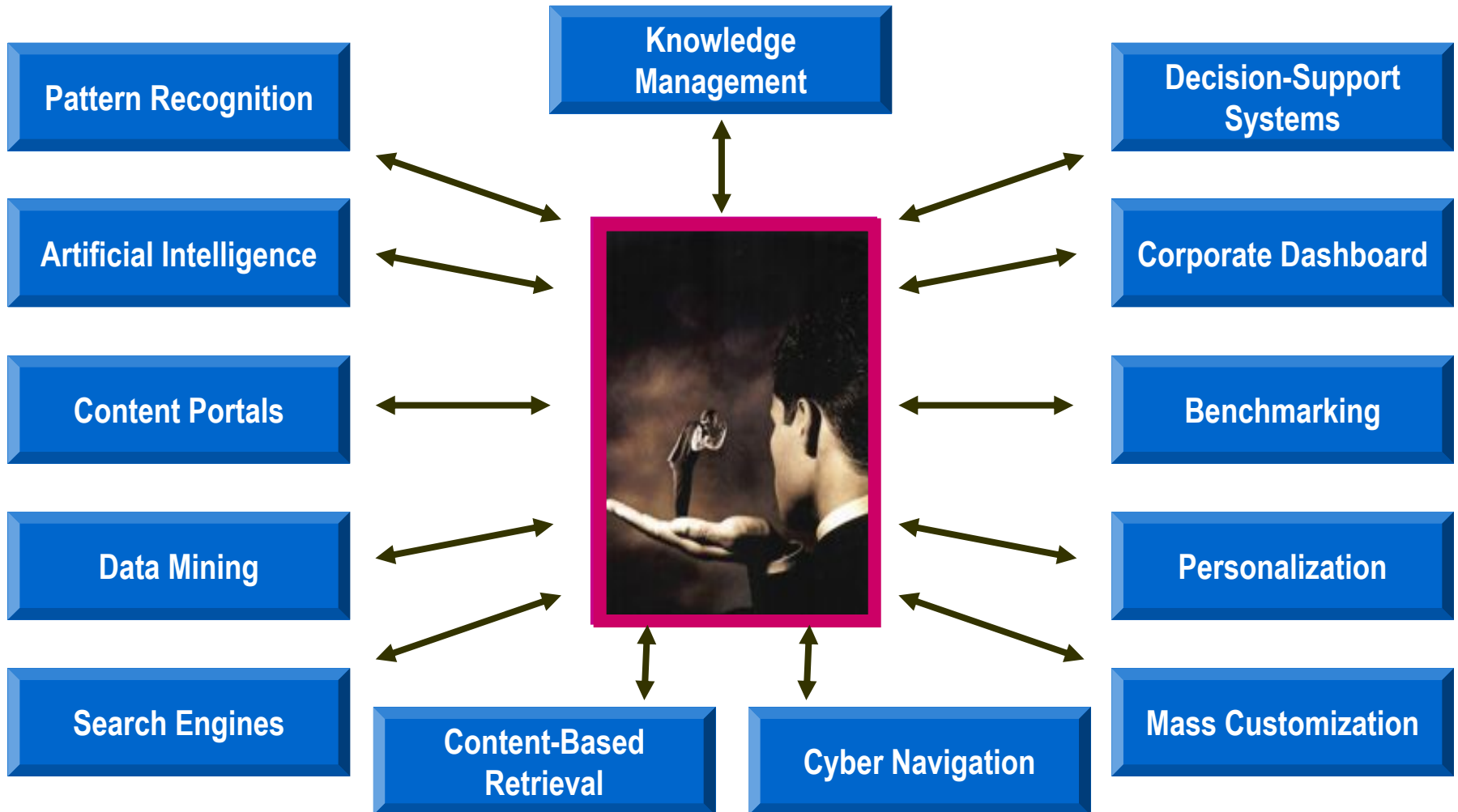
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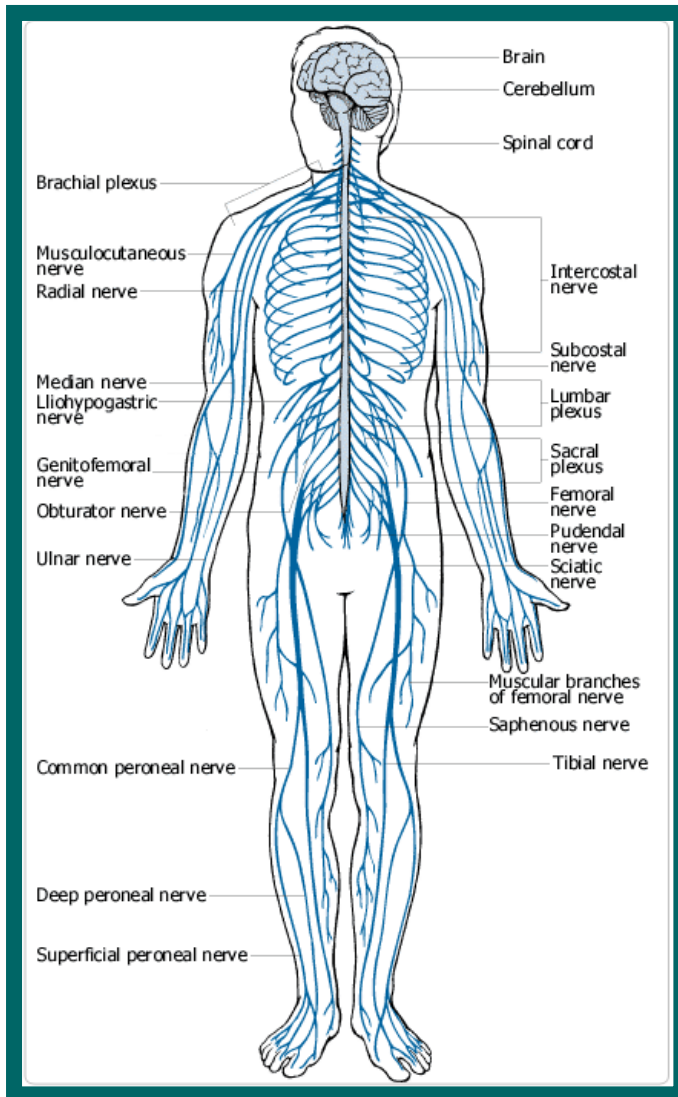
Knowledge Support and Diffusion

