本田賞 HONDA PRIZE 35 Anniversary

本田賞 35回記念シンポジウム　2014年11月14日（金）

「人間性あふれる文明を創る」

35th Honda Prize Commemorative Symposium

“Creating a Truly Humane Civilization”

November 14, 2014 (Fri.)

HONDA FOUNDATION
公益財団法人 本田財団

目 次（日本語）

Contents (English)

本田賞
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35
Anniversary

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35th Honda Prize Commemorative Symposium

「人間性あふれる文明を創る」
Creating a Truly Humane Civilization

2014年11月14日㈮
日経ホール
東京都千代田区大手町1-3-7 日経ビル

主催：公益財団法人本田財団
後援：日本経済新聞社

November 14, 2014(Fri)
Nikkei Hall
Nikkei Building, 1-3-7 Ohtemachi, Chiyoda-ku, Tokyo

Organized by the Honda Foundation
Supported by Nikkei Inc.

HOF
公益財団法人 本田財団
HONDA FOUNDATION

ご挨拶 Message from the President

本日はお忙しいなか、シンポジウムにお越しいただき、誠にありがとうございます。

2014年は本田賞の35回目の表彰の年に当たります。これを機会に、産業の発展、文明の進化によって得られた恩恵と、同時にもたらされた現代社会が直面する様々な問題との均衡について、現在の課題を再認識・共有するとともに、その解決に向けて今何がなされるべきなのか、また科学技術が進む方向性はいかにあるべきかについて議論する場を設けることとしました。

今回開催するシンポジウムでは、基調講演に続く記念講演として、過去の本田賞受賞者から選ばれた異なる分野を専門とする3名の科学者・経済学者が、エコテクノロジーの異なる3つの視座に従って、それぞれの持論を展開します。

最後に、記念講演を行った3名の登壇者に本年の本田賞受賞者であるヘルムート・クレメンス博士も加わって4つ目の視座「Sustainability」をテーマにパネルディスカッションを行い、学際的な討議・意見交換を通じて、現代の視点で最も重要な課題を認識し、その解決の糸口を見いだし、シンポジウムのテーマである「人間性あふれる文明を創る」ことに向けた提言の発信を目論見ます。

ご参加いただいた皆様にとって、本シンポジウムが有意義な場になることを切に願っております。

[4つの視座]

Paradigm Shift（パラダイム・シフト）
社会や個人に与える影響という点で大きく変革を遂げた、科学技術に携わる者に求められる資質と倫理を問う。

Sustainability（持続可能性）
地球環境問題に対し、科学者や技術者がとるべき方向性を探る。

Innovation（イノベーション）
人間と技術の共生という観点から、技術革新のあるべき姿を追い求める。

Life Frontier（ライフ・フロンティア）
生命科学技術の進歩と可能性、さらには生命の尊厳について考察する。

公益財団法人 本田財団
理事長
石田寛人
Hiroto Ishida
President, Honda Foundation

On the occasion of the 35th Honda Prize, the Honda Foundation has decided to organize a venue to review the current balance between the benefits of industrial development and the evolution of civilization, and various issues facing modern society as the consequence so as to re-realize and share current challenges. Also it aims to discuss what should be accomplished toward the resolution of such pressing issues as well as the role of science and technology in that context.

In this symposium, following the keynote speech, three past Honda Prize laureates in different fields will share their opinions through their speeches in the three different perspectives of ecotechnology.

Finally, joined by this year's Honda Prize laureate, Dr. Helmut Clemens, all four speakers will participate in a panel discussion on the fourth perspective “Sustainability.” Through an interdisciplinary discussion and exchange of opinions, the symposium intends to deliver suggestions toward "Creating a Truly Humane Civilization" as we share the recognition of the most important current issues facing this modern civilization and seek for clues to resolutions.

[Four Perspectives]

Paradigm Shift which questions the expected morals and credentials required for an individual engaged in science and technology which have created a big change in terms of impact on society and individuals.

Sustainability which explores the direction scientists or engineers should take to face global environmental issues.

Innovation which pursues the vision of innovative technologies from a viewpoint of coexistence of humans and technology.

Life Frontier which considers advancement and possibilities of life-science technology and, furthermore, the dignity of life itself.

[会場のご利用にあたって]
・会場内では係員の指示に従ってください。
・会場内外での事故、盗難等、主催者は一切責任を負いません。自己管理をお願いします。
・喫煙は喫煙所をご利用ください。
・休憩時間に会場前スペースでドリンクサービスを行います。お飲物の会場内への持ち込みはご遠慮ください。
・荷物等は会場内のクロークをご利用ください。
・お使いになった同時通訳レシーバーは必ずご返却ください。
・会場内へのカメラ、録音機器の持込は可能ですが、撮影・録音はご遠慮ください。
・危険物、火薬類、その他法律で禁止されている物の持ち込みはご遠慮ください。
・ごみは基本的にお持ち帰りいただくか、きちんと分別の上必ずゴミ箱にお捨てください。

[Notes on the Hall]
・Please follow the instructions given by the staff.
・We cannot be held liable for accidents, theft, etc., that may occur inside or around the hall. We ask that each person exercise their own discretion.
・Smoking is allowed only in smoking areas.
・Soft drinks are served in the space near the entrance during breaks. Do not take drinks into the hall.
・Please deposit your personal belongings at the cloak check.
・Return the simultaneous interpreting receiver to a member of staff when leaving.
・Although cameras and recording devices may be brought into the hall, please refrain from photography and audio recording.
・Hazardous materials, explosives and other substances prohibited by law are not allowed in the hall.
・Garbage must be either taken home or sorted carefully before disposing of it in the trash boxes.

プログラム　Program

11:45　開場　Doors open

12:30　開会あいさつ　Opening Remarks

石田 寛人　本田財団 理事長　Mr. Hiroto Ishida　President, Honda Foundation

12:40　基調講演　Keynote Speech

「人間性あふれる文明の創造へ向けて　Toward Creation of a Truly Humane Civilization」
小島 明 氏　本田財団理事、公益社団法人日本経済研究センター参与
Mr. Akira Kojima　Director of the Honda Foundation, Advisor of the Japan Center for Economic Research
質疑応答　Q&A

13:20　記念講演　Commemorative Speeches

Paradigm Shift（パラダイム・シフト）
「変容する経済システム　The Changing Economic System」
オーケ・E・アンダーソン 博士　Dr. Åke E. Andersson
質疑応答　Q&A

14:00　（休憩15分　15-minute break）

14:15

Innovation（イノベーション）
「人間性あふれる文明の創造における技術革新の役割
Role of Technology Innovation in Creating a Truly Humane Society」
ラジ・レディ 博士　Dr. Raj Reddy
質疑応答　Q&A

15:00

Life Frontier（ライフ・フロンティア）
「生物学と医学における水分子エコテクノロジー
Ecotechnology of the Water Molecule in Biology and Medicine」
デニ・ルビアン 博士　Dr. Denis Le Bihan
質疑応答　Q&A

15:40　（休憩20分　20-minute break）

16:00　パネルディスカッション　Panel Discussion

Sustainability（持続可能性）
本田賞の受賞者たちがそれぞれの専門分野の視点から、持続可能な社会の実現への想いを語り、未来への扉を開く。
Honda Prize laureates will speak from their respective areas of expertise on achieving a sustainable society.

［モデレーター　Moderator］

角南 篤 教授
本田財団業務執行理事、
政策研究大学院大学教授
Professor Atsushi Sunami
Executive director of the Honda Foundation, Professor of the National Graduate Institute for Policy Studies

［パネリスト　Panelists］

オーケ・E・アンダーソン 博士
Dr. Åke E. Andersson

ラジ・レディ 博士
Dr. Raj Reddy

デニ・ルビアン 博士
Dr. Denis Le Bihan

ヘルムート・クレメンス 博士
本年度本田賞受賞者
Dr. Helmut Clemens
2014 Honda Prize Laureate

17:25　閉会挨拶　Closing Remarks

村上陽一郎　本田財団評議員　Dr. Yoichiro Murakami　Councilor, Honda Foundation

17:30　閉会　Closing

＊テーマは変更になることがあります。
＊The themes are subject to change without notice.
＊講演及びパネルディスカッションは日英同時通訳を行います。
＊Japanese-English simultaneous interpretation available for both lecturers and panel discussion.

小島 明 氏
Mr. Akira Kojima

1942年日本生まれ。本田財団理事。公益社団法人日本経済研究センター参与
Born in Japan in 1942. Director of the Honda Foundation, Advisor of the Japan Center for Economic Research

1965年日本経済新聞入社。ニューヨーク支局長、編集員、論説員、常務取締役論説主幹、専務取締役論説担当などを歴任。2004年日本経済研究センター会長、日本経済新聞社論説顧問などを経て、現在にいたる。1989年度日本記者クラブ賞受賞。
Joined Nikkei, Inc., in 1965. He has served as New York Bureau Chief, Editor, Commentator, Managing Director/Chief Editorialist and Senior Managing Director and Chief Editorialist, etc. He became Chairman of the Japan Center for Economic Research in 2004 and served as Advisor for Nikkei Inc., etc. He received the Japan National Press Club Award in 1989.

講演要旨

「人間性あふれる文明の創造へ向けて：バランス、価値観、倫理、総合性の視点」

科学技術に支援された活発な経済活動のなかで環境への負荷が増大した現実だが、同時に自然環境だけでなく時に人間さえも置き去りにされてきた発展のあり方を是正する必要がある。自然環境との調和に加え、人間環境との調和も考慮すること。我々が21世紀の価値観としてしっかり受け止めるべきものだ。

ローマ・クラブが『成長の限界：人類の危機』レポートを発表してから40年目の2012年1月に、ブカレストで開かれた40周年記念総会では、資本主義・市場経済と民主主義政治が短期指向・目先指向になり、人類が直面している構造的で深刻な問題に対応できていない指摘が相次いだ。そこで議論されたのが「新しい経済学」の必要性であり、「3つの分断」の問題、つまり①生産と雇用の分断の拡大②金融と実体経済の分断、それと③economyとecologyの分断―が指摘された。

「新しい経済学」には長期的視点、「科学技術」との総合性、それに時代感覚、倫理観も必要になる。50年前の1964年東京オリンピックの当時、経済の量的な成長が最重要課題だったため、東京の川は黒く濁り魚が消え、大気は喘息になるほど汚染した。当時の社会の危機感、問題認識が公害防止につながる新技術、生産プロセス、個人のライフスタイルなど多面的な、イノベーションをもたらした。

「人間性あふれる文明の創造」へ向けての課題は厳しいが、価値観を点検し、バランス、倫理を織り込んだイノベーションにより実現可能だろう。文部科学省が2014年6月に発表した『科学技術白書2014』は、日本が巨大災害やオリンピック開催国になることを踏まえ、「ライフ・イノベーション」や「クリーン・イノベーション」を推進することによって、このシンポジウムが目指すエコテクノロジーを世界に発信し、各国と協力する発想を示している。

このシンポジウムからの発信を通じて、世界中が享受できる「人間性あふれる文明」の創造へと展開することを期待したい。

Abstruct

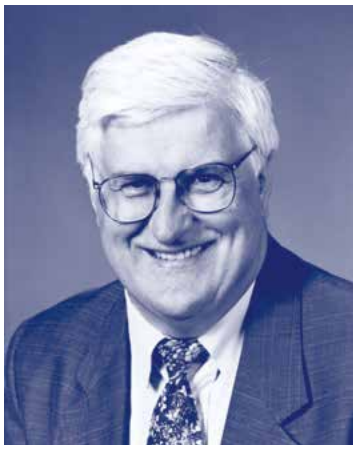
“Toward Creation of a Truly Humane Civilization: Perspective of Balance, Values, Ethics, and Comprehensiveness”

Vigorous economic activity supported by science and technology brings an increasing burden on the environment. We have to change the state of development in which not only the natural environment but sometimes even human beings have been neglected. We should consider harmonizing the human environment and the natural environment. We believe this to be the 21st century value system that we must embrace.

In January 2012, forty years after “The Limits to Growth,” the 40th anniversary general assembly of the Club of Rome was held in Bucharest. Repeatedly mentioned and emphasized was the increasing short-term and near-sighted orientation of capitalism/market economies and democracy and the inadequacy with which the world responds to the profound structural problems confronting mankind. The need to create a “New Economics” was debated. The problem of “triple divorces” was raised. “Triple divorces” refers to ①expansion of the divorce between production and employment, ②divorce between finance and the real economy, and ③divorce between the economy and ecology.

In the “New Economics,” a long-term perspective, synthesis with technology, a sense of the times and an ethical perspective are all important. Fifty years ago, at the time of the 1964 Tokyo Olympic Games, quantitative economic growth was the primary issue in Japan. And a few years later, the rivers in Tokyo became murky and fish disappeared. The air was so polluted that it caused asthma. But society’s sense of crisis and awareness of the problem engendered multifaceted innovation, including new technology, production processes, and individual lifestyle changes, all of which contributed to preventing pollution.

Resolving the obstacles to “creating a truly humane civilization” may be difficult, but it is possible to achieve if we check our values and make progress through innovation into which balance and ethics are woven. The “White Paper on Science and Technology 2014,” published by the Ministry of Education, Culture, Sports, Science and Technology in June 2014, puts forward the idea of cooperation between countries to spread ecotechnology through the world, which is the very objective of this symposium, by promoting “life innovation” and “green innovation” in light of the huge disaster that struck Japan and Japan’s hosting of the 2020 Olympics. We hope that this symposium will work to disseminate these ideas, and we look forward to progress in “creating a truly humane civilization” that will benefit the whole world.



Paradigm Shift（パラダイム・シフト）

オーケ・E・アンダーソン 博士
Dr. Åke E. Andersson

1936年スウェーデン生まれ。1995年第16回本田賞受賞。ヨンショーピン・インターナショナル・ビジネススクール経済学教授。元スウェーデン未来学研究所長

Born in Sweden in 1936. The 16th Honda Prize Laureates in 1995. Professor of Economics at Jönköping International Business School and Former Managing Director of the Swedish Institute for Futures Studies.

環境保全と経済発展を骨子とした地域計画、地域経済学の理論展開、都市づくりなどに多大な功績を上げた。地球環境問題が深刻化する中、自然環境の保全と地域経済発展の両立を図る理論モデルとして、次世代の産業社会「C社会」――創造性（Creativity）、コミュニケーション容量（Communication capacity）、製品の複雑性（Complexity of products）を提唱しているアンダーソン博士が、次世代型産業社会を展望する。

Dr. Anderson has contributed immensely to community planning founded on environmental protection and economic growth, theoretical application of regional economics, urban development, etc. He takes a look at the emerging industrial society from the new perspective of the "C-society" featuring creativity, communication capacity and complexity of products, which is a theoretical model aimed at both preserving the natural environment and developing regional economies in the face of aggravated problems with the global environment.

講演要旨

「変化し続ける経済システム」

世界経済は急速に変化し続けており、高速遠距離通信、知的職業や創造的職業、また文化的差異や対立をとりなす能力への依存度がますます高まっています。

世界経済が変化し続ける以下2つの現象を語ります。

持続的な経済成長

平均寿命を90～100歳とし、そのうちの40～50年における年間労働時間を1,300時間とすると、労働に費やされる時間は、総生存年のわずか7～8%ということになります。これを1900年当時の状況と比較すると、労働時間が70%削減されたことになります。

非常に重要な2つの課題：

- 大幅に増加する余暇の時間をどのように過ごすべきか？
- 豊かな国の国民は、何歳でリタイアするのか？

相転移

研究／開発／イノベーションのシステムは、科学技術がますます複雑になってゆくことにより、一定の確率で相転移を経験することになります。結果として、以下のような現象が予測されます：

- 基礎科学への財政支援増加のニーズが高まる。
- 基礎科学研究と産業界の研究開発とがより密接に関連し合い、研究活動の組織化の重要性が増す。
- 創造力のある広範な地域であるアジア、欧州、北米の相対的な重要性が増す。
- 世界の異なる地域同士の研究協力、特にアジアの科学研究が盛んな地域と、その他の科学研究が盛んな地域との連携が、今後ますます重要となる。
- 各国政府は、国や地域の比較優位性は刻々と変化しており、科学的新発見の有無に左右されるため、根本的に不確かなものであることを認識するようになる。

Abstruct

“The Changing Economic System”

The global economy is rapidly changing and becoming increasingly dependent on rapid long distance communication, cognitive and creative occupations, and a capacity to handle cultural differences and conflicts.

The reasons for the changing global economy are to be found in these two.

Persistent economic growth

The increasing stock of human capital, technological and organizational knowledge has ensured a steady rate of growth of per capita real income of two to three per cent per annum over the last half century. A fairly safe assumption is that the next 50 years will deliver a similar rate of increases of per capita income, at least in the OECD countries and probably at a faster rate of increase in the developing economies.

