Return-Path: <sfiorill@estec.esa.nl>
From: sfiorill@estec.esa.nl
X-Lotus-FromDomain: ESA
To: cenintaf@ccs.sut.ac.th
Date: Fri, 11 Jun 1999 21:28:12 +0100
Subject: ISU SSP'99 - Business & Management Department - Visit to Japanese
        firm on August 5, 1999 pm / Dept. Activity Day on August 9, 1999
Content-Disposition: inline

Dear Ruben,

How are you ?

As I think to you at this time (9,00pm!) of this Friday evening, I imagine
that the "fever" must be quite high in Nakhon Ratchasima, with so few days
left before the start of the session. You must be all very busy with a lot of
small and more substantial issues. But you will see : I am sure that, as
every time, this will all turn out to be a unique experience.
As far as I am concerned, I know already that I will learn far more than I
will be able to "teach" and the main feeling I have when thinking to this
experience is "humility". Yes, I am praparing myself to discover your country
and your culture with humility and respect.

The only problem I have, my dear Ruben, is that I am still so busy here that
I hardly find the time to "think ISU". I was doing so the last days, and
amongst the various things I would like to be 100% sure about, are the
practical arrangements for the two events described below.
I know that we already exchanged some e-mails on this. I know also that I
probably should not disturb you with that kind of issues. Please accept my
apologies to have done so, and feel free to "re-direct " my querries to Pim,
or to whoever will be so kind to provide me with the re-assurance I am
looking for.

1. Visit to a Japanese firm (plastic manufacturer?), on August 5, 1999

You may remember that I plan to use Workshops 10 and 11, in the afternoon of
August 5, 1999 to visit whatever company could have an interesting programme
for students of the Business & Management department.

You indicated to me at the time the possibility of some Japanese company. I even remember vaguely you referring to a "plastic manufacturer" ...
The question I have is whether you are in a position to confirm to me or otherwise whether arrangements have been made in that respect, and, if any, to provide me with some information on the company in question.

2. Departmental Activity Day, on August 9, 1999

Here again, I refer to discussions we had and e-mails we exchanged following the suggestion you had made to me in Strasbourg for a typical programme for my Departmental Activity Day :

    a) morning : visit of the Sea-Gate
    b) lunch : pic-nic to the near-by lake and reserve
    c) afternoon : Visit of the Jim Thompson silk factory

Here also, the question is whether you have been in a position to make the necessary arrangements so that I am not facing last minute misunderstandings.

I hope you will forgive me for this long note.

I will arrive in Nakhon Ratchasima on August 28, 1999 after having left my wife at the Bangkok Airport, from where she will fly back in Europe to come and take care of our three children. From July 18 until August 27, we will have discovered your country, through a tour which will have brought us from Bangkok to Chiang-Mai.

I am, very sincerely, looking forward to seeing you again.

Stefano

Return-Path: <PDiamandis@aol.com>
From: PDiamandis@aol.com
Date: Mon, 28 Jun 1999 21:11:01 EDT
Subject: ISU/Peter Video
To: cenintaf@ccs.sut.ac.th

Dear Ruben-
Thank you again for an amazing, friendly and wonderful experience!
Is it possible to get a video copy of the opening ceremonies that includes my
speech? If yes, pls send it to me at the following address:

Peter H. Diamandis
10721 Gloxinia Drive
Rockville, MD 20852
Tel: 301-468-5554

NTSC/VHS if possible, if not, then i'll have it converted in the States.

Thank you again!
-Peter

Return-Path: <PDiamandis@aol.com>
From: PDiamandis@aol.com
Date: Mon, 28 Jun 1999 21:13:52 EDT
Subject: Peter's ISU speech
To: cenintaf@ccs.sut.ac.th

Ruben-
Here's a copy of my speech as you requested.
thanks for everything!
-Peter

Attachment Converted: C:\EUDORA\ISU'99~1.DOC

ISU '99 Summer Session
Invocation Address -- 28 June 1999
The Future of Humanity
by Dr. Peter H. Diamandis
ISU Founder & Trustee

It's been said that you should be keenly interested in the future because you are going to spend the rest of your life there.

Today I plan to make my speech about the future of Humanity. While you are going to spend your summer focused on Space Exploration, Development and Technology, I am only going to discuss space only a small amount during the next 45 minutes and instead speak about the technology revolution which is impending in the decades ahead. As I hope to show you, space will play an important part for humanities survival, growth and expansion.

My goal here is to challenge the way you are thinking about the future and to push the limits of your pre-concieved notions of humanity.

This lecture is based on a book I've been writing for some years. The full context of this lecture should take a weeks to give, so I'll try my best to deliver it in something a bit quicker.

