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RESEARCH METHODOLOGY
RESULTS & DISCUSSION
FINDINGS
RECOMMENDATIONS/SUGGESTIONS
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EVALUATION OF THE REALIZATION OF SCIENTIFIC SPECULATIONS ON FUTURE ADVANCEMENT IN COMPUTER TECHNOLOGY

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ABSTRACT

Scientific predictions on the future of computer technology are based on success and collapse of Moore's law of computing (computing power doubles approximately every two years). This study is a qualitative evaluation of the speculations under the umbrella of Ubiquitous computing. The paper evaluates the realization of the speculations Vis-à-vis the laws of physics, laws of economics and in relation to systems, sensors, and experience. It also identifies and analyzes the successes, failures, major imperfections in those seemingly wild prophesy. The study concludes that the laws of quantum physics and economics favor the remarkable developments in Ubiquitous computing. Complete Ubiquity is not yet materialized when evaluated from the perspective of systems, sensors and experience.

KEYWORDS

Ubiquitous, Miniaturization, Photolithography.

INTRODUCTION

Scientists have been involved in speculating the future of computing technology. Predictions made by professional scientists rely on two solid foundations: fundamental laws of science and prototypes of existing technologies.

Short term predictions on computer technology (Which span a time frame of 30 to 50 years in to the future) scientists have provided so far depend on the success of Moore's law of computing.

The following major speculations have been profiled:

1. Ubiquitous computing: Computers will become so small, invisible, everywhere, and nowhere, so powerful that they will disappear from view.
2. The Disappearing PC, smart Office and home, wearable computers, and wall screens.

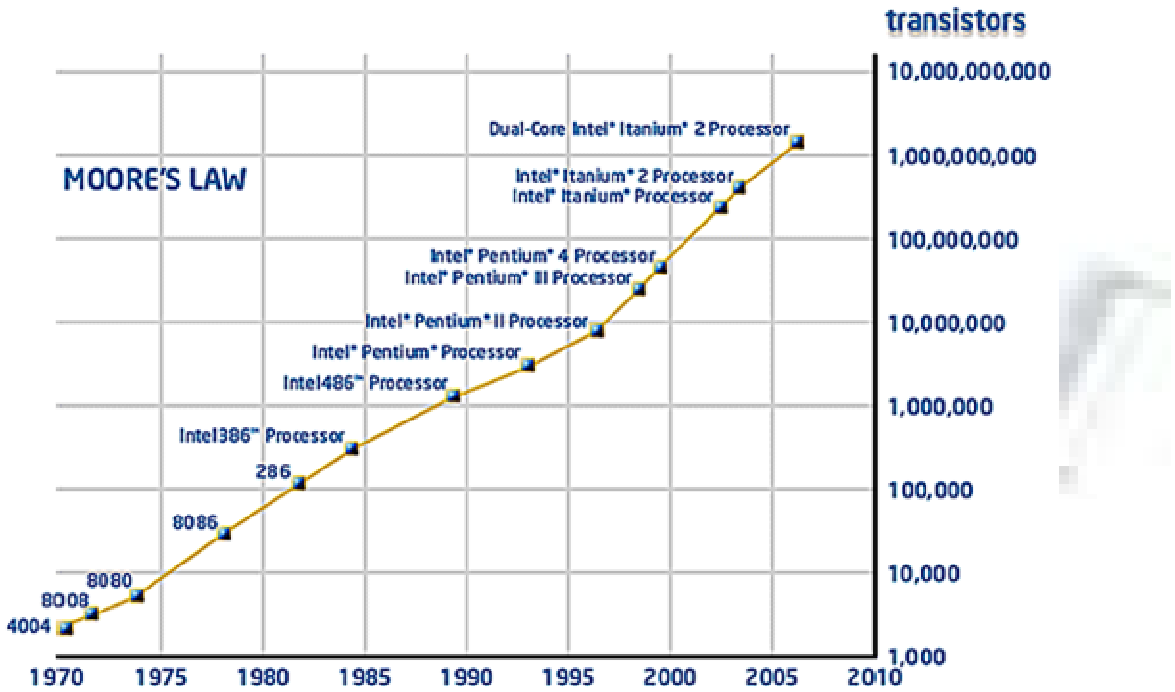
The disappearing PC (When technology advances, people cease to be aware of the presence of machineries around) is a direct consequence of Ubiquitous computing .Smart office and home of the future were envisioned to be made of a number of tabs, pads, and boards (major elements of Ubiquitous computing).Prototypes of the then envisioned wearable computers (merger of cellular phones with the lab top computer) were derivations of ubiquity.