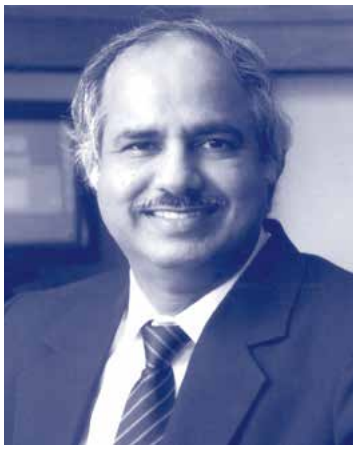
Two crucial issues:

- How will the massive increase in leisure time be used?
- At what age will people of affluent countries retire?

Phase transitions

The research, development and innovation system will with some probability be undergoing a phase transition caused by the increasing complexity of science and technologies. This will cause:

- A greater need for increased funding of fundamental science.
- A closer interaction between fundamental scientific research and industrial R&D, increased importance of the organization of research activities and increased relative importance of the large creative regions of Asia, Europe and North America.
- Research collaboration between different parts of the world and especially between Asian science regions and other science regions will become increasingly important.
- Governments will realize that the comparative advantages of regions and nations are dynamic and dependent on scientific breakthroughs and thus fundamentally uncertain.



Innovation（イノベーション）

ラジ・レディ 博士
Dr. Raj Reddy

1937年インド生まれ。2005年第26回本田賞受賞。米国カーネギーメロン大学計算機科学科教授

Born in India in 1937. The 26th Honda Prize Laureates in 2005. Professor of Computer Science and Robotics at Carnegie Mellon University, U.S.A.

コンピュータ科学とロボット工学の世界的先駆者。その広範にわたる研究は教育・医療・福祉に大きく貢献。中でも音声認識や人工知能に関する研究は現代のコンピュータテクノロジーの基盤となっている。国籍、言語、年齢・性別、経済格差を問わず誰もがその技術の恩恵を享受できることが、ロボット工学と知能システムの目指すべき未来だと考えるレディ博士。彼が標榜するガーディアン・エンジェル・テクノロジーとは？

A world renowned pioneer in computer science and robotics. His wide-ranging research has made major contributions in education, medicine and social welfare. In particular, his research on voice recognition and artificial intelligence has laid the foundations of today's computer technology. Dr. Reddy believes that the future that robotics and intelligent systems should aspire to lies in making the benefits of technology available to everyone, regardless of nationality, language, age, gender or economic class. What is this Guardian Angel Technology that he hopes to realize?

講演要旨

「人間性あふれる文明の創造における技術革新の役割」

真に人間性あふれる社会を作りあげるためには、地球上全ての人類の基本的なニーズに応えるための、拡張性があり、持続可能で、入手可能なソリューションの創造を目指さねばなりません。基本的なニーズには、食／エネルギー／水の安全保障、さらには奴隷制や拷問からの解放等の基本的人権に関する問題も含まれます。

本講演の基本的なテーマは、社会の基本的なニーズが何であれ、課題に積極的に取り組む姿勢こそが、真に人間性あふれる社会の特性を継続的に向上することのできる技術革新をもたらし得る、ということです。

一例として、台風や竜巻などの災厄が発生する恐れがある場合に、特定の地域ごとに一人一人が個別の警告を受けられるようにするという要件について考えてみます。本講演では、ガーディアン・エンジェル・テクノロジー（GAT）を開発し、常に改良を加えることにより、自然災害から人類を護り、それによって地球上全ての人々の生存可能性を高めるためのテクノロジーとして、どのような可能性があるのかを考察します。

ガーディアン・エンジェルのコンセプト／システム／ソリューションは、人間性あふれる社会を作る上でのあらゆる面に適用できます。例えば、基本的権利の侵害を事前に特定したり、人間性あふれる社会における個人の基本的なニーズや権利を保護するために利用することができます。

Abstruct

“Role of Technology Innovation in Creating a Truly Humane Society”

To create a truly humane society, we must aspire to create Scalable, Sustainable Affordable Solutions to provide for the basic needs of all human beings on the planet. These needs include topics such as Food Security, Energy Security, and Water Security as well as basic human rights such as freedom from slavery and torture.

The basic thesis of this talk is that, no matter what the basic need of society is, a proactive approach can lead to technology innovations which can continuously improve the attributes of a Truly Humane Society.

As an example, let's consider the requirement that every person should get location specific personalized warnings about potential calamities like typhoons and tornados. In this talk we explore technology options for protecting humanity from natural disasters by creating and continuously improving Guardian Angel Technologies so that every person on the planet has a better chance of survival.

Guardian Angel concepts, systems and/or solutions can be applied to all aspects of creating a humane society. It can be used to identify potential violations of basic rights and to protect the basic needs/rights of the individual within a humane society.

Life Frontier（ライフ・フロンティア）

デニ・ルビアン 博士
Dr. Denis Le Bihan

1957年フランス生まれ。2012年第33回本田賞受賞。フランス・ニューロスピン（NeuroSpin）超高磁場MRI 研究センター所長

Born in France in 1957. The 33th Honda Prize Laureates in 2012. Director of NeuroSpin, CEA Saclay, France.

より精細によりスピーディーに人体内部を映像化する拡散MRI技術の基礎から臨床応用までを確立。拡散MRIを用いることで、急性脳梗塞の早期治療が可能になっただけでなく、診断精度が向上したことで手術時に脳繊維を損傷してしまうなどの事故を激減した。脳内を鮮明に映像化できるため、神経疾患等の治療法の劇的な発見やさまざまな器官に対する応用の期待が高まっている。ルビアン博士は拡散MRIを通して水の知られざる姿に注目する。

Dr. Le Bihan created diffusion MRI technology from its initial development through to clinical application in visualizing the inside of the human body in finer detail and at speed. The technology not only made possible the early treatment of acute cerebral stroke but also reduced the number of accidents involving surgical damage to brain tissue through enhanced diagnostic accuracy. With crisp images of the brain now possible, there are expectations for dramatic discoveries in the treatment of neurological disorders, etc., and applications to various other organs. Dr. Le Bihan investigates the hidden potential of water through diffusion MRI.

講演要旨

「生物学および医学における 水分子のエコテクノロジー」

21世紀のはじめ、人類は、炭素原子1つと酸素原子2つという3つの原子から成る、非常に小さな分子に注目しています。大気中のCO_2の量を制御することは、経済的、社会的、政治的な面での主要な目標となりつつあります。ところで、近い将来に少なくともCO_2と同程度に重要な役割を果たす事になるであろう、酸素原子1つと水素原子2つという、同じく3つの原子から成る小さな分子がもうひとつ存在します。

周知のように、大気中におけるCO_2の濃度が過度になれば地球上の生命にとって有害である一方、H_2Oは、とくに液体の状態にある時には「ブルー・ゴールド」とも呼ばれ、まさに私達の生活にとって不可欠な存在です。水資源の枯渇は、何世紀にも渡って干ばつ、飢饉、さらには戦争を引き起こし、死をもたらしてきました。充分な質と量の飲料水を確保することは、今世紀各国にとって大きな課題となるでしょう。このことは驚くに値しません。

水は人間の体重の60～70%を占めており、生物学的機構の働きにとって不可欠な存在です。個々の生物は、水を最大限に活用するため、それぞれの生息環境に応じて異なった戦略を採ってきたのであり、水はそのようにして生物多様性に貢献しています。細胞組織による水の活用メカニズムが不全となると、重篤な疾患、または死へとつながる恐れがあります。

脳内の水拡散の状況を画像化する磁気共鳴画像法（MRI）によって解明された「生体分子」として最も重要な水を語ります。

Abstruct

“Ecotechnology of the water molecule in biology and medicine”

At the onset of the 21st century humankind is focusing its attention on a very small molecule made of three atoms, one carbon atom and two oxygen atoms. Controlling CO_2 in the atmosphere is becoming a major goal, economically, socially, politically. Yet, there is another small molecule, also made of three atoms, one oxygen atom and two hydrogen atoms, which is going to play a similarly prominent role if not more in the near future.

While an excessive concentration of CO_2 might be harmful to life on earth as we know it, H_2O, especially in its liquid form, the “Blue Gold”, is just indispensable to our lives. Over the past centuries lack of access to water has triggered death, through drought, famine or even wars. The preservation of the quality and abundance of drinking water will become a major challenge for nations during this century. This is no surprise.

Water makes 60 to 70% of the human body weight and is crucial to the working of the biological machinery. Different organisms have adopted different strategies in the way they get the most out of water, depending on their environment, and water contributes to the biodiversity. Faulty mechanisms in the use of water by tissues may lead to severe diseases or death.

Lecture about water as most important “biological molecule” to be analyzed by Magnetic Resonance Imaging（MRI）which images diffusion of water in the brain.

ヘルムート・クレメンス 博士
Dr. Helmut Clemens

1957年オーストリア生まれ。2014年第35回本田賞受賞。レオーベン鉱山業大学（オーストリア）金属物理・材料試験学部長

Born in Austria in 1957. Head of the Department of Physical Metallurgy and Materials Testing at the Montanuniversität Leoben, Austria.

職歴：レオーベン鉱山業大学 物理学部研究助手（1987年）、プランゼー株式会社（1990年）、シュトゥットガルト大学 金属物理学研究所 教授（1997年）、ヘルムホルツ・センター、ゲーストハッハト材料研究所所長（2000年）、レオーベン鉱山業大学 教授金属物理・材料試験学部長（2003年～）。

Employment History : Montanuniversität Leoben, Professor, Head of the Department of Physical Metallurgy and Materials Testing(2003-), Helmholtz-Zentrum Geesthacht, Head of the Institute for Materials Research (2000), University of Stuttgart, Professor, Institute of Physical Metallurgy(1997), Plansee AG(1990), Montanuniversität Leoben, Research Assistant at the Department of Physics(1987).

クレメンス博士は、チタンアルミナイド（TiAl）の分野において国際的に最も高名な専門家の一人です。20年以上にわたる博士の活動および研究の貢献により、γ-TiAl基金属間化合物合金は、次世代の先進ジェットエンジンや自動車エンジンに適用可能な高温構造材料として認知されるようになりました。TiAl合金は、その比重が現在使用されているニッケル基超合金の約半分であることから、燃焼エンジンの設計コンセプトの改良を可能とし、燃料節減やCO_2排出量削減の大きな効果が期待されています。

さまざまな研究の後にクレメンス博士が開発したTNM合金は、鍛造および熱処理により室温で一定の延性を保持しつつ、なおかつ現在使用されている鋳造合金の約2倍の強度を示します。この研究開発過程において、クレメンス博士は、TiAl合金の内部組織を原子レベルからマクロスケールレベルにわたって調べるために、最新の実験的手法を用いました。さらに、鍛造や熱処理などのプロセス技術をリアルタイムで調べるのに、斬新なその場観察技術も用いています。

TNM合金はエアバス社製旅客機A320neoおよびイルクート社製MC-21に搭載されるプラット・アンド・ホイットニー社製ギヤードターボファン（GTF）エンジンの低圧タービンブレードに使用される予定です。

燃費の向上およびCO_2排出量の大幅な削減を目指した、次世代の自動車および航空エンジンに使用される新しい構造用材料は、非常に厳しい条件に耐えうる「軽量かつ高強度」な材料である必要があります。TiAl金属間化合物は、この難しい目標を達成するための重要な材料と考えられています。

クレメンス博士が開発したチタンアルミ合金及びその加工技術は、次世代先進低排出ガス・低燃費エンジンにとって不可欠な要素と考えられており、航空機・自動車の環境性能向上が期待されています。人の行き来に必要なエネルギーをより少なくしうるのに貢献したこの功績は、まさに本田財団設立の理念に合致するものです。

Dr. Clemens is one of the internationally most renowned experts in the field of titanium aluminides. His activities and research on intermetallic γ-TiAl based alloys for more than two decades have significantly contributed to the fact that they are presently seen as key structural materials for high-temperature application in advanced jet and automotive engines of the next generation. Due to almost half the specific weight of TiAl alloys compared to presently used Nickel-base superalloys, improved design concepts can be applied to combustion engines. A considerable potential for saving fuel and reduction of CO_2 emission is a further consequence.

After thorough research activities, Dr. Clemens developed TNM alloys which show approximately the double the strength of already used cast alloys, yet maintaining certain ductility at room temperature. The most advanced experimental methods were applied to investigate the internal structure of the developed TiAl alloy from atomic to macroscopic scale. Furthermore, novel in-situ techniques were used to study technological processes, such as forging and heat treatments, in real-time.

TNM alloy will be used for low pressure turbine blades of geared turbofan(GTF)engines manufactured by Pratt & Whitney for Airbus A320neo aircraft and also Irkut MC-21.

New structural materials have to be “lighter and stronger” to withstand the extremely high demanding conditions in the next generation of automotive and aircraft engines, which are targeted to exhibit higher efficiency leading to reduced fuel consumption as well as significantly decreased CO_2 emissions. Intermetallic titanium aluminides are considered as key materials to meet this challenging goal.

The titanium aluminum alloy and the processing technology developed by Dr. Clemens are considered as key elements to be used in the next generation of advanced low-emission/fuel-efficient combustion engines. Thus, improvement in environment performance of aircraft and automobiles is anticipated. His achievements could further reduce energy necessary for transporting humans and are recognized as exemplifying the philosophy of the Honda Foundation.

角南 篤 教授
Prof. Atsushi Sunami

1965年日本生まれ。政策研究大学院大学教授・学長補佐／科学技術イノベーション政策プログラムディレクター代理／教授

Born in Japan in 1965. Advisor to the President; Deputy Director of Science, Technology and Innovation Policy Program ; Professor, National Graduate Institute for Policy Studies.

専門分野：科学・産業技術政策論、公共政策論

Specialty : Science and Technology Policy, Public Policy Analysis

現在の研究対象

国家（地域）イノベーション・システムの比較研究（主に中国）、アジアの科学技術政策、「Evolutionaryアプローチ」を用いた科学技術分野における政策形成過程の分析、「科学技術と社会」（レギュラトリーサイエンスの制度設計）

略歴

1988年、ジョージタウン大学School of Foreign Service卒業、89年株式会社野村総合研究所政策研究部研究員、92年コロンビア大学国際関係・行政大学院Reader、93年同大学国際関係学修士、97年英サセックス大学科学政策研究所（SPRU）TAGSフェロー、コロンビア大学政治学博士号（Ph.D.）取得。独立行政法人経済産業研究所フェロー。2003年政策研究大学院大学助教授、2014年教授、学長補佐（現在に至る）。主な著書はIntellectual Property Rights, Development, and Catch Up an International Comparative Study（Oxford Univ. Press, 2010）, “Environmental Technology: Hong Kong’ s Innovation System” in Innovation and the Limits of Laissez-faire: Hong Kong's Policy in Comparative Perspective, （Palgrave, 2010）, A Comparative Study on the Role of University and PRI as External Resources for Firms' Innovations, （ERIA Project Report 2011, No.10）

Current Research Interests

His research has concentrated on a comparative analysis of national innovation systems and an evolutionary approach in science and technology policy and public policy analysis in general.

Education and career

Professor Sunami holds BSFS from Georgetown University. He obtained MIA and PhD in Political Science from Columbia University. He was a Fellow at Research Institute of Economy, Trade and Industry established by the Ministry of Economy, Trade and Industry, Japan. He also worked as a researcher in the Department of Policy Research at Nomura Research Institute, Ltd. from 1989 to 1991. He was a visiting researcher at Science Policy Research Unit, University of Sussex, and Tsinghua University, China.

Atsushi Sunami is currently Professor, and Special Assistant for the President, President’s Office at National Graduate Institute for Policy Studies, Japan. The recent publications include Intellectual Property Rights, Development, and Catch Up an International Comparative Study, edited by Hiroyuki Odagiri, Akira Goto, Atsushi Sunami, and Richard R. Nelson（Oxford Univ. Press, 2010）and “Environmental Technology: Hong Kong’s Innovation System” in Innovation and the Limits of Laissez-faire: Hong Kong's Policy in Comparative Perspective, edited by Doug Fuller,（Palgrave, 2010）. A Comparative Study on the Role of University and PRI as External Resources for Firms' Innovations, edited by Atsushi Sunami and Patarapong Intarakumnerd, （ERIA Project Report 2011, No.10）

本田財団設立のきっかけとなった ディスカバリーズ国際シンポジウムと本田賞の創設

The DISCOVERIES International Symposia as the origin of the Honda Foundation and establishment of the Honda Prize

社会における自動車のあり方、交通社会の現状と将来のあり方をテーマとし、自由に討議・研究する場として発足した国際交通安全学会（IATTS）。その活動を世界に広く発信すべきだとして、1976年に「ディスカバリーズ（DISCOVERIES*）」と銘打たれた国際シンポジウムが開催されました。

その反響は想像以上に大きく、とりわけ文明論的、学術的なアプローチが高い評価を得て、継続的にシンポジウムを開いていくべきとの機運が高まりました。そして1977年、ディスカバリーズの運営母体として、本田財団は設立されたのです。

以下に引用するのは財団活動の根幹となる3つの取り組みが規定された『ディスカバリーズ宣言』です。この宣言をもって本田賞が設定されました。「ディスカバリーズ国際シンポジウム ストックホルム1979」で発表された文章の端々には、設立前夜の熱気を感じることができます。

＊Definition and Identification Studies on Conveyance of Values, Effects and Risks Inherent in Environmental Synthesis. 環境全体において、人間活動に何が本質的問題かを発見する――という意味の英文の頭文字を取ったもの。

The International Association of Traffic and Safety Sciences（IATSS）was established as a venue for free discussion and research to explore the role of the automobile in society and the current state and future of our motorized society. The first DISCOVERIES* international symposium was organized in 1976 to communicate with other countries and to promote its activities across a broader spectrum.