CHAPTER 1: THE DIGITAL LOOKING GLASS

"Some men see things as they are and say 'Why?'
I dream things that never were, and say, 'Why not'?"
          -George Bernard Shaw

Human knowledge and capabilities are growing exponentially. Far faster than our ability to handle the awesome power being unleashed to each and every individual. Humanity has made more progress in the past hundred years than we did in the thousand years that proceeded. We will make more progress in the next ten years than we did during the last century. Human knowledge is doubling every ten years, computer power is doubling every eighteen months, the internet is doubling every year. The rate of growth is awesome, inspiring, risky and unstoppable.

What the average child can do today, would have appeared god-like to any of our ancestors a mere hundred years ago.

Can you imagine what a child might be able to do in 10 years time that would appear magical to you?

Imagine being able to know anything you wish… instant knowledge on any subject… recall any fact… ask any question and have it answered instantly. Imagine being able to have your consciousness projected to any corner of the globe. How about having your literal thoughts converted into matter. Live forever… travel to the planets… The human race is about to transform itself into something wonderful and very different from what we are today.

This transformation is inevitable for two important reasons:

first, there are more and more minds on the planet thinking up brilliant ideas, identifying problems and inventing solutions. The population today is almost 6 billion compared to 2.5 billion on 50 years ago and only 250 million only two hundred years ago. Second, all of these minds are building upon the accomplishments of the past. A scientist today's has one-billion times the processing power of a scientist 50 years ago! The exponential growth of human brains on this planet, compounded by the exponential growth of technology, specifically information technology, is unleashing a future beyond our wildest dreams.

How will this technology effect society?
In the past, new technologies have toppled long-standing cultures, creating a new balance. The printing press lead to the widespread distribution of the bible and thereby Christianity. The timepiece allowed the British Empire to conquer the seas and spread the English language and their system of governance around the world. The telescope shifted humanity from the center of the Universe, to an existence on a small planet circling a small and average star.

In the 15th century, the Renaissance was a time of rebirth and revival. During this last stage of the Middle Ages, a repressed society gave birth to classical learning and art. This period laid the ground work for exploration of the Earth, the heavens, philosophy and all fields of science and culture.

Today, we are on the cusp of yet another, far greater, renaissance, which is being lead by the explosive growth of a five key technologies each of which are undergoing simultaneous exponential growth. It is these five areas I wish to discuss today.

As Oliver Wendell Holmes said, "One's mind, once stretched by a new idea, never regains its original dimensions."

Today I would like to stretch your minds... a lot!

As we discuss and predict the future, remember that the most learned leaders of our society have typically guessed wrong whenever they ventured to limit human ingenuity. Following are just a few examples of statements made by certain prominent individuals who would rather have history forget.

In 1904, Lord Kelvin, President, London's Royal Society, said
"Heavier than air flying machines are impossible"
"Radio has no future" ...
"X-rays are a hoax"

In 1923, Robert Millikan, Nobel Prize in Physics, said
 "There is no likelihood man can ever tap the power of the atom."

In 1899, Charles Duell, Commissioner, U.S. Patent Office, said
"Everything that can be invented has been invented."

Change is never easy. In the renaissance which is approaching whole ways of life and livelihood will disappear, and new ways of living and learning will be created. Its hard to appreciate how much change we all accept on an incremental basis... one miracle at a time. To appreciate the level of change which we take for granted, just imagine yourself explaining life today to someone alive in 1900:
Wireless, mobile communicators
Cars that talk to you, and direct you by GPS
A global electronic banking system
Global jet passenger service
The atomic and hydrogen bomb.
Cures to thousands of diseases... heart transplants
A life expectancy past 80 years old

A global population of 6 billion
We've walked on the moon
The computer and the World Wide Web
The color TV showing world news around the clock
The Compact Disk!
Genetic Engineering
Human Cloning!

Today I will speak briefly about five key technologies
Information Storage & Processing (Computers),
Human Interface
Communication Networks
Nano-technology,
Genetic Engineering

How do we handle the Dangers?
For each positive aspect of technology there are invariable negative consequences. Since the taming of fire, flames have been used to preserve life or destroy it. One of the most concerning aspects of the approaching revolution is the amount of power, both creative and destructive, that will be concentrated in the hands of individuals. We truly live on a single fragile planet and until we can move some of humanity into space we have, to use an English term,
"All of our Eggs in one Basket."

By my nature I am an optimist, but I also know that since the discovery of fire, every technology brings a balance of good and bad, salvation and disaster. When the famous physicist Richard Feynman observed the detonation of the atomic bomb over Hiroshima Japan he became profoundly depressed. He stopped working. He was convinced that the end of the world was near. How could humanity possible help from destroying itself when such destructive power was available? Yet we have survived. There is no doubt in my mind that we live during the most exciting and delicate segment of humanity's short 40 million year history.

