Abstract: Resources needed for travelling the path of any sustainable journey consist of knowledge, infrastructure, ability, energy, mindfulness, and optimism. Technology has made great contributions to knowledge, infrastructure, and energy. What sort of new devices and applications will provide the other resources? Can sensors cheer us up when we are down? Help us release stress? Can sensors nudge us if we are losing sight of our journey?

Age of Mindfulness: Technology as Guide and Mentor?
April 6, 2012

The Series will also be available for viewing on YouTube at: http://www.youtube.com/user/EECSatUM

Refreshments will be available!
Engineers/Humanists/Entrepreneurs ... all Welcome!
Semiconductor based technologies have transformed societies.

Cell phones, internet, laptops, tablets, GPS, …it seems we cannot live without our gadgets …. almost like food and water!

Where are needs still unmet?

Focus on intelligent technologies driven by semiconductors and other sensing materials.
Technology March
Where Does the Drive Come From?

Survival

Warfare

Search for truth: Space exploration

Entertainment

Economy: Jobs, efficiency
Technology Drivers

Telecommunications

Military

Entertainment

Video-gaming

Healthcare diagnostics

Aerospace, Transport
Military has been a major driver of technology:

Guidance/Homing System
Lasers
Microwave transistors:
Radar, Receivers
IR detectors
Night vision
Healthcare industry has been important in driving technology:
US Market: ~ $2 Trillion

Diagnostics: MRI, Catscan,…
Entertainment

Video Gaming

Movies

Internet video

High performance video chips, processors
Digital cameras
High density displays
Sustainable Good Life as a Driver?

✧ Energy Needs & energy sources: Constrained
✧ Globalization of economy: Human cogs
✧ Everyone wants a Good Life: Democracies
✧ Information Age and Robotics: What do humans do?
✧ Healthcare for rich and poor: Population demographics
Individual Wellness as a Driver?

Knowledge and Ability: Understand the path I want

Physical Safety: Safe from injuries, accidents, disease

Environmental Safety: Water, food, air,…

Awareness of culture around me and its impact

Self-Awareness: Know myself

What can technology do?

Remove the gap between my knowledge and action

Jasprit singh
## Individual Wellness

What can technology do?

### Leading causes worldwide

Leading causes of preventable death worldwide as of the year 2001.\(^2\)

<table>
<thead>
<tr>
<th>Cause</th>
<th>Number of deaths resulting (millions per year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension</td>
<td>7.8</td>
</tr>
<tr>
<td>Smoking tobacco</td>
<td>5.0</td>
</tr>
<tr>
<td>High cholesterol</td>
<td>3.9</td>
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<tr>
<td>Malnutrition</td>
<td>3.8</td>
</tr>
<tr>
<td>Sexually transmitted diseases</td>
<td>3.0</td>
</tr>
<tr>
<td>Poor diet</td>
<td>2.8</td>
</tr>
<tr>
<td>Overweight and obesity</td>
<td>2.5</td>
</tr>
<tr>
<td>Physical inactivity</td>
<td>2.0</td>
</tr>
<tr>
<td>Alcohol</td>
<td>1.9</td>
</tr>
<tr>
<td>Indoor air pollution from solid fuels</td>
<td>1.8</td>
</tr>
<tr>
<td>Unsafe water and poor sanitation</td>
<td>1.6</td>
</tr>
</tbody>
</table>
Wellness: How do we Achieve it?

Technology has primarily provided knowledge and infrastructure

Physical Wellness:
Medicine: Diagnostics Chemicals Surgery

Mental/Emotional Wellness:
Medicine: Psychiatrist Psychologist

Knowledge-Action Gap:
Behavior modification therapies
Intelligent Technologies
Almost Magical
- **Electric field detection**: Digital and analog electronics
- **Photon-Electron Interaction**: Light emitters, LEDs, Lasers, Displays, Detectors, ...
- **Energy conversion**: Solar energy to electricity
- **With piezoelectric materials**: Force sensors, ..
- **Merger with new materials**: Opportunities!
Technology: Devices that form the building blocks

- Transistor
- Laser, Light emitters, Light Detectors
- Touch Screen, force sensors
- Liquid Crystal Display
Digital Logic

Functionality will double every 18 months
Technology Today

USE OF POLAR HETEROSTRUCTURE FOR MULTI-FUNCTIONAL DEVICES

Traditional “voltage” sensor FET

\[ g_m = \frac{\Delta I_D}{\Delta V_G} \]

Pressure sensor FET

\[ g_m = \frac{\Delta I_D}{\Delta P_G} \]

Temperature sensor FET

\[ g_m = \frac{\Delta I_D}{\Delta T_G} \]

POLAR OXIDES + SEMICONDUCTORS
Digital Logic

Boolean Algebra for digital technology
Technology can instantly enhance ability

In societies with less developed infrastructure technology provides unique opportunities for enhancing lifestyle.
New Materials!