Continued advances in underlying computing power and the accompanying explosion in data volumes both enables and necessitates new, highly value-added ways to structure, manage, access, share, and present information.



Creating New Approaches...

Relief for spinal-injury patients and a procedure to make their lives easier



- Pioneered in China
- Purpose: To ease loss of bladder control
- Delicate procedure
 - Surgeon sutures two normally unrelated nerves together
 - Connects one nerve from the bladder to one from the thigh via a single stitch
 - Scratching the thigh would signal the bladder to empty
- Benefit: Release from catheters and result in fewer infections and other serious complications

Genomic Analysis to ID Patients with Postoperative Infections

Scientists could develop a bedside blood test that would greatly speed the diagnosis of post-surgical infection



- Post-surgical differential diagnosis between systemic inflammation and infection difficult
- Gene microarray analysis used to understand the biology of leukemia, lymphoma, and breast cancer used in distinguishing infection from systemic inflammation with 94% accuracy by determining level of mRNA in blood samples
- Bypass the usual cultures (blood, sputum, urine) in favor of a bedside blood test
 - Diagnostic speed
 - Efficiency
- Next step = bedside blood test to determine the infecting agent...



Critical Success Factors and The Perioperative Professionals Role in Emerging Technologies

Critical Success Factor — Connection

New technologies, new challenges, new mind sets

- New technology creates:
 - Challenged traditional roles...
 - Potential for...
 - Misunderstanding and misuse of technology
 - Haphazard communication if hand-offs and process are not clear
 - Increased need for more accurate and timely information
 - A new set of terminologies that are not known and understood by all participants in the healthcare field...