Its impact exceeded the Association's expectations, winning high recognition for its academic focus and theoretical approach to examining our civilization, and it seemed certain that the symposium would continue thereafter. The Honda Foundation was subsequently established in 1977 as the organizing body for the DISCOVERIES symposia.

The following is the "DISCOVERIES" DECLARATION that defined three objectives that serve as the basis for the Foundation's activities. The Honda Prize was established by this Declaration. The passages from the Declaration at the DISCOVERIES International Symposium Stockholm 1979 reflect the momentum building on the eve of its establishment.

ディスカバリーズ宣言

1979年8月17日　ストックホルム

人間尊重の文明を創造することは、今日、われわれ全人類にとっての大きな願望であります。それは、現代に生きる多くの知識人、とりわけ科学技術にたずさわる人々の相互協力によって、はじめて可能になり得るものであります。

本田財団によるディスカバリーズ国際シンポジウムは、こうした理念をもとに、東京にはじまり、文明のふる里ローマ、文化の都パリ、そして学術と科学の薫り高いストックホルムへと引きつがれてまいりました。

われわれは、これまでの国際シンポジウムにおいて、現代文明に内在するものと考えられるカタストロフィーについて討論し、人類が早晩直面するであろうメガクライシスへの認識を深め、これに対処するため"インフォメーション"と"コミュニケーション"という、人間活動にとっての最も基本的な課題について、総合的な検討を行ってきたのであります。

われわれのディスカバリーズ活動の目標は、現代の技術文明が直面している真の問題を見極め、それらに取り組むための方法論を見出し、ついで、この任務を果たすために人間の英知を結集する舞台をつくることであります。

このため我々は次の三つの活動をはじめることを宣言いたします。

1.エコ・テクノロジー確立のための国際的技術協力の推進

人間社会に真に役立つテクノロジーを確立することを目的としています。

エコ・テクノロジーの概念はエコロジーとテクノロジーの調和をはかるものであり、適合技術（アプロプリエート・テクノロジー）をも含むものであります。

2.本田賞の設定

エコ・テクノロジーの分野で顕著な業績をあげた方に贈呈いたします。

原則として年間一名、副賞として賞金1,000万円。

3.ディスカバリーズ国際シンポジウムの継続

エコ・テクノロジーの分野に関連し、今後も必要に応じ、国際シンポジウムを開催いたします。

"DISCOVERIES" DECLARATION

Stockholm, August 17, 1979

The ardent desire of mankind today is to create a civilization in which utmost respect is paid for the human being as such, and this will be possible only with mutual support and concerted action among the intellectuals of the world, especially among scientists and technologists.

The Honda Foundation, inspired by this philosophy, has sponsored the "DISCOVERIES" International Symposia, first in Tokyo, then in Rome, the cradle of civilization, and Paris, the capital of culture, and now in Stockholm, this serene guardian of academic and scientific achievement.

At these symposia we have discussed the catastrophe deemed inherent in modern civilization, recognized the megacrisis which will sooner or later confront mankind, and, in order that mankind may overcome that crisis, made comprehensive studies of the fundamental prerequisite for human activity, that is, information and communication.

The purpose of "DISCOVERIES" activity is to identify the real problems facing the mechanical and technological civilization of today, to discover the methodology which will enable us to cope with them, and to set a stage for the concentration of the wisdom of mankind on the task,

To achieve this purpose, we now declare that we shall:

1. Promote international technical cooperation for the establishment of *Eco-Technology*

The aim here will be the establishment of a technology which will truly serve humanity, *Eco-Technology* being a concept which includes appropriate technology.

2. Establish a HONDA PRIZE

It will be awarded each year to a person who has made an internationally recognized achievement in the field of *Eco-Technology*, with an additional prize of ten million yen (¥10,000,000) going to the same person.

3. Continue the "DISCOVERIES" International Symposia

These will continue to be held, as the need arises, in connection with the field of *Eco-Technology*.

Opening Speech

Mr. Hiroto Ishida

Opening Speech

I am Hiroto Ishida, thank you for the introduction. I would like to thank everyone who came here today despite your extremely busy schedule. It has been already 37 years since Honda Foundation was established with the goal of contributing to the creation of a humane civilization. In that period, various technological innovations have occurred, and the political and economic worlds have also changed immensely.

However, there are many of us who are disheartened by such news as the increasing sense of crisis from global warming despite the proliferation of activities to reduce carbon dioxide emission, the remarkable worsening of pollution also in developing countries, and the seemingly endless regional conflicts and terrorism. With eyes fixed on these real world problems, looking for solutions to each one, Honda Foundation ponders what we should do to realize the creation of a humane civilization that it hoists as a slogan. What kind of future should we leave to the next generation?

To commemorate the 35th anniversary of the Honda Prize awarding ceremony, I would like to invite everyone to think together about such problems as I open this symposium. We lift up the Honda Prize to the men and women who have made considerable achievements in bringing us closer to the ideals of civilization that we aim for.

The Honda Foundation has advocated ecotechnology, for its ability to harmonize the natural environment and human society, as an approach to solving various problems, and our invited speakers, Dr. Andersson, Dr. Reddy, Dr. Le Bihan, and Dr. Clemens, who will be joining the circle of the Honda Prize laureates on the 17th, are highly recognized practitioners.

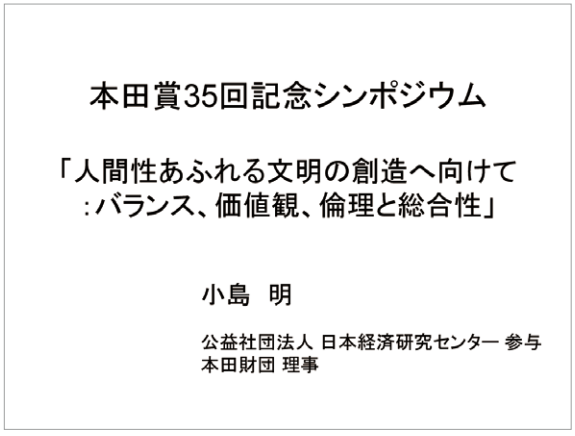
Today, we shall listen to four different perspectives as these four gentlemen express their excellent views on ecotechnology through their lectures and panel discussion, and may their thoughts shine a bright light into the future. I also urge everyone to lend their ears to these distinguished scientists and experts, and together, let us think of what we ought to do as a step towards creating our ideal world. It would indeed be a great joy for me if this were possible. I hope everyone will have a relaxing day today. Thank you very much.

Keynote Speech

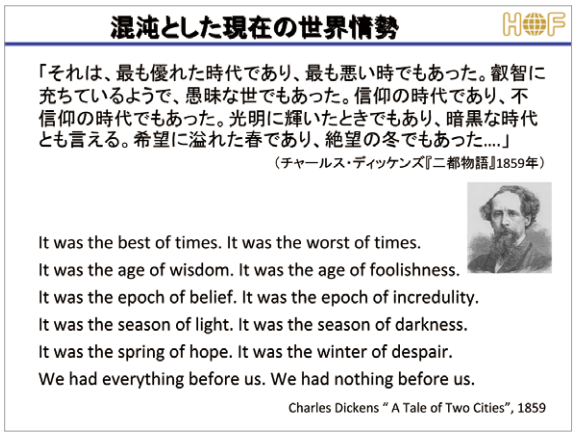
Toward Creation of a Truly Humane Civilization

Mr. Akira Kojima

Toward Creation of a Truly Humane Civilization



Good day, ladies and gentlemen. I am Kojima. Since there was already an introductory video presentation and President Ishida had already spoken precisely about the essence of this symposium, I am somewhat at a loss as to what to talk about. However, please allow me to recapitulate the objectives and concept in order to carry on this symposium in regard to the important theme "Toward Creation of a Truly Humane Civilization." I would appreciate it if you would take this as a report on what I just mentioned rather than a keynote speech.



First of all, the world, including present-day Japan, is in a very chaotic state as unexpected events occur one after another and the risk is increasing. The statement in the slide is fondly remembered. The following words appear at the beginning of Charles Dickens' *A Tale of Two Cities*. This speaks of 1858, but it

seems to speak about our present world as well.

"It was the best of times, it was the worst of times, it was the age of wisdom, it was the age of foolishness, it was the epoch of belief, it was the epoch of incredulity, it was the season of Light, it was the season of Darkness, it was the spring of hope, it was the winter of despair, we had everything before us, we had nothing before us..." This is a famous opening passage.

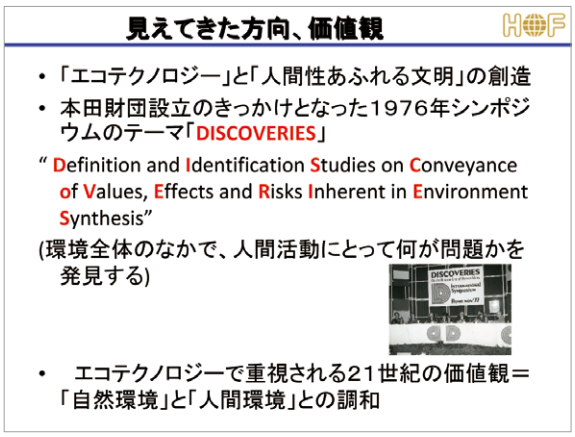
However, even as the new era is appearing before us, we recall that on the 9th of this month, 25 years had elapsed since the collapse of the Berlin Wall in 1989. Through this event, the process of ending the cold war had drastically accelerated. In 1991, the Soviet Union collapsed. The drama of the end of the cold war that had continued for more than 40 years happened only very recently.

November 9, 1989 is the day that the Berlin Wall collapsed. If we try to remember, 11 and 9 are days on which fairly significant or unexpected events happened by sheer coincidence. The opposite of 11.9 is 9.11, and this is the day on which the simultaneous terrorist attacks happened in the United States. 9.15 refers to September 15, 2008 during which Lehman Brothers went bankrupt and a financial crisis that jolted the world set in. 3.11 refers to the great earthquake of 2011 that we in Japan experienced. Yet, in any case, just like the rapid unfolding of the end of the cold war with the collapse of the Berlin Wall in 1989, many people expected peace and stability in the post-cold war world.

But this has not necessarily been the case. In 1991 when the Soviet Union collapsed, the Japanese bubble economy burst resulting in harsh economic conditions that still persist. If one were to speak of the rest of the world, as pointed out by the Nobel Prize economist Joseph Stiglitz, the 1990's was an era of mega growth. In the midst of all these, there are high expectations that the 21st century would be one of peace and prosperity. But as pointed out in the earlier video, the reality is that in terms of number, there are more conflicts in the present than in the cold war era, and the resolution of these conflicts is hardly in sight. The world has become more unstable.

Even as the economy grows, severe crises keep recurring time and time again. Concerning this world, the American political scientist Zbigniew Brzezinski, who in the past wrote *Hiyowanahana, Nippon* or *Japan: The Fragile Blossom*, stated the following in his book *Out of Control*: "History is accelerating, however its trajectory is becoming unstable. Established values are massively collapsing especially in the advanced parts of the world. Consumerism masquerades as a substitute for ethical standards. The world is rather like a plane on automatic pilot, with its speed continuously accelerating but with no defined destination." That was how he characterized the 1990s.

That being said, our future direction and our shared values are slowly coming within sight before us. You may call this foresight when in December 1977, Honda Foundation was established, and continues with its advocacies following the principles of Soichiro Honda, "Technology must be humble and humane, and must give care to all aspects of the natural environment, including man."



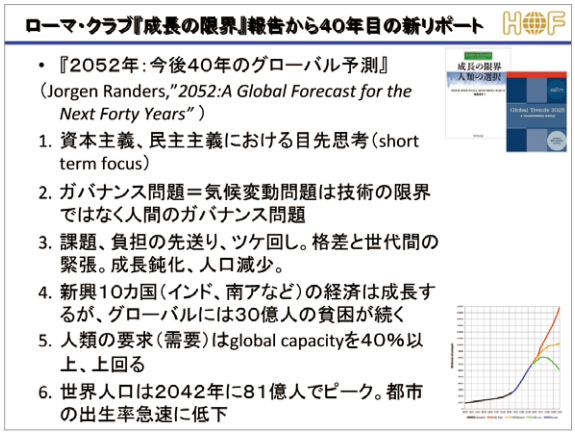
The catalyst for this was the symposium entitled "DISCOVERIES" held in 1976. This word "DISCOVERIES" is indeed a sophisticated coinage. An acronym for "Definition and Identification Studies on Conveyance of Values, Effects and Risks Inherent in Environment Synthesis," it is a statement signifying the discovery of what the problems are for human activities in the entire environment.

There was considerable impact when the symposium "DISCOVERIES" was opened. Expectations rose that the discussion would continue and expand, and, in fact, Honda Foundation was born in 1977 in response to such demand. Since the Honda Foundation consistently identified itself with ecotechnology as a focal point, its awareness of the issue has been very clear from the start. It has maintained and pursued its focus on ecotechnology, superimposed on the ecosystem and science and technology.

As earlier mentioned, the Honda Prize was established in 1980 to recognize individuals or groups with remarkable accomplishments in ecotechnology. And now, we are commemorating its 35th anniversary. As we commemorate this 35th year, we have the Honda Prize laureates come on stage to discuss the ideal state of civilization.

One of the realities given attention to in ecotechnology is the increased burden on the environment as a result of brisk economic activity aided by science and technology. At the same time, it is important that ecotechnology also seeks to correct the kind of development that neglects not only the natural environment but also, at times, humanity. The idea is to give care not only to harmonizing the natural environment, but also to harmonizing it with the human environment. This is the 21st century—the world has to take these ideas seriously as shared values and respond accordingly.

Perhaps everybody has heard about the Club of Rome. The Club of Rome is a private organization established in 1970 as a Swiss corporate entity. Consisting of scientists, economists, educators and business leaders from around the world, it has been discussing the various problems attendant to science and technology and economic development. It became widely known when it published a famous report in 1972 entitled, *The Limits to Growth, Crisis of Mankind*. The report *The Limits to Growth* warns that unless we respond promptly to demographic changes and economic development, we would face the problems such as environmental destruction, depletion of natural resources, and food crisis.



Protest and criticism arose from the global industry against this. They argued that zero-growth theory or anti-growth theory is nonsense. But subsequently, in 1973, the oil crisis occurred, an event that Japan can never forget, and because of this the Club of Rome drew a great deal of attention from around the world.

In 2012, an updated version of *The Limits to Growth* report was released. In January 2012, or forty years after the publication of *The Limits to Growth*, I incidentally had the chance to attend the 40th commemorative annual conference held in Bucharest. There, an outlook on the next 40 years was presented. This was also translated into Japanese. Jorgen Randers, an environmental strategy professor who was one of the authors of *The Limits to Growth* 40 years ago, also attended, and both the retrospective of the past 40 years and the perspective and challenges of the next 40 years were discussed.

The points made by Prof. Randers can be summed up as follows. The most important issue for the next 40 years is the short-term focus or shortsighted thinking on capitalism and democracy. Unless this is rectified, the long-term well-being of mankind cannot be realized, and the world's response to significant issues will be too late.

The second point is the problem of governance. He stated that if the problem of

climate change will not be solved in the next 40 years, it will not be because of the limitation of technology itself but because of the issue of people, the problem of governance. There is no dearth of what is technologically available, such as heat-insulating materials, heat-insulating homes, battery cars, solar panel, wind power and many others. But if society is built solely for the purpose of maximizing short-term profit, we will lose the ability to respond to this problem.

The third point is that perhaps both democracy and capitalism have not given sufficient consideration to repercussions on our children and grandchildren. The burden of the responsibility and unsolved issues are passed on to the next generation. It is very likely that henceforth, the tension between generations will intensify. In fact, in the last 20 to 30 years, economic disparities have widened markedly in the United States. As a result of this, appropriate measures are being discussed. However, simply putting the brakes on economic growth rates will not solve the problem.

The fourth point is that while the economies of 10 emerging countries such as India and South Africa are growing, poverty continues among 3 billion people globally. The fifth point is that the desire, want or demand of mankind exceeds global capacity by 40%. How do we deal with this problem? The sixth point is that world population will peak at 8.1 billion in 2042. After this, the population will decline. I think it pointed out the problems that accompany change of value systems due to urbanization and remarkable trends of a drop in birth rate will then be apparent.

The point that was repeatedly alluded to and emphasized in the Bucharest annual conference was that capitalism, market economy, and democracy will become increasingly so shortsighted in its thinking that the world will not be able to sufficiently address the structural and deep-seated problems that confront mankind. What left the greatest impression on me were the words "Short-termism" and "Governance."