In 1980 few people had ever touched a computer. Ten years later, in 1990 the number of businesses and individuals dependent on computers was staggering. In 1990 few people had heard of the internet. Ten years later the number of people and businesses dependent on the internet is

unprecedented. As human's we are first amazed by new technology and then rapidly incorporate it into our daily lives.

We will soon enter a phase in humanity's history which I call the next renaissance, or what might better be referred to as the 'post-human' era. A time when the humanity we know today will merge irreversible with the technology currently under development in the same fashion that life has merged and reorganized itself in the past to form greater and stronger forms of life. Out of this merger will come a new type of society and a new species of life on and off this planet – one which I call a 'Meta-Intelligence'.

1st TECHNOLOGY -- INFORMATION STORAGE & PROCESSING

Introduction:
I have an average memory, and I'm envious of those individuals who can remember names, faces, and trivial facts without difficulty. I've often wondered what it would be like to be able to read a book once and have instant recall forever, a photographic memory! Not only would it be convenient and time-saving, but I could no doubt improve my personal and business life immensely. Wouldn't that be great.

There is something even better. What if I told you, that you could instantaneously recall not only the books you had read, but any book that had ever been written. Imagine instant access to any information you desire at any time of the day or night? Lets say that your on the beach with your girl friend, it's a full moon, the moment is romantic, but alas there's something missing… your at a loss for words. In a flash of inspiration, you command, and the words of Shakespeare's most romantic poems are there for you.

How would your life change if you could have any information researched, analyzed and presented to you by simply making a verbal request.   I submit we would have a lot of unemployed analysts and consultants! But might we not also liberate the thinker from the drudgery of library searches and number crunching.

What is the value of information to humanity?
If we had a time machine which allowed us to transport a new born human from five thousand years ago into present day civilization, would

that baby grow up to be an average citizen or a moron? Its clear that humanity five thousand years ago was far less advanced technologically then we are today, but were they fundamentally more or less intelligent? It surprises many people to find out that there is no significant difference between you and the average human from 3,000 BC. For the most part, we are genetically identical to our distant relatives.   Our brains and the manner in which they store, recall and process information is the same.

What would happen if you were suddenly teleported back in time 5,000 years, how would you survive. If you made your voyage at 1 year of age without any education, would you still grow up understanding the basics of trigonometry the concepts of computers and the fact that humans have genes? Obviously not.   Ask yourself a different question, if you had to make that voyage today and could only bring one material object with you, what would it be?   For me the answer is easy, a book, the struggle would be in choosing which one (or maybe my PowerBook laptop stuffed with a few gigabytes of carefully chosen information). In the final result, what separate humans today from our predecessors is our knowledge base, the information we have learned, assimilated and stored. Information storage is the single most critical factor which makes today's twenty-first century human "civilized". The difference between us and our 5,000 year-old counterpart is the knowledge we have discovered, learned to utilize, and put to use. Destroy this knowledge and we would return to a primitive stage of existence.   In one sense, the ability for a society to advance is dependent upon its ability to store, retrieve and manipulate information from generation to generation. Just imagine for a moment how many times a fundamental discovery must have been made, only to have its disappear into oblivion when the discoverer was killed in an accident. How many works of greatness were lost when the ancient library of Alexandria was burned to the ground?

Information storage, our ability to reliably record and recall the information of our species and make it available to all people is unquestionably tied to the survival, growth and progress of society.

An important measure of information storage is that of information density or bits per gram. How many bits of information we can efficiently and compactly store in a gram of material. If one were to graph information density versus time, beginning with the stone tablet and ending with today's frequency domain optical storage the image would be that of an exponential curve – better known in the industry as a

'hockey stick' – flat, followed by a sharp, unstoppable rise. Two thousand years ago, a stone tablet held about .04 bits per gram. Six hundred years ago the first bibles off the Gutenberg Press held about 100 bits per gram. The first CD ROMs held about 27 kilobits per gram. Today's leading storage technologies hold about 1 gigabit per gram. What is so amazing is to plot the information density of the human brain (est. $4x10^{12}$ bpg) and that of human DNA (est. $7x10^{15}$ bps)... within the next one to two decades we will surpass both of these storage densities! Imagine being able to store the some total of your experiences on something the size of a sugar cube. Every work of music, every painting and every poem ever written on a device no larger than your finger tip.

But having access to this vast wealth of information is only valuable if you can access and process it into something useful... like Shakespeare's Sonnet on a romantic evening. To do this requires processing capability. The ability to manipulate data into useful information.

Can you remember the first computers which chugged along at a mere thousands of instructions per second. Today's machines are running at 500 Million instructions per second. Within a decade or two they'll be running at 20 to 100 GHz. These computers will not use electrons but photos and quantum effects to carry the one's and zero's. The size of these computers will be limited by how far a photo can travel in one-hundred billionth of a second. Imagine a computer one thousand times faster than your laptop less than a millimeter in any dimension.