A critical look at the aforementioned speculations reveals that they are either derivations or amplifications of Ubiquitous computing. Evaluation of Ubiquitous computing is tantamount to evaluating the major speculations in computing technology.

THE PHYSICS BEHIND MOORE'S LAW OF COMPUTING

Moore's law of computing which states that computing power doubles every eighteen months have been so successful in quantifying the growth rate of computing technology. Moore had predicted the increase in the number of silicon components that can be crammed on a chip, the dramatic decrease in the cost of transistors, and the increase in the speed and power of computers. Moore's original statement can be found in his publication.[1] The number of transistors on integrated circuits doubles approximately every two years implies a proportional rise in Processing speed, network capacity, storage capacity, number and size of pixels in digital camera, and computational performance.

GRAPH 1: MOORE'SLAW: GRAPH SHOWING MICROPROCESSOR TRANSISTOR COUNTS, YEARS OF INTRODUCTION, COMPANIES INVOLVED



Source: http://declineofscarcity.com

Two quantum mechanical devices (Transistor and Laser) take a lion's share in materializing the origin and advancement of computing technology.

TRANSISTOR AND LASER

Transistor is a valve that controls and regulates the flow of electricity. It also amplifies weak electrical signals. The presence of discrete energy levels in semiconductors has made possible the creation of the most dazzling display of light known as LASER. The LASER (Light Amplification by Stimulated Emission of Radiation) is a quantum mechanical device, an instrument which produces intense beams of light which are monochromatic (extremely pure wave length compared to other sources of light), coherent (light beams which vibrate in exact synchronization with each other), and highly collimated. Laser is made possible by manipulating the electrons making quantum jumps between orbits within an atom. By exploiting a quantum mechanical effect called stimulated emission, lasers generate a coherent, nearly monochromatic beam of photons.

Moore's law of computing is based on the miniaturization of transistors in to smaller sized chips through the technique of photolithography.

MINIATURIZATION OF TRANSISTORS THROUGH PHOTOLITHOGRAPHY

Photolithography is a standard method of microprocessor fabrication or chip manufacturing. The process of Photolithography involves beams of Laser light to make microscopic grooves and lines on silicon wafers. Light is shined through a series of layers each called a "mask," which is placed over a silicon wafer. The light beam focused through the mask imprints the pattern on the wafer.

The process is repeated for a series of layers molding multilayer features of the chip containing wires and transistors on to silicon wafers.

Laser beams from a mercury lamp, which have wavelengths .436 micron (in the visible range) and .365 micron (in the ultraviolet range) have been widely used in Photolithography. Current use of excimer lasers (wavelengths of 248 and 193 nm) has enabled minimum feature sizes in chip manufacturing to shrink from 500 nanometers in 1990 to 45 nanometers and below in 2010.

The increase in the speed and power of computation depends on the miniaturization of transistors in to smaller sized chips. This demands the use of smaller and smaller wave lengths of laser beams for photolithography.

UBUIQUITOUS COMPUTING: SPECULATIONS

Mark Weiser, former head of the computer science laboratory of Xerox PARC in his article written for scientific American magazine 'The computer for the 21st century' envisioned ubiquitous computing:

"Ubiquitous computing names the third wave in computing, just now beginning. First were mainframes, each shared by lots of people. Now we are in the personal computing era, person and machine staring uneasily at each other across the desktop. Next comes ubiquitous computing, or the age of calm technology, when technology recedes into the background of our lives.'' [2]

Weiser envisioned that: Computers will become so small, invisible, everywhere, and nowhere, so powerful that they will disappear from view. He explained that such a disappearance is a fundamental consequence not of technology, but of human psychology and whenever people learn something sufficiently well, they cease to be aware of it.

Ubicomp, for Weiser, was a stage into which we would advance, where 'machines that fit the human environment instead of forcing humans to enter theirs''

"Ubiquitous computers will also come in different sizes, each suited to a particular task. My colleagues and I have built what we call tabs, pads and boards: inch-scale machines that approximate active Post-It notes, foot-scale ones that behave something like a sheet of paper (or a book or a magazine), and yard-scale displays that are the equivalent of a blackboard or bulletin board." Weiser, 1991.