As a matter of fact, I have been frequently hearing the word "short-termism" in the US after the Lehman Shock in 2008. Short-termism in the US is a criticism against economics and management that attach too much emphasis on the financial aspect. Demonstrations against the short-term profit-seeking financial industry symbolized by Wall Street have been in the news.

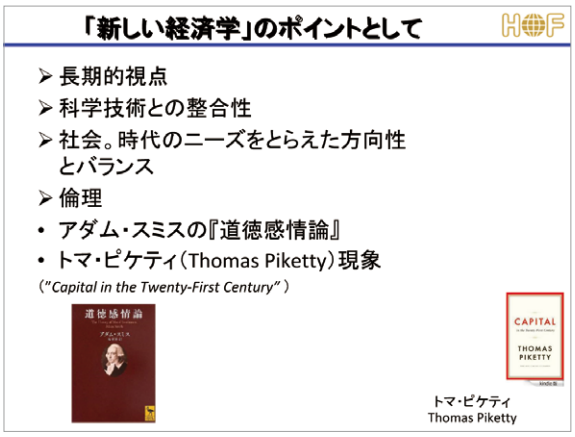
At the Bucharest annual conference of the Club of Rome, aside from the points made by Randers, Wirkman's report on *Bankrupting Nature* and Prof. Lietaer's *Money and Sustainability* were also released. Centered on these two reports, the conference tried to discuss issues from a future-oriented, long-term perspective. The Club of Rome avoids propounding zero growth or anti-growth policies as measures against the global crisis. Zero growth or anti-growth policies will not solve the problem. The consensus at the conference was that the quality of growth is important and thinking only in terms of GNP has to change.

What came out of this was a discussion on the need to build "New Economics." There, it has been determined that the present Economics is outdated and can no longer address real issues, the reason raised being the triple divorces. The first is the divorce between production and employment, the second between finance and real economy, and the third between economy and ecology. There were also reports by working groups regarding this problem.

Among the reports, the following statement was made. The New Economics must be built not through realistic dogmas but through rational thinking. The Economics we should aim for is not one of mathematical rigor but one concerned with the well-being of mankind. The present economics is based on the flawed accounting system that makes growth, any form of growth, desirable.

It is pointed out that the present system of

accounting lacks a viewpoint that seeks to improve harmonization of economic benefits from such problems as war, pollution, crimes, spikes in oil prices, terrorism, contagious diseases, natural calamities, scarcity of water resources, and destruction of forests with improvement of nutrition, housing, health, and society. Or, on the other hand, it just treats all these problems alike. What the New Economics seeks is consistency with science and technology as well as balance and ethics.



The following point was raised in regard to the second of the three divorces, namely the divide between finance and real economy. In 1997, the Asian crisis broke out. In Japan, the financial crisis began in November of that year. Attending the January 1998 Davos Conference in Switzerland that was held in the midst of the Asian crisis, I had a random conversation over breakfast with George Soros, a financial capital guru.

He said the following. "The Asian Financial Crisis was not an Asian crisis. Neither was it a financial crisis. In essence, it was a global crisis of finance capitalism. The finance world is different from the real economy. In the real economy, processes such as product planning, design, procurement of raw materials, production of parts, assembly, manufacturing, sales, after-service care, and sales service take time. In that interval, price is determined by demand and supply, and move spontaneously towards equilibrium."

However, in the financial market, transactions are instant, and as soon as an expectation of price arises in the market, new supply and demand arise immediately in response to it. The price of money is interest rate, foreign exchange rate and stock price, and as soon as this is determined a new expectation arises, which results in the shaping up of a new price, and gradually the prices undergo significant change. On the final analysis, the price can deviate in any number of ways from the equilibrium of neoclassical economics, and the equilibrium point from the theoretical.

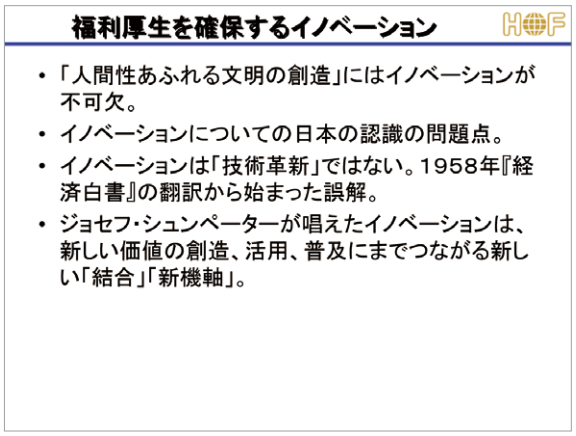
This actually happened during the Asian crisis, which George Soros pointed out was in fact a global financial crisis. The Davos Conference was held in January 1998, and by the end of the year, he published a book that clearly posited the problem. By the way, if you look at the present financial capital market, stock exchanges all over the world compete against one another. Within that, high-speed trading proceeds in what can only be called an abnormal manner. A system is being developed that makes possible trading in 1 millionth of a second or 100 millionth of a second. Competition in the development of this system has given rise to a world which makes it difficult to make a profit unless one is able to invest in units of 100 millionth of a second.

In the recent boom in discussion of economic systems, the problem of disparity as shown in the introductory video has come up. The book written by French economist Thomas Piketty on the 21st century capitalism is gaining attention among readers around the world. Originally written in French, it became a worldwide bestseller after it was translated to English, selling 400 thousand copies three months after the English edition came out, of which 75% were sold in the heart of capitalism, the United States of America. The sense of crisis towards the excesses of American finance capitalism is very strong. Unable to address this crisis, the Obama administration received a considerably severe backlash in the recent mid-term elections.

What are needed in the New Economics are long-term perspective, consistency with science and technology, a sense of the times and a sense of ethics. To deliver positive results towards the creation of humane civilization, there must be a sound awareness of social needs, the needs of the times, and a sense of direction whether in economics or in science and technology.

If one were to speak of Adam Smith, he would be like the originator of free competition and free economy. But there is a book that he had revised many times and he claimed was more important. It is not *The Wealth of Nations* but *The Theory of Moral Sentiments* which placed greater emphasis on the ethical aspect. It is said that he revised it many times.

In 1990, I incidentally had the chance to attend the 200th year commemorative conference of Adam Smith held in University of Glasgow. In that conference, the ethical issues in economics as expounded in *The Theory of Moral Sentiments* drew attention. Whether in economics or science and technology, what will become increasingly important are not fundamental principles or fundamentalism but synthesis, morality, and balance. From what viewpoint should one resolve the issues of global environment, energy resource, aging society, contagious diseases, and medical problems is extremely important. Alongside the energy issue of Peak Oil, Peak Water, or the problem of water resources, is increasingly being discussed.

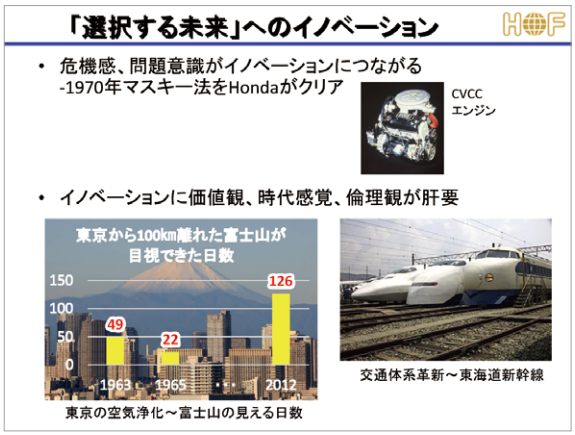


Be that as it may, innovation will become a very important issue. Innovation is essential to the "creation of a truly humane civilization." However, what is more important than innovation only in science and technology is a multi-faceted, comprehensive innovation that encompasses government administration, policy decision-making process, management and academic-industrial cooperation.

In Japan, innovation is generally spoken of as technological revolution. Therefore, partly as a result of the translation of the word of "technological revolution," there is a tendency for "innovation" to be used in the context of an engineer's worksite. This came about because in the 1958 *Economic White Paper* by the government, "innovation" was translated as "technological revolution."

At that time, Japan was a late-developing industrial country that was catching up, so it may have been alright to limit the word to technological revolution, but now that use is being strained. The word has to be discussed in a broader context. There was a famous, Austria-born scholar named Schumpeter. Discussing innovation in a systemic manner, he defined innovation as a new combination or a new idea that leads to the creation, practical application, and diffusion of new values.

In concrete terms, he pointed out five aspects, namely the production of new goods and services still unknown to consumers; second, the introduction of an improved or better method of production; third, the cultivation of a new market; fourth, the procurement of a new source of supply of raw materials or half-manufactured goods; fifth, the realization of a new organization. To discuss this in the present context, a multi-faceted systemic innovation that includes the state's policy decision-making process is very important.



Next, the ability to choose our future is very important to innovation. Fifty years ago in 1964, the Tokyo Olympics were held. At that time Japan was still in the least developed stage and the quantitative expansion of its economy was an overriding imperative, so everyone was happy about the high

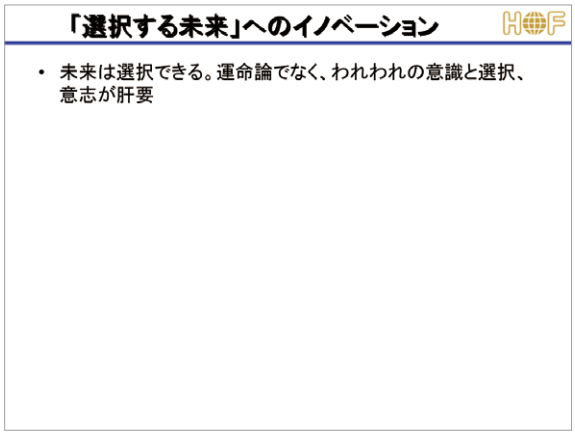
growth. Seeing smoke coming from the chimney, I remember rejoicing, "Oh, Japan is alive and kicking." However, several years later, rivers in big cities like Tokyo became muddy with black filth, and the fish disappeared. The atmosphere was also so polluted one could get asthma. Pollution was such a big issue in the Diet during 1960s that it generated a debate so rabid it earned the nickname "pollution Diet."

But it gave rise to a sense of crisis that in turn generated a multi-faceted innovation. The Muskie Act of 1970 addressed the issue of pollution, and Honda's CVCC took the challenge of the strict standard to significantly reduce SOx emission. Furthermore, someone has been conducting an ocular observation to determine how many days in a year Mt. Fuji was visible from Tokyo for even a short interval during the day. One year prior to the Olympics in 1963, it was visible for 49 days of the year. However in 1965, one year after the Olympics, it was visible for only 22 days, and I think the environment progressively deteriorated afterwards until the number of days fell to zero.

But the new innovation born inside organizations gave rise to changes not only in technology itself but also in management style, state administration, and lifestyle and, as a result, Japan became an environmentally advanced country. In 2012, one could catch a glimpse of Mt. Fuji for 126 days in one year. Very recently, we learned from the news that a man from Kyoto, 220 km away from Mt. Fuji, succeeded in taking photographs of the mountain. This is one symbol that Japan has been able to address the pollution issue through innovation.

Now, the lower right photo shows a bullet train. It has been 50 years since the Tokaido Shinkansen was launched. It has transported 550 million people without accident within those 50 years. Barring earthquakes, its time is very accurate. More than being merely an innovation in transport technology, it is an example of innovation of management. It is progress in operation. It has had a powerful effect on the world's transportation system as a whole. Therefore, when it comes to innovation, it is important to think from a broad perspective.

Certainly, there are enormous difficulties in realizing the theme of helping create a humane civilization but by checking our value system, and weaving balance and ethics into innovation, it can become more feasible. What are essential are awareness and choice, not fatalism. In other words, the perspective and the standpoint where we can choose our future through our own effort is necessary. Likewise, we can overcome the issue of aging society through a broader definition of innovation and create a deep, mature society.



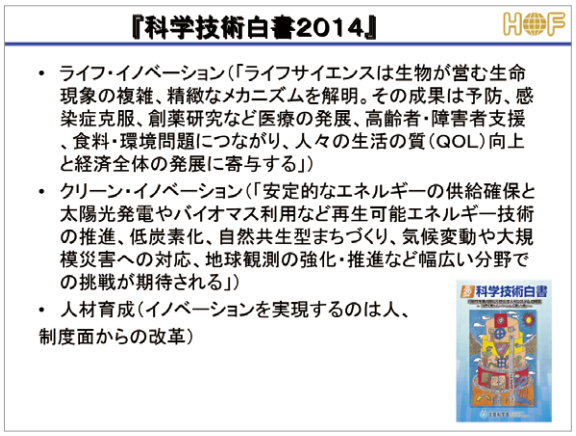
Being one of the pillars of growth strategy in Abenomics, robotics holds possibilities not only at the production site but also in a variety of other fields. The photo on the left side is that of a wearable robot that was developed by Prof. Sankai's group from the University of Tsukuba. This is an excellent invention. A limbless person's brain can connect to a robot through its sensor, and when that person thinks of walking, the machine detects minute signals and moves forward. It is indeed a marvelous invention.

In fact, Japan's administrative innovation is hampering the use of robotics. In Europe, mainly in Germany, robots are rapidly being adopted for use even in hospitals. Especially in Germany, if one uses one, it is covered by public health insurance. In Japan, however, it can be used in nursing care to assist in work that requires use of muscles, but not in medical care. It is an example of technological innovation that holds great possibilities in Japan if such innovation were adopted in its broad meaning.

Furthermore, Japan has already made advances in such fields as plant factories, renewable energy, hydrogen energy, and fuel cell batteries, as well as the so-called Elements Strategy for the

securement of rare earth functions, its areas of expertise, and should challenge itself further towards the technological innovation frontier that is integral with the economy. I believe this frontier is immense.

Next, I have also picked out some points at issue in the NIC (National Intelligence Council) Report. Where are the areas of possible technological innovation? These areas are classified into three based on degree. Aside from robotics that we have already mentioned, the other areas of possibility are energy, water treatment facilities and the ubiquitous computer. How do we choose the field and move in the direction that will enable us put it to actual use?



Finally, I would like to mention this year's *White Paper on Science and Technology*. The *White Paper on Science and Technology 2014* released by the Ministry of Education, Culture, Sports, Science and Technology in June this year promotes life innovation and clean innovation in light of the 3.11 disaster and the 2020 Tokyo Olympics. The idea of the white paper is to convey to the world the very objective of this symposium, which is ecotechnology, and to cooperate with countries in the world.

The Tokyo Olympics 50 years ago symbolized a developing country's pursuit of quantitative expansion and growth. It has been 50 years since then, and the question that will be asked about the second Tokyo Olympics, which will be held a few years hence, is how Japan can translate its mature society and new innovation into the enhancement of social and global well-being. It will be an important opportunity to showcase in concrete forms our contribution to today's very theme of humane civilization, which includes environmental issues.

We look forward to hearing specific wisdom from the lectures of Honda Prize laureates who are here today. I appreciate your forbearance and thank you for your presence here today.

Commemorative Speech

The Changing Economic System

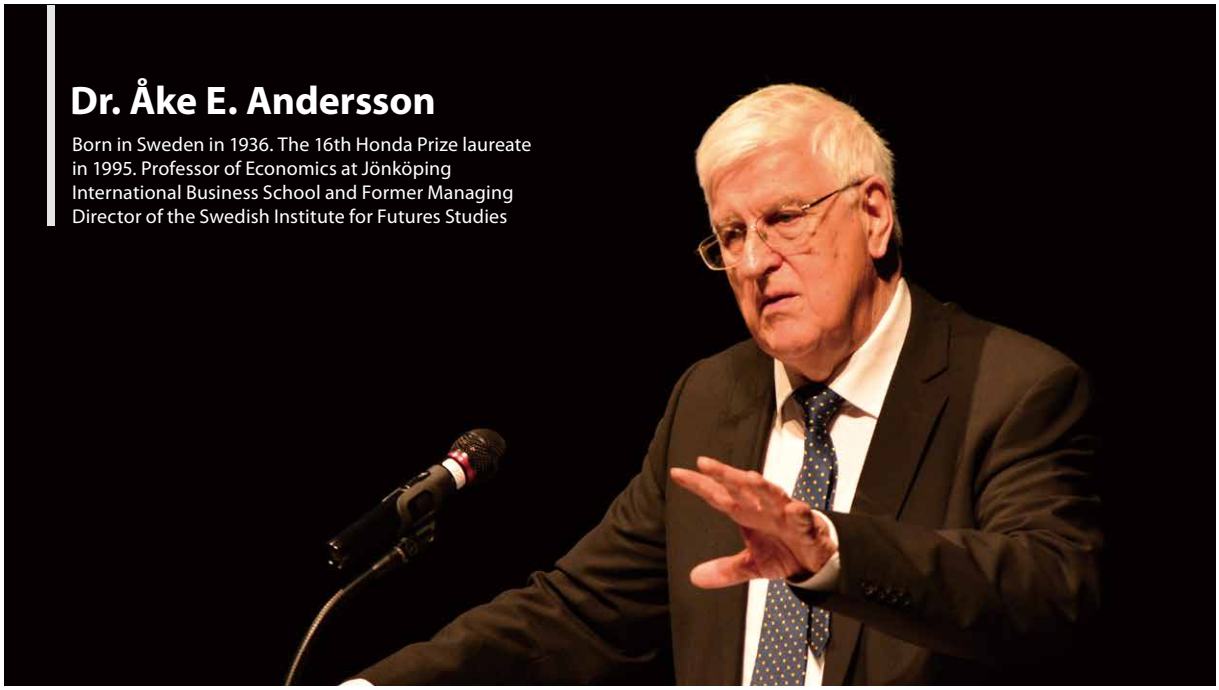
Dr. Åke E. Andersson

Guardian Angel Technologies: Providing Right Information to the Right People

Dr. Raj Reddy

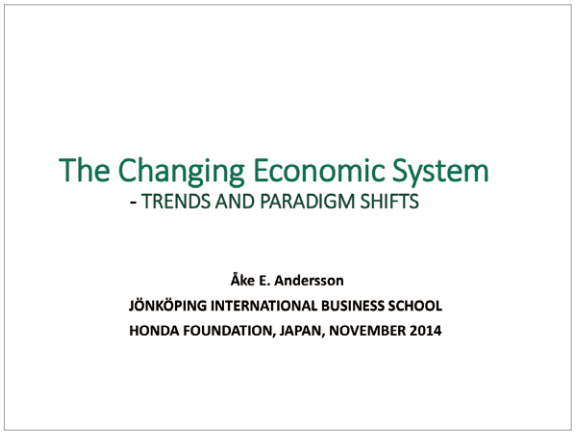
Ecotechnology of the Water Molecule in Biology and Medicine

Dr. Denis Le Bihan



Paradigm Shift

The Changing Economic System



Ladies and gentlemen, I am very honored to be one of the contributors to the Honda Foundation memorial system.