If anyone should doubt that these machines are coming, just try to explain today's Pentium II chip to the designer of the ENIAC computer fifty years ago. I can only imagine that my predictions are conservative and pale compared to what will actually materialize.

From 1950 to the present, there has been an increase in computer power by a factor of about 10 billion.
Ron Bernal, president of MIPS Technologies, predicts that the price of the microchip will drop to 2 cents by 2010, and Andrew Grove, CEO of Intel Corporation says, in the future computer power will be "practically free and practically infinite."
In 1996 the Department of Energy awarded a $93 million contract to IBM to build the world's fastest supercomputer, capable of 3 trillion calculations per second (3 terraFLOP per second, with 2.5 trillion bytes

of memory). In comparison, it is believed that our brain routinely calculates at 10 terraFLOP speeds or faster, which will be surpassed early in the next century by supercomputers.

One of the most interesting discoveries of the past decade is the DNA computer, conceived of by Leonard Adelman of the University of Southern California.   Such DNA computers can blow-away silicon computers for a certain category of calculation by performing billions or trillions of parallel computations. In a DNA computer, an astronomical number of DNA molecules stored in a typical test tube ($\sim 10^{20}$ molecules) can perform calculations simultaneously. Just an ounce of DNA could be 100,000 times faster than the nations fastest supercomputers.

THE SECOND TECHNOLOGY IS HUMAN INTERFACE

When I walk into a bookstore I'm typically overwhelmed by a mix of emotions, both excitement and guilt. I love books and I love new information. There is much being discovered, so much to learn. But unfortunately I'm a slow reader -- for me to polish off reading a book takes a number of weeks, and I'm jealous of many of my friends who can devour a book in the course of a couple of nights, let alone one sitting. So when I see the hundred or so new books sitting on the shelves I feel guilty because I know there's no way I could ever read a small fraction of them.

My ability to input information by reading is perhaps average, but in my own evaluation, it is severely limiting. I would love to be able to read books at a rate of one per minute. I would love a more efficient human information input device, a more efficient human interface.

Throughout history, a great constant of society has always been a person's ability to communicate and obtain information. No matter what technology we use, most people can only speak about 150 - 200 words per minute, listen to information at a rate of 200 - 300 words per minute, read at speeds ranging from 250 - 1000 words per minute – that's just the way humans are hardwired. But there's no way that any of us can come even close to the communications speed of a basic $500 computer.

In one sense, how fast we humans communicate, our input/output or " I/O" rate is a bottleneck for the information revolution – we, not the

computers, are the slowest link in that chain. How can we improve the situation? What technology is coming down the road that will allow me to interface with the information world in a more rapid and precise fashion?

Increasing Human I/O rates
There are basically two solutions to increasing the useful "I/O" rate of the human being.

First is use of Software Solutions who help to selected, sift through and analyze the available data and present us with the answer or options from which to make a decision;

And Second are Hardware solutions is to actually modify the brain's connections to the outside world.

Lets look at the Software Solutions or the 'non-invasive' option first. This comes in two flavors:
Smart Environments
Intelligent Agents

Smart Environments

Since the emergence of our species, we have always shaped our environment to suit our needs. We do this for two reasons, first for personal comfort, and second to make our interactions with the surroundings most "user friendly".

Currently in development is something called the "smart tag", a small, low power transmitter that has the ability to make various environments mold themselves to meet your needs and desires. Just imagine that you go out for dinner in an unfamiliar city. You to go to a recommended local restaurant. As you enter the restaurant and request a table, a local wireless network scans your smart-tag located somewhere on your personal, perhaps in your wallet. During the scan it learns everything you want the restaurant to know about your ideal dinning experience. The waiter soon comes up to great you, he has never seen you before. " Hello Dr. Diamandis, a pleasure to have you join us this evening. I have selected just the right table for you." He guides you to the brightly lit booth, away from the loud music. Just the way you like it. Waiting for you at the table is a glass of 1992 Merlot. Just the way you like it. As

you sit down, a piano concerto from Vivaldi begins playing, one of your top 100 picks. You get the idea.

Intelligent Agents?
I believe that humans will soon begin fully using wearable computers to interface with the world around us. These computers will always be on, always be listening, always be watching out for your best interest and trying to please you and anticipate your every desire. These wearable computers will be resident in your clothes, home, office, car where ever you send time. They will be a complex piece of software which you train over the years. The software will run on a photonic processors at multi-gigaFLOP speeds and make use of molecular memory, and will be linked to the rest of the world by the digital broadband matrix. They will understand your spoken command. Ask any question of your Intelligent Agent and it will find the answer. They will provide you with instantaneous translation, allow you to speak and understand any language in any part of the world. These agents will provide an " Enhanced Reality" – making information available to you even before you know you need it.