ACCORDING TO WEISER

- Inch Scale Tabs: Tabs are tiny, inch sized clip –on badges that employees can wear which are interconnected and can identify themselves to receivers placed throughout a building, thus making it possible to keep track of the people or objects to which they are attached.
- Foot Scale Pads: Pads are foot-sized intended to be 'scrap computers' (analogous to scrap paper) that can be grabbed and used anywhere; they have no individualized identity or importance.
- Yard-size displays (boards) serve a number of purposes: in the home, video screens and bulletin boards; in the office, bulletin boards, whiteboards or flip charts. A board might also serve as an electronic bookcase from which one might download texts to a pad or tab.

Michio Kaku in his book 'Visions' had speculated a range of time frame for the actualization of Ubiquitous computing: "…It may take until the year 2003 to begin to see these ideas affect our lives in an appreciable way. And it may be years after that before they reach "critical mass" and ignite the marketplace. But by 2010, one can expect to see ubiquitous computing becoming of age. By 2020, it will dominate our lives.'' [3]

UBUIQUITOUS COMPUTING: CURRENT STATUS

Careful consideration and observation of present day technology shows that the following are ubiquitous and similar to those speculated by MARK Weiser:

1. INCH SCALE TABS: The following are some of the devices similar to the envisioned tabs:

- **Smartphone** (is personal, portable, stores data, interacts with "the cloud", keep us in touch with remote services, reports on locations, and accesses a ubiquitous data network). **Cell phones**, **I-phone(Apple I phone)**
- **Smart dust** best exemplified by sensor motes(allow more sensing capability in a smaller package)
- **Sifteo cubes (**used for entertainment and education and capable of interacting each other).
- **Active Badges: RFID** badge(can communicate with receivers, notify its own location, and locate peoples location)

2. FOOT SCALE PADS: The following are some of the devices similar to the envisioned pads:

Modern lab tops, Apple's iPad, **Samsung's Galaxy Tablet, a medical imaging playback device (**enabling doctors and medical staff to access scans wherever needed), **Modern electronic books (like Sony e-reader, Amazon Kindle)**

3. YARD SCALE BOARDS: **Microsoft table, Smart Board**, **Promethean**, **Hitachi's StarBoard**, **Smart walls** that can download data to other devices over the network.

COMMERCIAL DEPLOYMENTS

The following links show the commercial offerings of such inch scale, yard scale, and foot scale computers.[5]

INCH SCALE

i'm Watch: http://live.imwatch.it/, Radianse ID Tags: www.radianse.com/products_tags.html
MOOG Crossbow motes: www.xbow.com, Sifteo cubes: www.sifteo.com
Active Wave RFID Active Tags: www.activewaveinc.com/products_active_tags.php
Arch Rock motes: www.cisco.com/web/about/ac49/ac0/ac1/ac259/archrock.html
Fruition Sciences sensor nodes: http://fruitionsciences.com,

YARD SCALE

Amazon Kindle: https://kindle.amazon.com, Apple iPad: www.apple.com/ipad
Samsung Galaxy: www.samsung.com/us/mobile/galaxy-tab,
Deploid Tablet PC Menus: www.deploid.com/tablet
Barnes & Noble Nook: www.barnesandnoble.com/nook
Jeppensen Mobile FlightDeck:http://ww1.jeppesen.com/apps/mobilefd

FOOT SCALE

SmartBoard: http://smarttech.com
Promethean Activ Classroom: www.prometheanworld.com
Hitachi StarBoard: www.hitachisolutions-us.com/starboard
Cisco Tele Presence: www.cisco.com/en/US/products/ps7060
Polycom Real Presence: www.polycom.com/products/hd_telepresence_video
AdSpace Digital's Mall Network: www.adspacenetworks.com/index2.php
Appliance Studio Print Sign: www.ambientweb.co.uk/sectors/smartsigns.htm

DISCUSSION

1. REALIZATION OF THE SPECULATIONS VIS-À-VIS THE LAWS OF QUANTUM PHYSICS

Ubiquitous computing bases itself on the success of Moore's law of computing. The secret of success of Moore's law depends on the possibility of using finest wave length laser beams to cram hundreds of millions of transistors on to a microprocessor and that of placing unlimited amount of information on a laser beam.