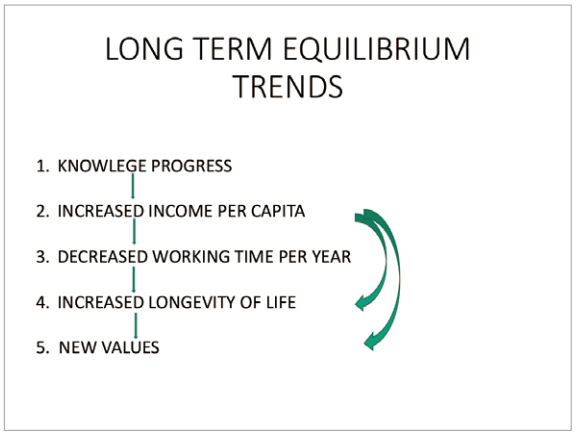
When we are looking at economic development, we must be very clear about two things. The first is that most of the time over history our societies have experienced equilibrium growth, and much of the time we have thus experienced rather predictable situations.

However, once in a while there is a phase transition or a major change of the whole economic structure, and we are currently, after 200 years of industrialization, moving into such a phase transition.

The global economy is now rapidly changing and becoming increasingly dependent on cheap, long-distance communication capacity, cognitive and creative occupations, and a capacity to handle cultural differences and conflicts.

As I said before, the reasons for the changing global economy are to be found in a phase transition that we will soon experience and a persistent equilibrium economic growth caused by the growth of knowledge due to steady growth of education and by research and development activities of research institutions and industry, and the innovations made possible by research and development activities.

The recent phase transition, I will talk about a little later, and it has to do with a soft and hard infrastructure for communications, for financial transactions and trade, and by the increased openness in many respects of many countries.



The long-term equilibrium trends are associated with knowledge progress. In the early 1960s, there was an extensive discussion about the relative role of different factors of production, and an American economist, Robert Solow, claimed that in fact the long-term rate of growth of per capita income in the USA could only, to a very limited extent, be explained by savings, or the growth of the stock of material capital, or the increases of quantitative labor supply.

It is rather the steadily increasing stock of human capital, technological and organizational knowledge that ensures a steady rate of growth of per capita real income of 2% to 3% per annum in the OECD countries and a faster rate of increase, in fact, in the developing economies.

An important contribution by Angus Madison and his associates has made it possible for us to study the macroeconomic accounting data over very long periods of time for a large number of industrialized nations. This database has increased our possibilities to explain the stable rate of growth of real national products, as I will show in a table.

However, if we look at the factors that I will then discuss, we have to start with knowledge progress and look into the impact on the increases of income per capita and how that influences in its turn working time per year, longevity of life of the populations, and finally the emergence of quite new value structures.

So let's look at the rate of growth of economies. If we make a calculation from 1870 to 1979 using Angus Madison's original data, we find that Japan was the world leader. It had a growth rate of 3.0% per year in terms of real per capita income.

Long-term growth rates of real per capita GDP of industrialized market economies 1870–1979 and 1870–2010, per cent per annum

		1870–1979	1870–2010
Japan	wave 3	3.0	2.6
Sweden	wave 3	2.9	2.7
Finland	wave 3	2.7	2.6
France	wave 2	2.6	2.3
Germany	wave 2	2.6	2.5
Norway	wave 3	2.6	2.7
Austria	wave 2	2.4	2.4
Italy	wave 3	2.4	2.2
United States	wave 1–2	2.3	2.4
Canada	wave 2	2.3	2.3
Denmark	wave 2	2.3	2.2
Belgium	wave 1	2.1	2.1
Netherlands	wave 2	2.1	2.2
Switzerland	wave 2	2.1	2.1
Great Britain	wave 1	1.8	1.9
Median		2.3	2.3
Standard deviation		1.5	1.0

However, if we extend the time until the latest observable material in 2010, the income growth has dropped to 2.6% and it's now closing in on the average rate of growth of the OECD countries. It seems like the OECD area is now tending towards something between 2.0% and 2.5% of real per capita income growth.

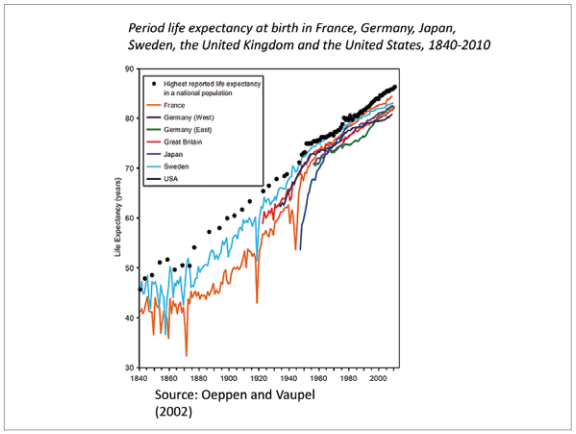
Per capita working time in the OECD countries

What consequences will this have? Well, one of the important consequences is shorter working time and increased leisure time. A persistent empirical regularity in growing economies is the decline in the number of hours a member of the labor force devotes to work within a fixed time period.

An econometric estimate that I've done is based on Madison's data for the OECD countries for the period 1870 to 1980, and it shows that there tends to be a reduction of average working time by

about 0.3% per year in the growing industrial economies, if we have this rate of growth of, let's say, 2.5% per year.

And this result supports the old hypothesis of the backward-bending labor supply curve, which essentially says that you'll make a choice between working more and consuming more when you have an increase in productivity. People simply prefer to work a little less when they can afford even more consumer goods. So there is a kind of break to the consumption and demand with the increasing rate of growth of the economies.



The other phenomenon is the increased longevity of life. John Maynard Keynes, who may be the greatest economist in the 20th century, famously remarked that in the long run we are all dead. And that's not a probabilistic statement, he said, it's a certainty.

Every human being has a finite life expectancy but this finite time period has been increasing in most parts of the world. You in Japan would know that. Globally, the increase in human life expectancy averages between three and four years per generation, which corresponds to a year-on-year increase of 0.6%.

However, according to a study by the National Institute of Health, while some experts assume that life expectancy must be approaching an upper limit, data on life expectancies between 1840 and 2007 show a steady increase averaging about three months of life per year. This is supported by studies by Vaupel and others, as illustrated by the figure above.

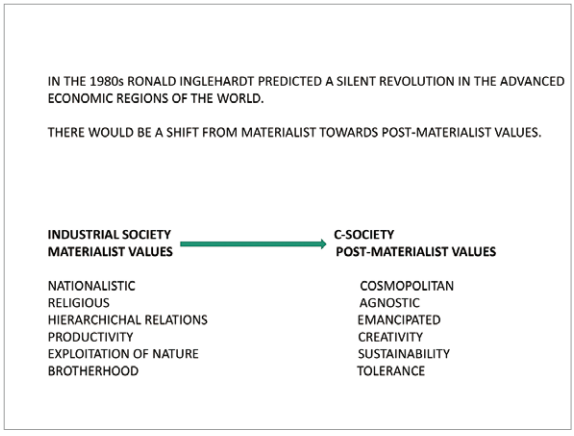
As you can see, it's a fairly linear development over time of life expectancy, and what does this mean? Well, it means essentially that we are approaching a fairly high level of life expectancy, and that will have consequences.

Now if I would summarize some of these long-term trend consequences for people's behavior, I would get the following result. There will be a steadily increasing growth of knowledge and information, even if we don't have a phase transition, meaning that we would move into a new economic system.

There would be an increasing income per capita at the rate of 2% to 3% per annum, with the latecomers having 3% and the early birds having 2% approximately.

There will be an increasing life expectancy towards 100 years in the most advanced parts of the world, and this will, of course, mean that people will have to work for a longer period of their lives. The expectation is that we will have something like 75 years as a fairly normal retirement age in the long run, not the 60 to 65 years that we find currently.

However, the decreasing working time per year is dropping as a consequence of the backward-bending supply curve and that will lead to something like 7%, maybe 8%, of total lifetime being spent working. This is in fact shorter than the share of life that we spend on drinking and eating currently, so in the long run, eating and drinking will be considered a more basic part of life than working.

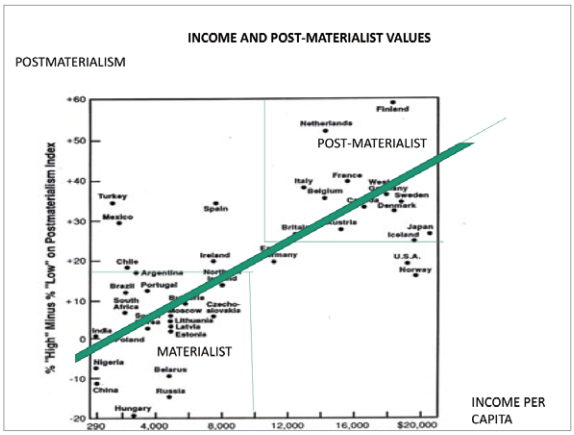


There will be a steady shift towards a post-materialist value structure. What does that mean? Well, it means that we will move from the industrial society materialist value structure when people were

nationalistic, fairly religious on the average, they believed very much in hierarchical relations, productivity was a driving force in every decision process, nature was there to be exploited, and brotherhood was a central aspect of life.

What does it look like in the post-materialist **C-society***, that I would call it? It would be cosmopolitan rather than nationalistic, it would be agnostic, it would be emancipated, it would be creative, it would be sustainable, and it would be rather tolerant. So it's a completely different situation.

* Emerging industrial society as new theoretical model proposed by Dr. Andersson, which aimed at both preserving the natural environment and developing regional economies in the face of aggravated problems with the global environment. "C" features creativity, communication capacity and complexity of products.



Now, the question is can we observe this shift anywhere? Yes, we can. We can observe it rather clearly. This is a classical picture from Ronald Inglehart's study where on the x-axis he has plugged in income per capita and on the y-axis he has plugged in the frequency of post-materialism.

In the upper-right corner you find the typical post-materialist societies at the beginning of this century. You find countries like Finland, the Netherlands, Italy, Belgium, France, Sweden, Germany, Denmark, Austria, Britain, Japan, and Ireland. And in the lower part of it you find countries like Russia, Nigeria, Belarus, Latvia, South Africa, Brazil, Portugal, and so on.

So there is a kind of hidden conflict between the post-materialist countries in the world and the materialist countries in the world, and within the countries there is a conflict between the people who are linked to the old structure and the people, mainly young, well-educated women, who are linked to the new value structure.

CONCLUSIONS FROM LONG TERM TRENDS

1. STEADILY INCREASING GROWTH OF KNOWLEDGE AND INFORMATION
2. INCREASING INCOME PER CAPITA AT THE RATE OF 2 – 3 % PER ANNUM
3. INCREASING LIFE EXPECTANCY TOWARDS 100 YEARS
4. DECREASING WORKING TIME PER YEAR TOWARDS 7 % OF TOTAL LIFE TIME
5. STEADY SHIFT TOWARDS A POST-MATERIALIST VALUE STRUCTURE
6. INCREASING CULTURAL CONFLICTS BETWEEN MATERIALISTS AND POST-MATERIALISTS

Now, let me then move to the paradigmatic changes that we are facing. The paradigmatic changes are actually a historical phenomenon that we can observe. We've had such changes during the latest millennium. The economic history of the world during the last millennium has been dominated by long periods of equilibrium growth or stagnation interspersed by four logistical revolutions or phase transitions.

PARADIGMATIC CHANGES

- THREE LOGISTICAL REVOLUTIONS FROM AROUND 1000 TO 1990 AD FOLLOWED BY LONG PERIODS OF EQUILIBRIUM EVOLUTION OF THE ECONOMIES
- THE FOURTH LOGISTICAL REVOLUTION LEADING TO THE C-SOCIETY, STARTING IN SCATTERED REGIONS IN THE 1990s.
- CAUSED AND PRECEDED BY SLOW AND STEADY EQUILIBRIUM CHANGES OF:

1. COGNITIVE CAPACITIES
2. CREATIVE ORGANISATIONS
3. COMMUNICATION AND CONTACT NETWORKS
4. CULTURE (INSTITUTIONS, VALUES AND ARTS)
5. COMPLEXITY OF PRODUCTS

The first logistical revolution was caused by the institutional and transport-system changes around the Mediterranean and the north of Europe, permitting a massive trade expansion and growth of wealth among the commercial innovators like the Medicis and the Fuggers in Europe, who

actually transformed the European scene in very many respects.

The second logistical revolution happened around the 17th century and was again a commercial revolution based on institutional innovations, but even more by the new sailing possibilities opened up by the creation of the caravel and later the Dutch, very efficient ship, the fluyt.

However, the most important innovation was institutional, and it had to do with the creation of a banking system in Holland and Great Britain where they managed to base the new banking system on governmental guarantees, and that made trade, even over very long distances and long periods of time, something that was viable.

The third logistical revolution, or the Industrial Revolution, started in the 19th century and hit country after country. It is still hitting some countries around the world, the newly industrialized countries. They are still moving from agricultural to industrial structure.

And that was founded on the combined effects of free trade, proper property rights, and specialization of production to reap advantages of division of labor, and trade was no longer then limited to the exploitation of given price differences between regions as it was during the former two big transitions.

It was instead an industrial approach where the focus was on the difference between the price of a good in the importing region and the lowest possible cost of supplying the good.

Importers therefore became interested in influencing the entire chain of logistical costs down to the production sites and bringing the good to the market, including the costs of organizing production and of transporting the product to the market, including the marketing process itself.

So the industrial revolution, which we experienced the last phases of here in Asia and Europe and North America, is a kind of complete logistical chain system.

Now, the fourth logistical revolution is now in effect in parts of the former industrial world. I would say that it's basically a regional phenomenon rather than a national phenomenon. No nation is fully influenced by it, but very many nations are experiencing it in the most advanced regions of those countries.

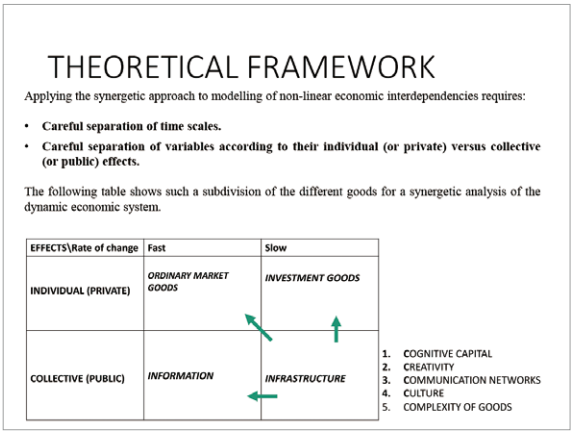
Now this new revolution is based on cognitive capacities; creative organizations; communication and contact networks; culture in the form of institutions, values, and the arts; and the complexity of products. There's an enormous increase in the complexity of products and thus our production system.

In discussions with the Nobel laureate Haavelmo and the Honda laureate Haken, I've found that a seeming paradox can be resolved. What is the paradox? Well, the paradox is the following: all economists and most engineers and policymakers realize that the economic system is essentially very nonlinear, and according to mathematics, the typical character of a nonlinear dynamic system is that it will always go into chaos. So chaos is an inherent problem of the nonlinear economic system.