Plugging-in – Hardwiring the Brain
The Borg do it on Star Trek, so does commander Laforge.
Modifying the human hardware to incorporate technology. Is there anything really wrong with this? In some sense its something we've been doing for decades... we call them eye glasses, contact lenses, hearing aids. Its all just a matter of degree.

Designer sensory organs: Bionics are coming.
I am a firm believer in using technology to enhance quality and potential of human life. Today, about 50% of human adults wear some time of corrective lenses to improve their vision. Today this is considered good. What if we take this a few steps forward with the help of nanotechnology, micro-machine technology or genetic engineering. Is there anything really wrong with enhanced sensory organs... eyes that can magnify and see in the infrared... ears that can receive radio signals and amplify sound?

Today U.S. labs are working on Brain Actuated Controls – the ability to control a machine by your thoughts alone... done through the measurement of minute magnetic fields less than 1 millionth the field strength of the Earth's magnetic field.

Direct Neuron/circuit interfaces

In 1995, a big step was taken by a team of biophysicists led by Peter Fromherz at the Max Planck Insitute of biochemistry. They announced that they had successfully created a juncture between a living neuron and a silicon chip. In this tremendous step forward, scientists were able to connection hardware to wetware. Their work demonstrated that ability to have an IC chip send a signal to a neuron directly and visa versa. The first step towards plugging the brain directly into the computer has been taken.

Today many labs are culturing neurons on silicon. We will see great breakthroughs here.

Dr. Burger at University of Southern California has actually designed and manufactured a chip which simulates 100 neurons. He built this chip for implantation into the human brain as the interface between flesh and chip.

THE 3rd TECHNOLOGY -- COMMUNICATIONS *

Introduction:

Staying in touch will never be a problem again. I am, without a doubt, an officially diagnosed phone addict. I can't look at a telephone without thinking about checking my voicemail or the 10 different critical phone calls I have to make at that very instant. I walk around with a cellular phone everywhere. Take away my food, my car, but please, PLEASE leave me a phone!

The world is being wired with a global digital telecommunications network. Gaia, the living Earth, is getting a multilayered nervous system installed care of the global communications industry. Soon there will not be a point on this planet, literally, that is not accessible for voice, data and video communications. Such a revolution will have profound effects beyond our ability to comprehend. This communications explosion will redefine the value of real-estate, no longer will you need to live in down-town Manhattan or Hong Kong to be a successful stock broker.

Within the next decade hundreds of billion dollar communication companies will invest trillions of dollars into a communications network

which will cover the Earth five layers deep in a digital communications infrastructure I call the Digital Matrix. Here's a quick glance at the five layers currently undergoing exponential growth.

Layer #1The "Wired" Terrestrial Infrastructure. Surface and subsurface fiber optic cables, twisted copper wire, and basic video cable will crisscross and circumscribe every continent;Layer #2The "Wireless" Terrestrial Infrastructure: On the land, millions of wireless towers will transmit voice, data, and video through cellular, point-to-point, and point-to-multipoint networks which operate a frequencies ranging from 50 Megahertz to 60+ Gigahertz;Layer #3The Stratospheric Layer: In the air above 50,000 feet (~10 miles), High Altitude Long Operation (HALO) aircraft and Stratospheric Balloons (Dirigibles) will serve as geostationary "atmospheric satellites" loitering above major cities providing narrowband and broadband point-to-multipoint wireless communication services. Layer #4Low & Medium Earth Orbit Satellite Systems: In low-Earth orbit (LEO) at 400 - 1000 miles altitude, and in Medium-Earth Orbit (MEO) 8,000 - 12,000 miles high, hundreds or thousands of satellites will circle the planet offering mobile voice, data and video links;Layer #5Geostationary Earth Orbit Satellite Systems: In geostationary orbit (GEO), at 22,300 miles altitude, hundreds of satellites will flood entire continents with radio transmissions providing cellular and point-to-multipoint wireless communication services.Over the next decade trillions of dollars will be spent. Soon communication channels will open upon command (or even at the your very thought!), dynamically allocating sufficient bandwidth at the lowest possible cost to pass a simple voice signal, or wide enough to transmit the Library of Congress or the contents of the Louvre in seconds.

Historical Overview
Given the nearly ubiquitous nature of communications today, its hard to fathom how isolated humans used to be even 50 years ago, let alone 500 years ago. For the first 99+% of humanity's existence the principal mode of communications was word of mouth or the human courier.

This mode of communications was a limiting factor which shaped the rise and fall of nations, their size, and the duration of their existence. An emperor's ability to rule his Kingdom was limited by his ability to have accurate knowledge with which to make decisions and communicate his proclamations. The size of his Kingdom was therefore limited by the distance his troops could ride (by horseback) within one or two days to

put down an insurgence. The American Revolution may have never been successful had the Atlantic Ocean not been such a barrier to communications between England and her colonies. Even as late as the start of the 20th century, the United Kingdom was investing heavily in the design and construction of airships (dirigibles), the R101 Airship was to be the flagship of the government-owned Royal Airship Works at Cardington. These airships were intended to fly nonstop between England and India, Canada, Australia to help hold together the crumbling British Empire.