- The following Laws of quantum physics are in action in the the realization of tabs, pads, and boards, the Disappearing PC, the mushrooming of wall screens, and generally the remarkable developments in ubiquitous computing: *Energy quantization, wave particle duality, and a quantum mechanical effect called stimulated emission.*

However, miniaturization of transistors is only possible up to the famous point one barrier (Silicon components can't be shrunk below point micrometer).The laws of quantum physics allow this miniaturization up to the point one wave length limit and will impede the complete fruition of Ubiquitous computing.

- The following Laws of quantum physics are formidable challenges to the ultimate fruition of Ubiquitous computing:

Quantum Tunnelling: transistors will be so small and electrons leak out of the wires.

The Uncertainty Principle: At the atomic level electrons can't be confined in ultrathin wire, leaks out causing short circuit.

2. REALIZATION OF THE SPECULATIONS VIS-À-VIS THE LAWS ECONOMICS

The laws of economics (relentless decrease in the price of microprocessors which is the financial incentive to include microprocessors everywhere)

Decrease in the cost of microchip. When the price of a microchip is just one penny, the financial incentive to include everywhere rises. This is in favour of the assimilation of computing technology in to the background of our lives and the embellishment of Ubiquity as envisioned.

3. REALIZATION OF THE SPECULATIONS VIS-À-VIS SYSTEMS, EXPERIENCE AND SENSORS: (SMART PERSONAL ENVIRONMENTS, QUANTITY COMPUTATIONAL DEVICES, MACHINE CONNECTIVITY, DISAPPEARANCE OR INVISIBILITY, AND AVAILABILITY).

THE INCH SCALE TABS

Today's inch-scale machines are almost ubiquitous. However, there are mixed results in achieving the ubiquity envisioned. The vision was that to be used as badges for sensing or controlling our environment. Most of them are beyond badges mainly used for entertainment, personal productivity, and communication. (Example: wristwatch computers, sensor motes, MP3 players, and handheld games).Existing active badges are not widely used in business as envisioned because of the issue of privacy but have found applications in industries that consider safety as top priority. Smart and mobile phones have achieved the goal of ubiquity.

FOOT SCALE PADS

Today's Foot scale machines are not yet scrap computers as envisioned. They are typically personal devices owned and operated by individuals. The vision on scrap computers to be grabbed and used anywhere (not to be carried from place to place and not needing to be charged for days) is not yet materialized and seems an impossibility seen from the perspective of infrastructure and hardware.

No smart computational environments and scrap computers as predicted. Information still is available through personalized and highly specialized devices.

YARD SCALE BOARDS

Several companies today manufacture yard scale displays similar to those envisioned. They are being used for interactive teaching and support team collaboration.

QUANTITY COMPUTING, PRIVACY, AND INTERCONNECTIVITY

- The issue of quantity computing (one possessing a large number of devices) has not yet been materialized. This can be actualized when there is no more possibility to extract better quality. Users prefer few number of quality devices than more number of less quality. Imbalance in quality and quantity computing: quality computing not capitalized.
- The issue of privacy not seriously addressed. The question of transmitting, storing, and accessing personal data remains a challenge.
- Ubiquitous computing devises are largely disconnected from one another and with the environment. They are rather connected to a carriers or enterprises infrastructure.

CONCLUSION

1. Most of the speculations were actualized because they were firmly based on solid scientific laws and proto types of existing technologies. The remarkable developments in Ubiquitous computing mainly rely on the laws of quantum physics in action. Further progress and complete fruition of Ubiquity is again impeded by the laws of quantum physics. The laws of economics (The relentless decrease in the cost of a microchip) favor the integration of computing technology in to the background of our lives.
2. As seen from the perspective of systems, experience, and sensors; Complete Ubiquity is not yet fully actualized. User's preference of quality to quantity, the challenges of privacy issues, the fact that devices are still disconnected one another…etc show incompleteness to the full success of the speculations. Given the span of the time frame for short term predictions, there are speculations not yet materialized and are unlikely to be actualized in the upcoming five years.
3. A number of Giant software and hard ware companies have used the ideas of speculations to develop new computing devices and technologies. The speculations have been commercialized and used to boost the wealth of nations. The predictions have changed the way we socialize, communicate, learn, and play.

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