But Haavelmo, when I talked to him, said, "That's very strange because when I look at the statistics of economic growth, it looks very stable and that's not compatible with the idea of a very nonlinear economic system."

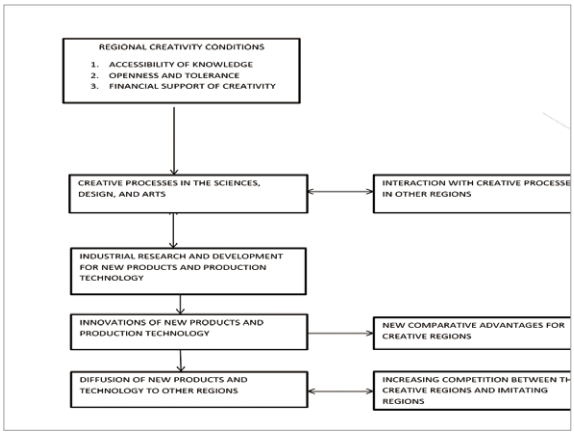
And I discussed this with Hermann Haken, the Honda laureate who could not be here today, and I found that some of his ideas of synergetics could actually be applied to economic theory.

Now, what do you need to do then? Well, you have to carefully separate the timescales. You have to carefully separate the variables according to their individual, or, as they are called in American economic studies, private goods versus collective or public goods, in the terms of its effects.



Now I've done this in this table. I have a rate of change: is it fast or is it slow? And when I say slow, it's by order of magnitude slower than the fast processes. Effects, on the other axes, is individual or collective.

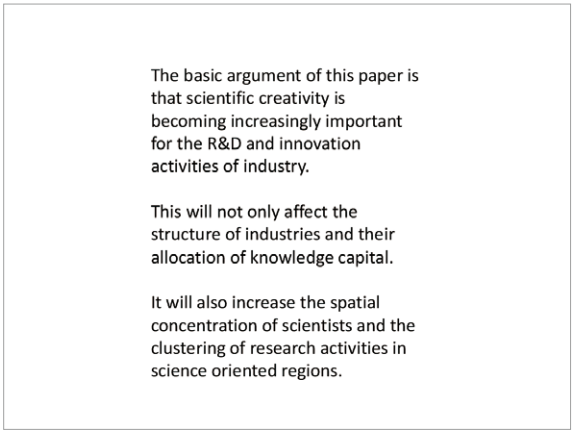
Now in the lower right corner I find the combination of slow and public or collective, and that is what we normally call infrastructure. And basically the idea is that economic decisions are mostly taken by firms and households under the assumption that infrastructure is given and not being changed by, for instance, a natural catastrophe or something like that. It's there as a stage on which the economic games are played.



What is the infrastructure then in this framework? It's cognitive capital, it's creative capacity, it's communication and transport networks, it's culture, and it's complexity of goods. These are the fundamentals on which the exchanges of ordinary market goods are happening and where the growth of private capital is determined.

In fact, with this approach we can actually see the market activities as something that are happening on a stable stage, as long as it is stable and does not change very much. And this was true during the industrial revolution.

Unfortunately, the industrial structure during the growth process goes towards a creative destruction. Sooner or later you come to a point where the arena has changed so much that the classical industrial manufacturing firms do not fit the arena. They start crumbling and fall to pieces and something else must come in its place, and this causes what we call structural unemployment.



The basic argument of this paper that I'm presenting today is that scientific creativity is becoming increasingly important for the R&D and innovation activities of industry. There is going to be a much closer link between scientific studies and industrial research and development and innovation processes.

This will not only affect the structure of industries and their allocation of knowledge capital. It will also increase the spatial concentration of scientists and the clustering of research activities in science-oriented regions.

The accessibility of the labor force with a high level of education is skewed in favor of what I call C-regions, that's regions that are rich in these new resources. The C-regions thus have an accessibility advantage in terms of the dynamics of knowledge accumulation and creation. This in its turn generates a more rapid pace of innovation and the development of new regional comparative and competitive advantages, as will be illustrated.

The knowledge infrastructure determining the conditions of creativity of a region is dependent on accessibility in the spatially extended network for communication and contact. It is also highly dependent on the openness, tolerance, and curiosity of the regional populations, and the allocation of resources to creative activities, and how the intellectual property rights are used in the sciences and arts.

Now, this table shows the overall research and development investments as a percent of GDP. And if we look then at the countries in the north of Europe, Sweden, Denmark, Finland, and the Netherlands, we

find rather high values, especially for Scandinavia: 3.43 for Sweden, 3.06 for Denmark, 3.89 for Finland. And if we take the average for OECD, it's much lower: 2.17% of the GDP during the period 2008 to 2011.

Research and Development Spending in selected OECD countries, 2008–2011

Source: OECD Science and Technology Indicators (2012)

Country	Overall R&D (per cent of GDP)	Scientific research (per cent of GDP)
Sweden	3.43	.90
Denmark	3.06	.90
Finland	3.89	.79
Netherlands	**1.83**	**.75**
Switzerland	2.97	.72
Austria	2.71	.72
Canada	1.80	.69
Norway	1.69	.55
Australia	2.18	.54
Germany	2.79	.51
Ireland	1.79	.51
France	2.12	.48
United Kingdom	1.70	.48
Belgium	1.97	.46
Japan	**3.33**	**.45**
OECD	**2.17**	**.44**
New Zealand	1.30	.43
South Korea	**3.58**	**.40**
United States	**2.28**	**.39**
Spain	1.34	.39
Italy	1.25	.36
Greece	.60	.30

10%-30%: SURPRISINGLY SMALL RELATIVE ALLOCATION OF FUNDS TO SCIENTIFIC RESEARCH

Now, if we look at the scientific research, how big is that? Well if we take Sweden, it's much lower than industrial R&D, which means that we have a problem. If we look at the OECD as a whole, it is 0.44 as compared to 2.17 in total. And if we look at Japan, it's a very high total allocation of resources to R&D, 3.33, but only 0.45% of your national product is going to scientific research. It's a surprisingly small relative allocation of funds to scientific research.

Politicians and bureaucrats who control the allocation of resources to science often assume that the currently popular national innovation policies are best at promoting future comparative and competitive advantages to the countries. The implication is, however, that they tend to support industrial R&D rather than scientific research in spite of the much greater and more widespread long-term social returns that scientific creativity would generate.

I could give you many examples. If we look at information technology, it's often assumed that that is something that happened primarily in the US on the West Coast during the 1980s and 1990s, but the basis of it was created in the 1930s by mathematicians in Britain and at Princeton.

Most of this was, so to say, highly dependent on rather ill-funded scientific research being done under very bad conditions in Great Britain in the 1930s. And it's probable that we will have the same problems emerging today because of the low relative share of scientific research.

TWO OPPOSING HYPOTHESES ON THE ROLE OF SCIENCE

Baumol´s hypothesis: *The R&D divisions of the large firm tend primarily to require personnel who have undergone training for mastery of extant information and analytic methods, while the work of the independent entrepreneur and inventor may prove to be more effectively facilitated by avoidance of that sort of preparation to the extent that it impedes imagination and originality.*
INVENTORS WORK IN ISOLATION FROM SCIENCE

Hollingsworth's hypothesis : *The increasing complexity of fields such as biomedicine means that large and multidisciplinary science teams are becoming increasingly important for basic research, which is the domain that has always been responsible for the most revolutionary creative breakthroughs.*
INVENTORS ARE INCREASINGLY DEPENDENT ON SCIENCE BECAUSE OF THE INCREASING COMPLEXITY OF PRODUCTS

What is complexity of products ?

There are, however, two opposing hypotheses on the role of science. The first one is called Baumol's hypothesis. Baumol is an American economist, associated for a very long time with Princeton, and he says inventors work in isolation from science. The other counter-hypothesis by Hollingsworth says that inventors are increasingly dependent on science because of the increasing complexity of products, and he went around to prove it.

Now the question is then what is complexity of products? What do we mean by complexity of products? Well, there are numerous proposed definitions of complexity. Most of these are, so to say, beer talk based on intuitive reasoning. However, Ray Solomonoff, Andrey Kolmogorov, and Greg Chaitin, three rather famous mathematicians, provided a mathematical and precise definition of complexity.

Complexity of algorithms and products

Kolmogorov and Chaitin provide a mathematical approach to the study of complexity.

Both claim that complexity is measurable: *it is the minimal length of a program or algorithm that yields an exact solution to a pre-formulated problem.*
This can be clarified with two examples.

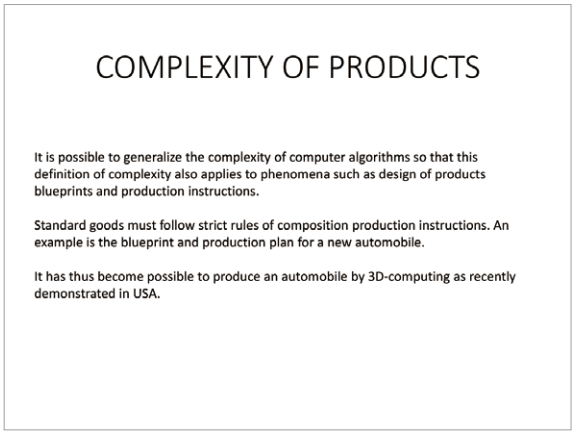
Example 1: 00200030000400000500000006...
Example 2:12154369982134579870981269994333.

It is easy to formulate an algorithm that is shorter than the number sequence of Example 1. In contrast, number 2 has no computation formula shorter than the series itself. It is thus more complex.

They claim that complexity is measurable and can be defined as the minimal length of a program or algorithm that yields an exact solution to a pre-formulated problem. So it's minimal length that defines complexity.

What did they mean? Well, I would say it's easier rather to show you. Let's say that we have example one, which says 002000300004, and then five zeros and 5, and then six zeros and 6 and so it goes on towards infinity.

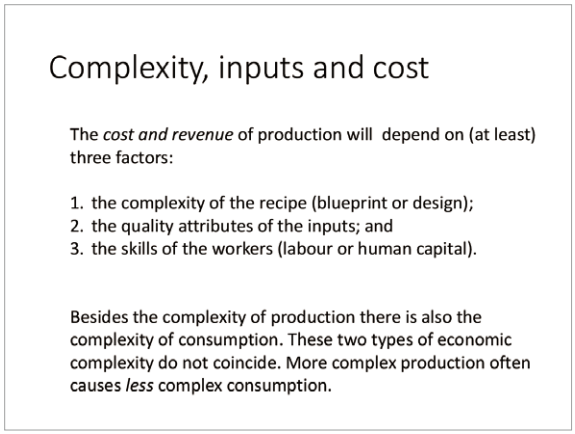
The other example is 121543699821345798709 81269994333. It can be shown that there is no possibility of finding a computation formula that is shorter than the series itself. It is thus more complex than the first example because anyone can write a short computer code to generate the first example.



Now, can we use this in engineering and sciences and technology and so on? Well, Solomonoff already claimed that it is possible to generalize the complexity of computer algorithms so that this definition of complexity also applies to phenomena such as design of products, blueprints, and production instructions because standard goods must follow strict rules of composition and production instructions.

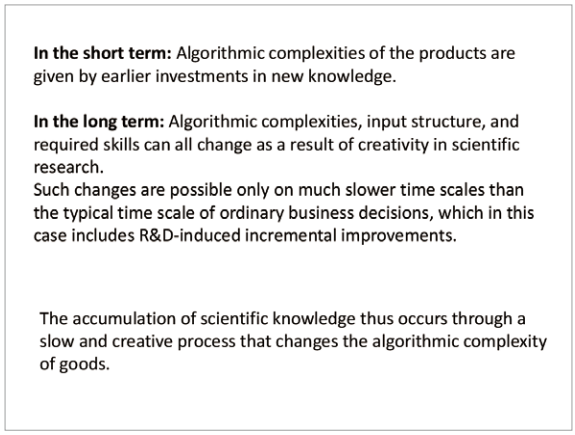
An example is the blueprint and production plan for a new automobile. It has, according to this procedure, become possible to produce even an automobile by 3D computing, as recently demonstrated in the United States by some scientists.

However, there are limitations. I could give an example. In Sweden, we make Swedish fish soup and that's a very simple soup. And the contrast is a French bouillabaisse soup. I would claim that the French bouillabaisse soup is by orders of magnitude more complex. It takes a minimal instruction that is very long compared to the instruction that is minimal for making Swedish fish soup.



But it also shows that there is a limitation that arises from the difference between a set of numbers in an algorithm and the set of ingredients in the soup. Soup ingredients have a much greater scope than numbers: they are heterogeneous rather than uniform in having an open-ended set of underlying attributes.

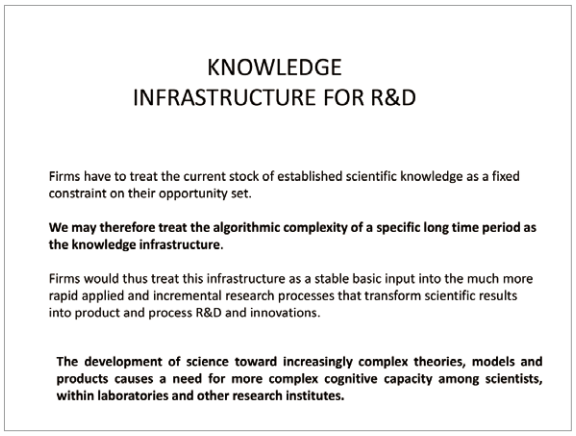
A second limitation is that soups, unlike numbers, are sensitive to the skill of the individual using the recipe. A recipe-using individual is not as homogeneous as an algorithm-using computer. A skilled worker can adjust the recipe if the delivery of an input is for some reason not good enough.



Now, how can this be handled in an economic analysis? Well, algorithmic complexities of the

products are basically in the short term given by earlier investments in new knowledge. In a way, the investments in knowledge provide a stage on which algorithmic complexities can be calculated.

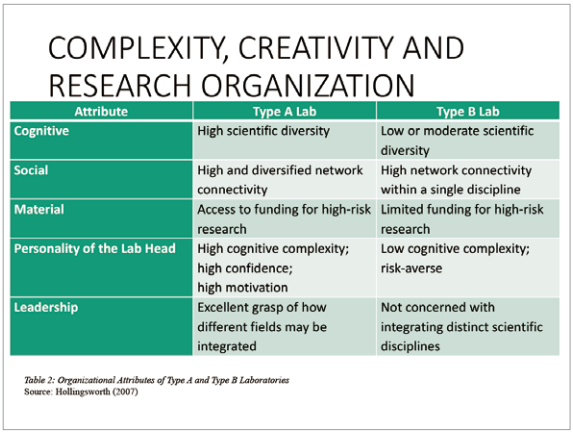
In the long term, however, algorithmic complexities, input structure, and required skills can all change as a result of creativity in scientific research. The accumulation of scientific knowledge thus occurs through a slow and creative process that changes the algorithmic complexity of goods, mostly in an increasing respect.



So, algorithmic complexity over a long time period can be seen as the knowledge infrastructure. The development of science towards increasingly complex theories, models, and products causes a need for more complex cognitive capacity among scientists within laboratories and other research institutes.

Now this is much talk, but it has been tested, and the test was done by Hollingsworth who actually addressed the question by connecting scientific complexity to the frequency of creative breakthroughs and the internal organization of universities, research institutes, and laboratories. And his focus was on biomedical science, which is unusually concerned with understanding and predicting highly complex systems. So biotechnology is now a focus of the complexity analysis.

Hollingsworth noted that high cognitive complexity is the capacity to observe and understand in novel ways the relationships among complex phenomena, the capacity to see relationships among often-disparate fields of knowledge, and it is that capacity which greatly increases the potential for making a major discovery. These were his conclusions.



Then he said, "Let's look at different types of labs. How are they organized?" And he found that there are Type A labs, which are characterized by high scientific diversity, high and diversified network connectivity, they are connected internationally in a diversified way, and they have access to funding, even for high-risk research.

The personality of the lab head is very central according to this analysis. High cognitive complexity, high confidence, and high motivation are the three characteristics of this type of lab head. And the leadership implies excellent grasp of how different fields may be integrated.

The Type B labs had a low or moderate scientific diversity and high network conductivity but only within their own single discipline. If they were analyzing some chemical substance, they had excellent relations with all people looking exactly at that chemical substance around the world. They had low cognitive complexity, they were risk-averse, and they had very limited funding for high-risk research.

And the leader was not concerned at all with integrating distinct scientific disciplines. He was not interested in interdisciplinary science.

The surprise was when they evaluated the success rate of these activities: "all of the 291 discoveries in our project were made in Type A laboratories. Significantly, none of the 291 discoveries in our research occurred in Type B labs." So this gives us a fairly clear understanding of in what way

reorganization of research should move.

Hollingsworth: "**all of the 291 discoveries in our project were made in Type A laboratories**. ...

Type B laboratories are at the opposite end of the continuum on virtually all the lab characteristics.

Significantly, none of the 291 discoveries in our research occurred in Type B labs."