The digital matrix has the ability to redefine nations and governments. Historically, humans are born into a community, live and die within that same community. You are born into your citizenship, religion, language, etc. - all of this a function of the people around you, and therefore your geographic location on planet Earth. This will not remain the case for long. In the near future virtual reality communications networks will blossom and give birth to a multitude of "virtual nations." Citizens of these virtual nations will retain dual citizenship in a physical 'terra-firma' country as well as a 'virtual-nation of choice'. These virtual citizens will live randomly throughout the planet yet communicate and interact as a co-located populace of a virtual nation on a daily basis.

The Digital Matrix: the information ether
I describe the Digital Matrix above as five distinct layers for the simplicity of cataloguing what is going on today. A decade or two from now, the Matrix will once again metamorphasize to meet growing demand. The Matrix is far more than a number of layers, it is in fact a living, growing organization of pathways, in which we humans are the agents of creation. Because the creation of new information, creates an even greater demand for information, the growth of the Matrix is exponential and will never cease. While it may sound fantastic, the end goal of the Matrix will be to make any and all accessible information available to any and all locations of the Matrix at any time, eventually at little or no cost. As the human race extends its reach beyond Earth to the Moon, to Mars and far beyond, the Matrix will extend there as well. Infact, the digital matrix will end up defining the very physical boundaries of humanity, in the same way that your own nervous system defined the boundaries of your body.

THE 4th TECHNOLOGY – NANO-TECHNOLOGY *

In the Star Trek universe every starship is outfitted with a "replicator" a handy wall-mounted device which obeys your verbal commands and creates out of thin air any food, beverage, or object or substance whose atomic construct is stored in its memory banks. "Tea, Earl Gray.... Hot" is the typical command that Captain Jean-Luc Piccard gives the replicator from episode to episode. I would honestly enjoy having a replicator. But I don't think I'd use it for making tea... You would probably hear me whisper something like "Diamonds, 30 carrots, blue, brilliant cut."

Only a century ago, prior to automated mass production, manufacturing was an imprecise and labor intense process. For the wood or metal worker, every component of a mechanical device was a one-of-a-kind work of art, made by hand. Presented with today's Computer Aided Design and Manufacturing (CAD/CAM) technology a blacksmith from last century would probably find it as magical as we find Captain Piccard's replicator.

There is now a technology on the horizon equally as magical, its called nanotechnology. In the early 1980's an MIT graduate student by the name of Eric K. Drexler wrote a book called Engines of Creation. In this book Eric described the fundamentals of the world of Nano Technology.

At a very basic level, we humans are machines. At a subcellular level we are a vast, complex and beautiful collection of trillions orchestrated nano-machines. For example, in your cell there are microtubules which serve as beams and support structures. DNA serve as memory. Ribosomes are manufacturing plants which build protein structures. Flagella which are small motors. Vacuoles are small pressurized fluid containers... the analogs go on.

Imagine a future where we will be able to build complex molecular machines one atom at a time. If you can fathom the implication of this capability, then you understand the power and beauty of nano-technology.

"Coal and diamonds, sand and computer chips, cancer and healthy tissue: throughout history, variations in the arrangement of atoms have distinguished the cheap from the cherished, the diseased from the healthy. Arranged one way, atoms make up soil, air and water; arranged another, they make up ripe strawberries. Arranged one way, they make

up homes and fresh air; arranged another, they make up ash and smoke."
-- Eric K. Drexler, Engines of Creation

Throughout history we have always built things out of atoms. The difference between the future and the past, is that in the past we have always manipulated atoms in giant numbers, on the order of trillions of trillion at a time. But now, we are on the verge of true miniaturization where each atom will be precisely placed to build machines composed of tens or hundreds of atoms rather than trillions. This new technology is molecular technology done on a scale measured in nanometers (one billionth of a meter).

Each and every one of us unconsciously manipulates atoms one at a time to build and rebuild the cells of our bodies. Today scientists use these same techniques to manufacture various proteins in the laboratory. But copying only what a cell does is very limiting.

The real secret to this world of nanomachines and nanoengineering is the creation of what Drexler calls the "assembler", the universal equivalent of the biological ribosome. A device capable of translating instructions and selectively assembling single atoms or small groups of atoms into a predetermined, useful nanomachine. These assemblers will be able to build structures out of carbon to form diamonds, rather than just proteins.