Beyond Electric field
Force,
Temperature, light, …

Magnetic fields,
Individual molecules,
Pathogens, …??

Currently detected by chemistry,
mass spectroscopy, dogs!

Carbon nanotubes
Graphene
Wellness as a Technology Driver?

A. Physical Safety: Safe from injuries, accidents,…

B. Mindfulness: Remove the gap between my knowledge and action

C. New Devices: Sensors for chemicals, pathogens, environmental safety Terahertz Devices

D. Self-Awareness: Know myself
   Awareness of culture around me and its impact
   Efficient techniques for stress release,…

A and B are easier: Technology exists

C and D require new technologies
Wellness As A Technology Driver: Accidents When we know why things happen

Physical Safety: Safe from preventable injuries, accidents,…

- Car crashes: $200 billion
- US: 35,000 lives
- Worldwide 1.2 million lives
Accidents: Asymmetry in the arrow of time

Safety driven technology: Technology is already here; Impact is like bringing clean water or roads to a community

Challenge: Not “sexy”; No heroics involved; comfort through inertia, acceptance of status

✔ Can make cars essentially immune to accidents;
✔ Can make power-tools immune to accidents
✔ Can make firearms immune to accidents

Semiconductor manufacturing ensures costs of technologies ~$100
Where can Technology Impact?

Leading causes of accidental death in the United States

US: Cost of car accidents ($200 billion) is almost 50% of new car sales revenue
Remove Accidents: Technology Exists

Nearly all anticipated accidents can be eliminated through today’s electronic technologies.
Existing Technologies

Car can turn the text device off

GPS: Minimize extra time/energy

Backup camera: Avoid catastrophes

Ignition Lock
Volvo's low speed accident prevention system

Human response time
20-100 Milliseconds: A car may go several feet in this time.

Technology Response time
Micro to nanoseconds
Knowledge-Action Gap

In some areas of our lives technology is used to help us stay mindful or to protect us from lack of mindfulness

- Intensive Care Units (ICUs) has lights and alarms that monitor patients and make staff aware of emergencies

- Alarms/clocks keep us on schedule

- Flashing signs, sirens inform us of danger, ....
Knowledge-Action Gap: Mindfulness

Before: PC, Internet, ... information was in the hands of big entities, ...
The PC Revolution: Bring the power of information to the individual

Now: Wellness is in the hands of the medical business. Yet 80% of the visits to the physician is for lifestyle related problems.

Technology bring wellness control to the individual? Behavior change?

Technology alters our behavior
Close the Knowledge-Action Gap

Observe our “mood”: Posture, breath, voice, and provide us suggestions

The flight simulator can change the pilot’s behavior
Technology is known to create products that change people’s behavior:

Internet surfing, smart phones (texting, browsing); games; social networks, apps …
Technology can play a role in enhancing mindfulness
Prepare our brain for modern stresses:

- Workplace posture
- Workplace demands
- Fear of failure, loneliness…
- Financial challenges,
- Mindful driving
C. Where can Technology Impact?

Most molecules have signatures in the terahertz regime

Detection mostly depends on chemistry or mass spectroscopy
Chemical Detection

Mass spectroscopy

The abandoned puffer
Coming to airports: TSA will swab passenger hands for explosives

The TSA announced Wednesday that it will begin random swabbing of passengers’ hands to check for signs of explosives.

By Ron Scherer, Staff writer / February 17, 2010

Air travel security - Luggage scanners, pat-downs, and specially trained K9s are all familiar to frequent air travelers, but starting soon, TSA officials will also be swabbing randomly selected passengers’ hands for trace signs of exposure to explosive materials.

Ben Margol/AP/Pool

Semiconductor chemical sensors: Semiconductor spectroscopy for molecules
Personal Wellness: My food, my environment, my diagnosis

HETEROSTRUCTURES FOR MULTI-FUNCTIONAL DEVICES

Chemical Sensors

Gate, surface chemistry

\[ g_m = \frac{\Delta I_D}{\Delta V_G} \]

Human "health" sensors

NEW MATERIALS + SEMICONDUCTORS
D. Self Awareness
Stress Release, Relaxation

Help awaken higher senses?
Meditative techniques
Efficient Relaxation techniques
Human mind remains primitive
Stress lingers long after its positive benefits

Mind remains in a ruminating state

Mind wanders into dark thoughts

Can technology interrupt us periodically and take us through techniques to bring us to an brighter state?
Without chemicals?
Self Awareness
Stress Release, Relaxation

Meditation tools implemented with help of technology

Brain activity sensors:
High sensitivity magnetic wave detection
Breath pattern detection

Nudge us with suggestions!

Jasprit singh