The problem is, however, because these are high-risk problems, there were a lot of mistakes also in the Type A laboratories. They made mistakes but they were on the whole much more successful than the risk-averse, highly concentrated Type B labs.

INCREASING COMPLEXITY AND REORGANISATION OF RESEARCH

There is a need for reorganization of research into Type A departments, labs and research institutes.

Increasing complexity of science requires good accessibility of new and diversified external knowledge.

This provides strong arguments for locating Type A research organizations in large, open and diverse C-regions.
(cf. Andersson, 1985; Kobayashi and Andersson, 1990 (in Japanese), Florida, 2002; Hollingsworth, 2007; Simonton, 2011)

There is a need for reorganization of research into Type A departments, labs, and research institutes. Increasing complexity of science requires good accessibility of new and diversified external knowledge. This provides strong arguments for locating these Type A research organizations that are growing into large, open, and diverse C-regions. It gives an advantage to some metropolitan regions in the world like Tokyo.

My son has been working with the top 12 science city regions, and he has shown that there are some persistent regions in the world that will probably be the world leaders in research and development also in the future.

The world's top-12 science city regions
Source: Andersson D. et.al. (2014) : Calculated by the authors on data from Thomson Reuters' Science Citation Index (SCI)

PERIOD	96-98	papers	02-04	papers	08-10	papers
1	London	69,303	Tokyo-Yokohama	81,798	Beijing	100,835
2	Tokyo-Yokohama	67,628	London	73,403	London	96,856
3	San Francisco Bay Area	50,212	San Francisco Bay Area	56,916	Tokyo-Yokohama	94,043
4	Paris	49,438	Osaka-Kobe	54,300	Paris	77,007
5	Osaka-Kobe	48,272	Paris	53,005	San Francisco Bay Area	75,669
6	Moscow	45,579	New York	51,047	New York	70,323
7	Boston	42,454	Boston	49,265	Boston	69,250
8	New York	41,566	Los Angeles	44,401	Seoul	67,292
9	Randstad (Amsterdam)	37,654	Randstad (Amsterdam)	44,094	Randstad (Amsterdam)	65,527
10	Los Angeles	37,437	Beijing	42,007	Osaka-Kobe	60,615
11	Philadelphia	29,376	Moscow	41,001	Los Angeles	58,176
12	Berlin	24,514	Seoul	33,083	Shanghai	50,597

London is one case, Tokyo/Yokohama is another case, and an upcoming case is Beijing, and if we look at this table that goes all the way from 1996 to 2010, it gives a kind of stable picture of the global leaders in terms of regions of the future.

PARADIGM CHANGES IN THE RESEARCH SYSTEM

A. FACT :INCREASING COMPLEXITY OF R&D CAUSES HEAVIER RELIANCE ON SCIENTIFIC RESEARCH

CONSEQUENCE: MORE RESOURCES OUGHT TO BE ALLOCATED TO SCIENTIFIC RESEARCH IN ALL ADVANCED COUNTRIES

B. FACT : SCIENTIFIC R&D ON COMPLEX PRODUCTS AND SYSTEMS IS ALREADY CLUSTERED IN LARGE C-REGIONS

CONSEQUENCE: THE INCREASED COMPLEXITY IMPLIES A FUTURE OF INCREASED CLUSTERING OF SCIENTISTS AND INDUSTRIAL R&D IN LARGE C-REGIONS

C. FACT: INTERNATIONAL SCIENCE COLLABORATION IMPROVES DIVERSITY AND QUALITY OF KNOWLEDGE INPUTS

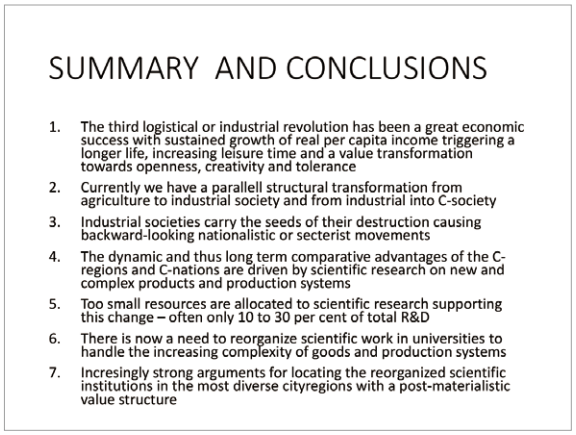
CONSEQUENCE: MORE FUNDING OF SCIENTIFIC COLLABORATION IS NEEDED

So we have some paradigm changes ahead in the research system. The first fact is increasing complexity of R&D causes heavier reliance on scientific research. Consequence: more resources ought to be allocated to scientific research in all advanced countries.

B. Fact: Scientific R&D on complex products and systems is already clustered in large C-regions. Consequence: The increased complexity implies a future of increased clustering of scientists and industrial R&D in the larger C-regions of the world.

C. Fact: International science collaboration improves diversity and the quality of knowledge inputs, according to the study by Hollingsworth, but also studies I've performed together with my

collaborators. Consequence: More funding of scientific international collaboration is needed. Unfortunately, the resources to do this are quite limited in parts of Asia, and especially in China.



So let me then summarize and conclude. The third logistical or industrial revolution has been a great economic success with sustained growth of real per capita income triggering a longer life, increasing leisure time, and a value transformation towards openness, creativity, and tolerance.

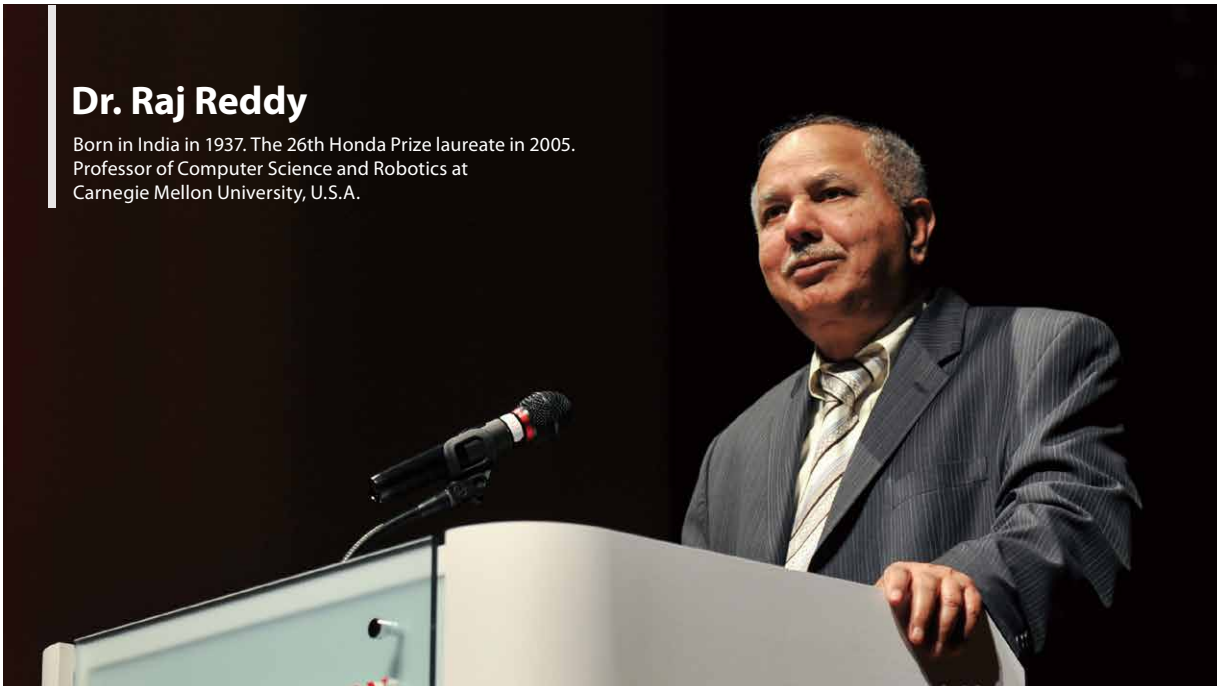
Currently, we have a parallel structural transformation from agriculture to industrial society in parts of the world, and from industrial into C-society in countries like Japan.

Industrial societies carry the seeds of their destruction causing backward-looking nationalistic or sectarianist movements like we see in Europe today.

The dynamic and thus long-term comparative advantages of the C-regions and C-nations are driven by scientific research on new and complex products and production systems. Too small resources are allocated to scientific research supporting this change, often only 10% to 30% of total R&D.

There is now a need to reorganize scientific work in universities to handle the increasing complexity of goods and production systems. There is an increasingly strong argument for locating the reorganized scientific institutions in the most diverse city regions with a post-materialistic value structure.

Thank you.

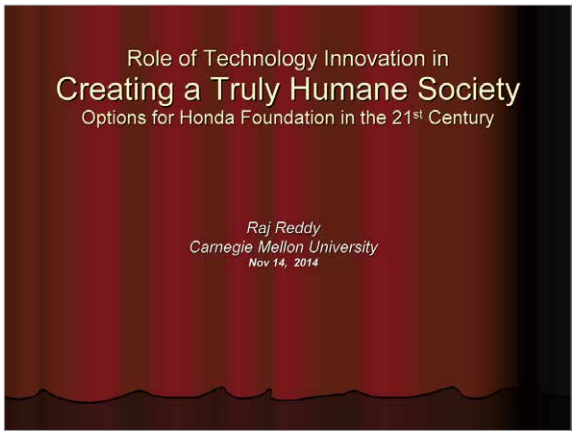


Dr. Raj Reddy

Born in India in 1937. The 26th Honda Prize laureate in 2005.
Professor of Computer Science and Robotics at
Carnegie Mellon University, U.S.A.

Innovation

Role of Technology Innovation in Creating a Truly Humane Society



Good afternoon. It's kind of late, but I'm sure we'll have an exciting panel discussion so I recommend that we get there quickly. It's an honor to be back here and participating in the Honda Memorial Symposium with distinguished laureates.

The theme of the symposium today is how to create a truly humane civilization and to review and explore solutions to the issues facing modern society from an eco-technology perspective.

Technological innovation in the past has largely been responsible for the improvement of quality of life. If you look back 200 years ago, women spent all day in the kitchen cooking. That's all they did. And men spent all day in the fields working in agriculture. Today, as Dr. Andersson pointed out, we probably spend less than 20% of our daily hours in work, and it's supposed to go to 7% in another 10 or 15 years. That's amazing.

Technological innovation comes in many forms, not all of which are eco-technologies, but the closest thing I can think of that is a good eco-technology, but it doesn't quite fit Mr. Soichiro Honda's definition, is the invention of the self-driving car, which is just around the corner.

I've been working on it since 1982 and we knew it could be done 15 years later. We went to General Motors and said we should start working together to do this, but they said, "No, no, no, no, we're already doing it. Don't bother us with your

ideas." Now it's 20 years later and they haven't done it yet, but we do have Google doing a self-driving car. I also hear that Honda is about to release their self-driving car and I hope it will be the best selling car.

Unfortunately, however, this particular technology doesn't quite satisfy the requirements of scalable, sustainable, and affordable. Only less than 15% of the population has cars today and out of those, who can afford a self-driving car? Maybe half, and even those may have to wait another 10 or 15 years for the cost to come down.

So that was affordability, and now the issue of sustainability. The pollution and various other problems we have with all cars, including fossil-fuel cars, makes it not quite the eco-technology that Mr. Soichiro Honda talked about.

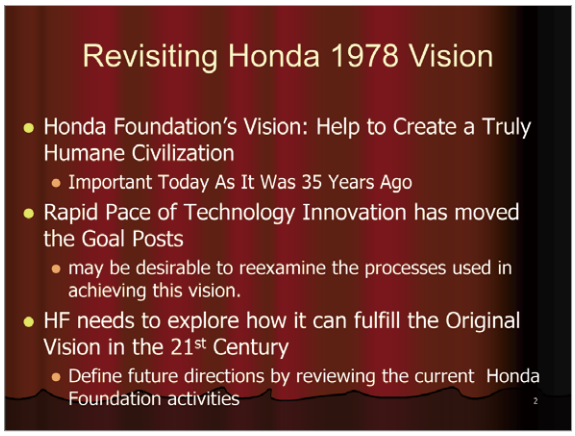
Today, I'd like to talk to you about one magical technology, or at least to me it seems like a magical technology, that I think would enable a truly humane society for every man, woman, and child on the planet, and for the issue of whether it is affordable by every man, woman, child, I'll try to convince you it is.

The topic is to create a "Guardian Angel" that is always with you, knows everything about you, and is able to give every person the right information in the right timeframe. The right information for you is not the same as the right information for me. It has to give the right information to the right people at the right time.

The assumption is if each of us knew the right information in the right timeframe, then we could make appropriate decisions to avoid catastrophes like Fukushima, the recent Mount Ontake explosion, and all kinds of things that are knowable. This whole presentation is to convince you that this can be done; that it is affordable for every man, woman, and child; and that it's a truly magical technology that fits Soichiro Honda's definition of eco-technology.

So let's re-visit the definition of Soichiro Honda's 1978 vision. The Honda Foundation vision of helping to create a truly humane civilization is as important today as it was 35 years ago. However, given the rapid change of pace in technology innovation over the last five decades, it may be desirable to re-examine the strategy and tactics needed for achieving this vision.

To create a truly humane society, we must aspire to create scalable, sustainable, and affordable solutions to provide for the basic needs of all the human beings on the planet. This is a very important sentence: a truly humane society will provide the basic needs of every person on the planet.



So what are the basic needs of every person on the planet? We all need water, we all need energy, we all need food, we all need shelter, we all need clothing, I can go on, but the point is that these are not negotiable. Everybody needs them. And insofar as we can work towards making sure that every human being has them, then we will come towards creating that humane society.

And it is not only material possessions. If you look at all the things I said, food, energy, water, transportation, various other things, they are all what I call atom-based, physical things. But there are also information solutions. When you get information, then there's a whole set of things, as Dr. Andersson

talked about, and an information economy. So we need to kind of look at the societal needs.

There's also a set of needs of every human being that are related to human rights. Every person has the right of freedom from slavery. Every person has the right of freedom from torture. I went through and got this list of 30 basic human rights that we are all entitled to that the United Nations collected in 1948.

This was a major philosophical discussion in the 18th and 19th centuries where it was decided there are certain inalienable rights for every human being or for the right to "life, liberty, and pursuit of happiness" as Jefferson and Madison wrote in the Declaration of Independence.

To me, I can live without many of them. Even if I don't have freedom of religion, I may be able to live with it, not completely but you know, religion turns out to be one of the biggest sources of friction in the whole world today when it should not be.

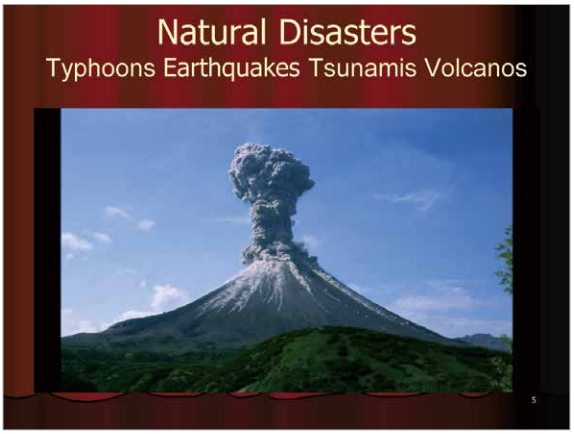
You take Muslims. There are two sects, Sunni and Shia, and they are constantly fighting and killing each other. It should not be the case, and it's not at all obvious to me what it is that we can do, but at least slavery and torture are things that we should try to eliminate or abolish.

There are 30 million people today that are under some kind of slavery-type conditions. There is an index called the Global Slavery Index, if you go to Google and type it you'll find it, and there are 30 million people under slavery conditions.

And, unfortunately, I'm ashamed to say, I come originally from India, although I've been in the US for 50 years, and India has the largest number of people under slavery. Modern slavery is not like the old slavery. It's defined as indentured labor, where because of debts or something you sell your son or daughter into another family and they're there for 20 years or 30 years or something. That is slavery.

There is also trafficking and all kinds of examples of this kind. They collect these things and it's amazing to me because I never saw slavery when I was growing up, but there are parts of the country, India's a big country with 1.3 billion people, which are tribal areas where there is no education, where they are still living like they were living 500 years ago, and indentured labor is an accepted form of settling disputes.

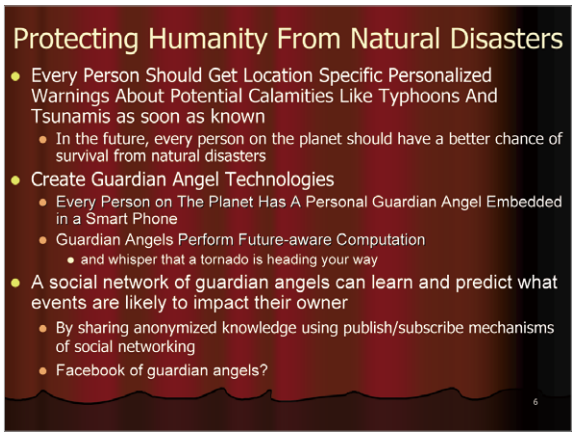
So the issue here is for us to understand and define what we mean by a humane society. I said a human society must provide the basic needs and it must provide the basic human rights, and the question is how can we, the Honda foundation, and all of us together, make that happen? What do we need to do to create a humane society?