The power and implications of nanotechnology are unfathomable. Nanotechnology gives the human race omnipotents. The ability to have your very thought translated into substance. It is the mechanical version of the Replicator on Star Trek. Give an assembler a healthy supply of raw materials, instructions on how to operate and you can create to your heart's content.

One of the most interesting nanomachines is a nano-computers. In the mid-1800's an inventor by the name of Charles Babbage invented the first every computer. A century before the creation of the transistor, and decades before the vacuum tube, Babbage's computer was purely mechanical. A huge and complex adding machine build of brass gears and moving shafts capable of doing large mathematical computations specifically build for the government wishing to oversee the collection of taxes.

Now imagine such a mechanical computer built out of atoms. Drexler estimates that such a 'simple' machine would fit within 1/100 of a cubic micron (within a human cell). According to Drexler "Mechanical nanocomputers will likely be hundreds of thousands of times faster than electronic microcomputers."

So, now imagine that everything we build, from a desk to a street lamp has nanocomputers embedded into their structure. Why not? It costs no more. What would the world be like with trillions of computers scattered in our everyday life.

Further lets imagine that these nanocomputers embedded in everyday objects are able to control a fleet of nano assemblers and disassemblers also embedded in these same objects. Can you imagine a command given to your desk... "excuse me desk, I need a Bed now." To which the Desk rapidly dissassembles itself from one structure and reassembles itself into another. The world of the future will be in constant change, reorganizing itself as a forest changes with the seasons.

The implications for good and evil are staggering.

THE 5th TECHNOLOGY GENETIC ENGINEERING

I plan to live to the ripe young age of 700 years old - I made the claim 10 years ago and plan to stick by it for the next 662 (I'm now 38 years old). When I bring my expectation up in conversation most people politely laugh at what they consider a joke. "Seven hundred years... why not!" When I tell them that I'm serious, they pause, get quiet and look at me with that "what do you know that I don't know" expression. The target of 700 years was not chosen at random, I adopted my goal when I found out that certain species of sea turtles achieve a life span of 700 years on a regular basis. If turtles, why not humans? Its only a matter of time before science finds out what they have they we don't have... or perhaps equally possible, what 'suicide genes' or genetic clocks we have that they don't have.

Everyone should have a similar goal of an extended and enjoyable life. The fact that today's average life expectancy for a male in the United States is only 69 years old and 77 years for women has nothing to do with my life expectancy – the world of genetic engineering and medical technologies will change that soon enough. The questions I (and you)

need to ask is "when will the key longevity breakthroughs happen?", " will I get access to the various treatments?" and "can I keep myself from any fatale accidents in the mean-time?"

"I don't want to live forever through my works. I want to live forever by not dying!"
     - Woody Allen

In his book "Imagined Worlds", Freeman Dyson predicts that the Biotechnology Age is "due to arrive in full force early in the next century, driven by DNA sequencing and genetic engineering" matching the achievement of today's Information Age. Already the government and private industry are both pouring billions into research hoping to cash in on a multi-trillion dollar industry. An industry with two key objectives in mind (1) increasing quality of life and (2) increasing life expectancy. For most people alive today, everything else is secondary to these goals.

Genetics: The Human Software
In the computer world we constantly hear about computer software and hardware upgrades. In the world of carbon-based life (in other words, you and me) we too have software and hardware which can be upgraded and improved upon. In the parlance of the genetic engineer, human DNA, genetic material, can be considered software, a set of instructions to be followed in order to perform a function, life. In a like fashion, the human body can be viewed as 'hardware' (for fun, computer geeks sometimes refer to humans as 'wet-ware', referring to the fact that we're mostly water and kind of gushy compared to silicon chips).

The human DNA is the single most complex piece of software written... so far. It is also a piece of software which has ability for self replication, self correction, self evolution and improvement, and has reliably been duplicated over 6 billion times with only minor variations. Quite impressive.

In the early 1990's the National Institute of Health (NIH) kicked off one of the most ambitious projects know to man… called the Human Genome Project.. This $3B project now employs thousands of talented engineers, scientists and technicians who are diligently decoding and recording the 3 billion DNA basepairs of the human genome to locate and catalogue 100,000 human genes. Since DNA has only four letters, in

terms of data, we can calculate that the human genome represents about 6 billion bits of information. The genetic content of the human being would require a book about 150,000 pages long. The project is well ahead of schedule and should be completed in 2003.

In the final result I expect that the human genome will become a standard library resource on biologists laptop. A file labeled "Human Genome -- Release 1.0" will be located on their hard drive next to their Webster's Dictionary file.

Thousands of researchers around the world will race to decode their little part of the puzzle and in a very short time we will go from a collection of data, to a collection of useful information, namely an understanding an understanding of gene functionality and control.

In the same fashion that software engineers are constantly fixing and upgrading new releases of software such as Word and Excel, Human Software Engineers will seek to improve on our own DNA sequences. The resulting work will eventually lead to the active manipulation of genes, and to something which might be called "Human Genome -- Release 2.0".