Critical Success Factor — Culture

Culture “eats strategy for lunch...everyday”

- Identifying and aligning stakeholders is crucial
 - The unique characteristics of the institution and the perioperative area itself must be considered
 - Continuous feeding and support of the desired culture is required to facilitate acceptance of emerging technologies within the perioperative area

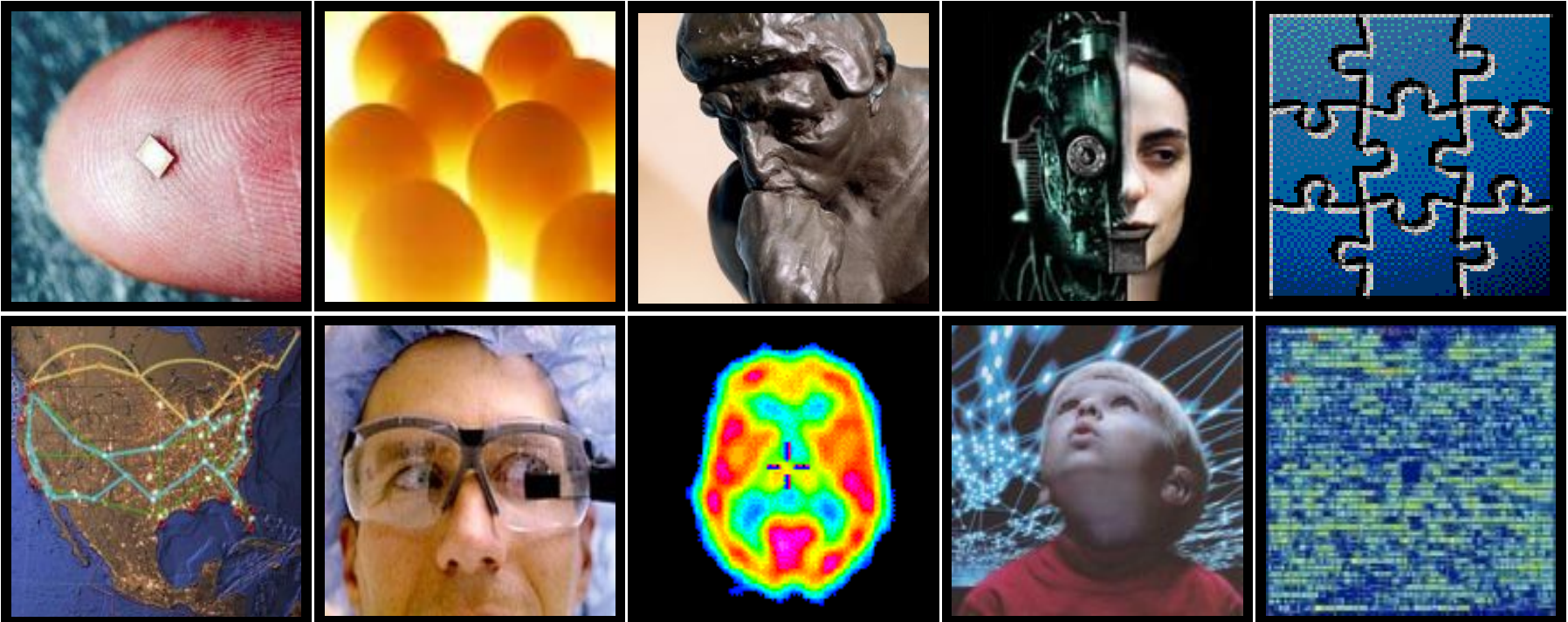


Critical Success Factor — Commitment

- Commitment by the entire perioperative team must be visible and palpable
 - Strong sponsorship and commitment is required
 - Representation from the perioperative team regarding emerging technologies and their use is critical



Satisfaction – when I want it...
Outcomes – with the results I want...
Value – at the right cost





A Final Thought



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