The knowledge and power which will be unleashed during this next century in the field of genetics is unimaginable. As a species we will be dealing with very difficult questions and choices not unlike those which came to us during the past 50 years with the invention and implementation of the atom bomb. While I will be speaking mostly about the beneficial aspects of genetic engineering, the power of genetics for terrorism and biowarfare far exceeds anything available in today's arsenals. The only force of greater destructive power is a related cousin to genetics called nanotechnology.

Is it moral and ethical to choose your Babies genes?
Today the genetic make up of your children is decided by a two step process of pure and random luck. The only choice you have in the matter is who you choose for a mate, and that's all. And even then, you better look at his or her family tree to see what genetic recessive genes lie dormant.

If I know that one of my two intelligence genes is stronger, why shouldn't I choose to pass the better one along? If I know that I have a

recessive gene for a cancer, why shouldn't I make sure to discard that gene?

Once a baby is born, most parents provide the very best care possible for their child. They buy them the best clothes, provide the top medical care, send them the finest schools... why is that different from giving them the best genetic material available to you at the time of conception?

I have no doubt that in the future selecting your children's genetic makeup will be common practice.

Is it moral or ethical to choose your babies genes? Obviously that is a personal choice. But don't forget that morals change over time. Imagine trying to explain a heart transplant to someone 500 years ago. "You're going to do what! Take the heart of a dead man and put it in my chest! Are you crazy!"

But what about for the rest of us, the living, the already born? Are we stuck forever with our 'randomly' selected genetic complement? Today the answer is yes, but in the future it most definitely is no. In the mid-1980's a group of genetic engineers began to research a concept called " Gene Therapy". A way of introducing new genes into living cells. The technique is being used today in hospitals.

In the future people will head down to the local Human Software Engineer for genetic consultation and a genetic make-over. Your genetic beautician will first read and interpret your genome. Next offer you suggestions on how to modify, improve or replace certain genes. It might even be the case that if you are found to have a very unique gene encoding a beautiful smile, that you'll be able to copyright or trademark the genetic sequence for future resale. Just imagine the advertising campaign, "Genome by Loreal". I don't want to make light of this subject and I'm setting aside some of the more obvious moral/ethical issues for later discussion.

Beyond Gene Therapy the world of nanotechnology will eventually develop nanorobots which will travel from cell to cell and scan your DNA for imperfections or desired modifications. They will be custom produced to meet your specific needs. Would you like to live for another hundred years? These nanorobots go around to every cell in your body

and reset their internal clock? Are you fat and prefer to be thin? Would you like to have more muscle mass?

To quote a friend and mentor, David Wine, the human race is moving from a time of "Evolution by Natural Selection, to Evolution by Intelligent Direction."

HARD QUESTIONS

There is no question that the technological breakthroughs of then next 10 - 50 years are going to drastically change society as we know it. They will challenge us ethically and they have the potential to threaten our very existence.

How do we stop a terrorist who now has the ability to create deadly a virus? How do we stop a terrorist who has nano-technology as their tool?
What value does gold have when you can make it from your nano-assemblers?
What value does information have when it flows so freely around the world?
What will happen to education when answers are available instantly from the digital matrix?
How will governments react to the free exchange of information that threatens their cultures and boarders?
How will people deal with the high levels of unemployment which results as technology displaces humans in the fields and factories?
Will we regulate life extension?
Will we regulate genetic enhancement and manipulation?
Can we curb the population growth of this planet – especially as life expectancies double and triple?

These questions are not easy – We will need to find the answers to these and even harder questions as we face them.

Looking towards Space

In the last few moments of my talk this evening I would like to turn the discussion towards space.

We have all been drawn together because of our fascination of space. Space is humanity's destiny.

We face an awesome responsibility in this regard for it is during OUR lifetime that humanity will leave the Earth to spread out irreversibly into the solar system and beyond. It is you, the Students of the ISU who will lead the way. You will need to harness the technologies I discussed earlier and use them for good.

I have dedicated my life to moving the human race beyond the bounds of Earth and into the cosmos. I view this as fundamental to our species survival. It is important that we colonize worlds beyond this planet for as the great Russian pioneer Konstantine Edwardovitch Tsiolkovsky said, "Earth is the cradle of humankind, we can not always remain in the cradle."

Everything we consider valuable here on Earth namely energy, metals, minerals, real estate and even information is available in near infinite quantity in space.

I would like to close with one last story. In 1983 when I was an undergraduate at MIT... We are all Starstuff... Nobel Lauret William Fowler ... 1000 – 10,000 stars

Life- The Science of Biology, by Purves et al.; www.cs.hmc.edu/~belgin/Population/stats.htmlISU Invocation Speech   28 June 1999

Page   PAGE 33