To give you some examples of the kinds of things I'm talking about, typhoons and earthquakes and tsunamis and volcanoes seem to be the bane of Japan. All of these things you seem to have more than your share of. The most recent explosion of the volcano in Japan was so dramatic even those of us in the United States were surprised.

No part of the world is immune to death and devastation from natural disasters, but Japan does seem to have more than its fair share of calamities, and what I'm proposing is if we had Guardian Angel

technology that got the right information to the right people at the right time, 80% to 90% of the deaths could be avoided and that would be something that a humane society would do if it could do it using its technology.

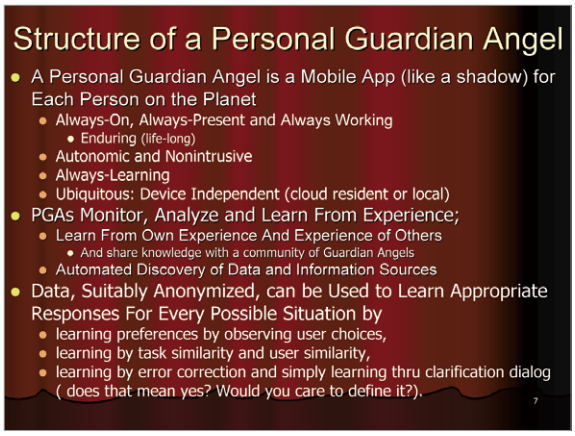


So the main thesis of this talk, then, is that mobile technology is sufficiently advanced today that it is now possible to envision that every person should get a location-specific personalized warning about potential calamities like typhoons and tsunamis as soon as they're known or knowable.

It assumes that we can create and deliver a personal Guardian Angel to every person on the planet embedded in a smartphone. Guardian Angels will perform future-aware computation and whisper personalized warnings in your ear about potential problems. It assumes that a Facebook or a social network of Guardian Angels are able to talk among themselves to discover what is known and what is knowable to all of them. If every person on the planet has a Guardian Angel and they're all on Facebook, they can discover.

The only problem is privacy. I may not want my Guardian Angel discussing all my details with everybody else, but it's a solvable problem, I assure you. We understand anonymization. We understand what kinds of things are already available. For example, the traffic system in Tokyo is controlled by cellphone location and traffic jams are identified and predicted by cellphone location, so this is doable.

So let me say a little bit more about what this personal Guardian Angel looks like. A personal Guardian Angel is a virtual avatar that is assigned to protect and guide a particular person. It knows everything about her, except possibly her deep dark secrets that she has not even whispered to anyone else in the world. If you've said something to somebody, the Guardian Angel knows it. If you haven't told it to anyone, then the Guardian Angel doesn't know it.



From a technical perspective, think of a personal Guardian Angel as an intelligent agent or an app on your cellphone that is on steroids. It would not reside on your cellphone, you don't tap it and activate it, but it's always on, 24/7, autonomic and nonintrusive, it never asks you anything, it never tells you anything, it doesn't bother you.

It's always learning and self-adapting to users' habits, preferences, and commands. A personal Guardian Angel is expected to monitor, analyze, and learn from experience, and then share the knowledge with a community of Guardian Angels. It is capable of automated discovery of data and information sources.

The personal Guardian Angel must communicate with human users. The publish/subscribe mechanism of social networks is adequate if you know what you want and from whom. Who do you ask when you don't know who to ask? What if you don't know who to "friend?"

These technical problems are solvable, so that a Guardian Angel in a Facebook-type environment can declare and decide what kinds of knowledge it needs and assign them as your "friend" so that you are actually getting all the knowledge not only that you have but that everybody else has that might

impact you in the future.

Data suitably anonymized can be used to learn appropriate responsible responses for every possible situation. The system non-intrusively learns. This is very important. It must never ask the owner anything. It must learn by itself, and we know how to do it, believe me. These days, for example, if you go to Google you can translate from Japanese to Chinese or Hindi or anything you want. It's not perfect but it's almost good enough for you to understand what the message is. It is derived by learning from data of literally billions of characters, trillions of characters collected from large numbers of people.

When you have that much data, what we call "big data," data analysis makes it possible to predict almost everything. When you're typing, you see predicted words. It is not just the word in the context you have just typed, it is using engrams, the four or five words before and after, so that it's able to predict in the context of what you just said what the most likely word is. Most of the time, even before you type, the word appears, so the predictive power in languages is amazing these days.

A humane civilization should be able to use the personal Guardian Angel to get the right information to the right people at the right time in the right language, and, importantly, in the right medium, because not everybody knows how to read. There are many illiterate people, and not everybody knows English. There are people that may need another language, so the right medium, text and multimedia, turns out to be very important.

At the right level of detail. All of these things are already possible to be done today. We call this the "Bill of Rights": the right information to the right people at the right time in the right language in the right medium at the right level of granularity. Six "Bills of Rights."

By 2020, a smartphone can be expected to cost about 20 dollars. That's about 10% of what it is today. That's what makes it scalable technology. Today, at the cost therein, like smartphones cost 200 or 300, almost half of the population of the world cannot afford one.

But by 2020, when the cost goes down by 90%, then it turns out that every man, woman, and child will have at least 16 GB, maybe more, of space on the cloud from Facebook, Google, and Microsoft, which is enough to host all of your personal information.

So the information is gathered from your daily activities, the Guardian Angel saves it there, it looks for patterns of behavior, and then it asks are there any other people among my friends having the same behavior, and given that behavior, what did they do? Then it predicts and tries to help you do the right thing in the right timeframe.

The language divide and literacy divide are problems that we just discussed. Sustainability and affordability are natural consequences of an exponential reduction in size and cost of information technology.

Now let's go to affordability because I just said "believe me everybody will be able to afford one." Have you thought about roads and water and systems that have infrastructure like sanitation that all of us have? Somehow society decided it is

necessary to have those fundamental things as a public good, so the government builds the roads and the airports and the sanitation systems and the water supply systems.

Conversely, there are certain things that society decided should be in the private sector, and one of them is the telephone. When the telephone came in they said it was very expensive technology and that it was only for rich people so they didn't need to make it a public good.

Guess what? Now every man, woman, and child needs a phone and needs to be able to communicate and cannot do without one, and therefore we just need to ask the question if it's good enough to build an electric grid and roads and other infrastructure, why is it not the case that governments and society are able to provide every person on the planet with a smartphone, especially if they only cost 20 dollars?

Just so that you know, 20 dollars is like less than 0.1% of the per capita income of most countries. If you take the United States and Japan, they are both at 40,000 to 50,000 dollars per year per capita income. One percent of that is 500 dollars; 0.1% is like 50 dollars. It's less than 0.1%. Why can't we, society, provide every person with a smartphone if it is as powerful as I'm claiming it can be made to be.

So the big elephant in the room is the cost enabling the Guardian Angels. We begin with the assumption that every person will have to have a free, sensor-intensive smartphone. It's very important. One of the major innovations that happened in computer science in the last 15 years is the arrival of the smartphone. Before then, all computers, all laptops, everything had computation but it did not have sensors and activators. Today, if you buy any of the smartphones, Samsung or anything else, they even have a barometer and all kinds of sensors.

There are about 10 different sensors, GPS being the most important one, location sensing, and it has cameras and microphones. Most of the systems didn't have that 15 years ago, and these are essential parts of building a Guardian Angel.

If you don't have sensing capability in your environment, all you have is computation and it's not useful for building a Guardian Angel. A Guardian Angel must constantly monitor what's happening to you. What you're doing, how you're doing it, and then it has to discover for itself how it can adapt the system.

In that kind of situation, a smartphone costing, let's even say 50 dollars because I want a sensor-intensive smartphone, I want every sensor in there, an iPhone 6 let's say, then it may be even 50 dollars. I'm saying there are lots of beneficiaries of this technology, the people that make the phone, the people that provide the service, the government, and the IT industry, and therefore each of them should pay one quarter of the cost so that everybody has a smartphone.

There are all kinds of distribution issues and other kinds of things, so I'll have to talk to my friend Dr. Andersson to come up with an economic model so that people don't game the thing, but it's possible. I can work out systems where everybody can have one and everybody can upgrade if they can afford better systems and so on.

If you don't believe what I have there on the slide, you will just have to trust me; otherwise, I'll be happy to answer questions, but I believe we can think of a way of doing it without any problems.

The other biggest problem is privacy. If a Guardian Angel on my body knows everything I'm doing, are there no secrets at all? Is there a way I can turn off the phone? It turns out you cannot. With this phone, even if you turn it off, if there is an emergency it will turn the phone back on and warn you.

Current phones don't have that capability because they are trying to save energy, but in the future, phones will turn on every five minutes or so and get warning systems without losing too much energy.

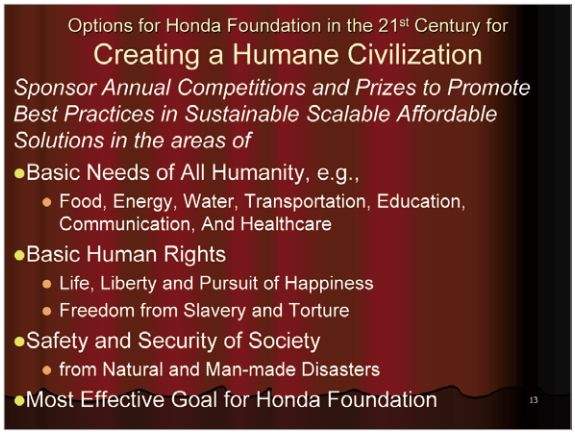
It turns out this is a new feature that will come. I've been talking to phone manufacturers and they shake their heads, but I'm sure it will happen. They did the same thing when I was saying we need cameras and microphones in every phone and every laptop, and it only took 10 years for that to happen.

So for privacy, a Guardian Angel knows the location information of the owner at all times so as to be able to provide alerts and detailed notifications. If needed, it must be able to turn on the smartphone. There is no privacy breach because every Guardian Angel only shares the information already known to other people. For example, the service provider already knows where you are, so location information is already there.

So, in conclusion, creation of Guardian Angel technologies for providing the right information to every man, woman, and child on the planet in a timely manner can eliminate surprises and reduce human suffering and misery. While the cost appears to be prohibitive, on a per capita basis it represents less than 0.1% of the gross work product.

A social network of Guardian Angels that can anticipate potential disasters and incidents in the life of each person on the planet and warn and take protective actions might be able to save 50% to 80% of all accidental deaths in the world. This would result in savings of over one million lives and hundreds of billions of dollars of damage to property.

This is certainly the most important research that we computer scientists could be doing in the 21st century, and it is certainly the most important research project that the Honda Foundation could be doing and undertaking to create a humane society.



Finally, here are some options for the Honda Foundation in the 21st century for creating a humane civilization. The foundation could sponsor annual competitions and prizes and promote best practices in creating and identifying sustainable, scalable, and affordable solutions in all areas of basic needs of human society such as food, energy, water, transportation, education, and so on; in protecting basic human rights, life, liberty, and the pursuit of happiness; in providing freedom from slavery and torture, and in ensuring safety and security from natural and man-made disasters.

In general, the Guardian Angel concepts, systems, and solutions can be applied not just to some natural calamities like the ones I showed you but for almost any problem you can think of that would affect each individual. It can be used to identify potential violations of basic rights and ensure the basic needs and rights of human beings and all

individuals in the humane society. Therefore, I submit that this is the most important technology towards creating a humane civilization.

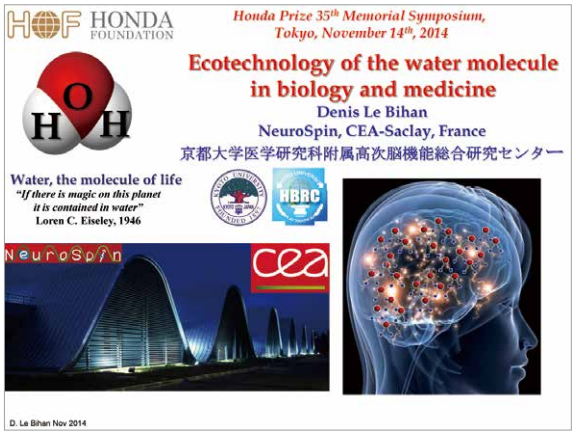
Thank you.

Dr. Denis Le Bihan

Born in France in 1957.
The 33th Honda Prize laureate in 2012.
Director of NeuroSpin, CEA Saclay, France

Life Frontier

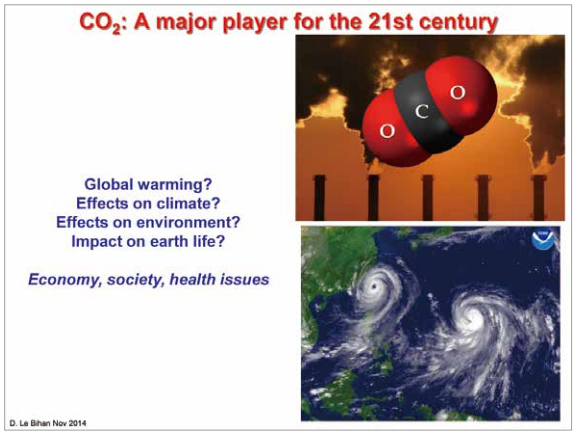
Ecotechnology of the Water Molecule in Biology and Medicine



Thank you very much. Good afternoon, and it's a great honor to be with you today. I'm very, very thankful to the Honda Foundation for inviting me again to share with you some of my views about how I can see the future regarding eco-technology.

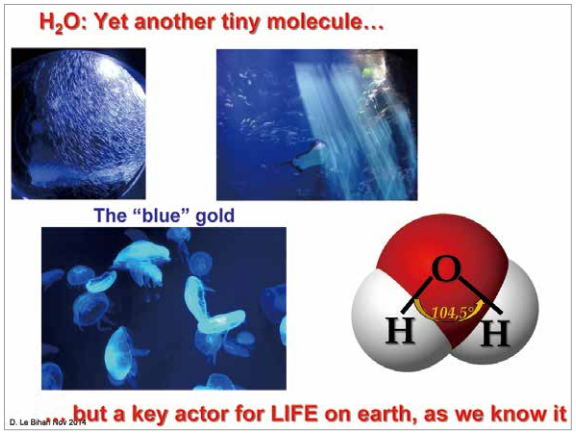
As you know, we are doing a lot of thinking about a tiny molecule, CO_2, because of the predictions of global warming, the effects on the climate, the effects on the environment, and so on.

Of course, these changes in the climate also have very large consequences on water, for instance, typhoons, and that's what I'd like to show you today.

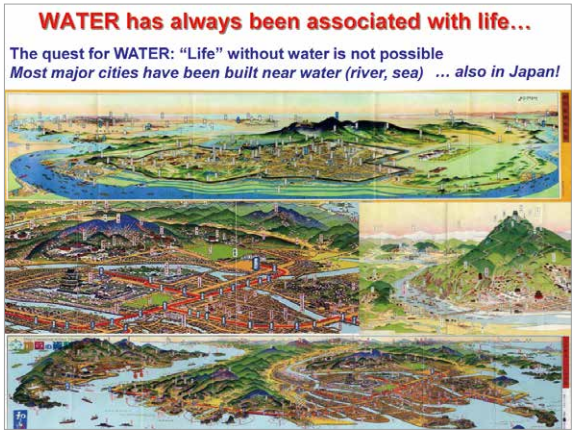


My talk will focus mostly on this other tiny molecule, H_2O, so just water, the "blue gold" as we know it, which is of course very beautiful, and I'd like to remind all of us that water is really a key actor for life on earth as we know it. And I'll show you that it is

even more important than what you think.



Water has always been associated with life. Without water we cannot have any life, as we know it today at least. And most of the cities in the world have been built next to water like rivers or seas, and of course, Japan is no exception.

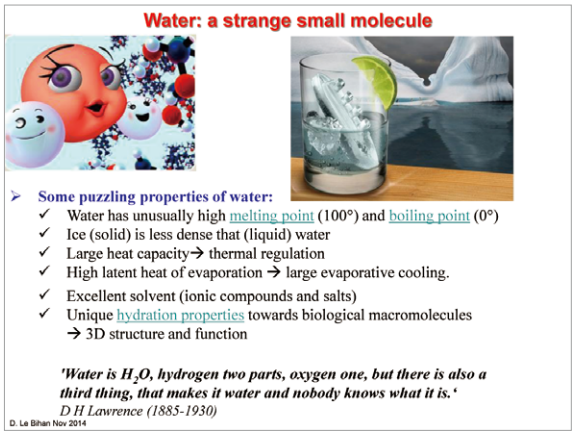


Unfortunately, water may also be associated with death, for instance when we lack water, and this is of course, terrible but that may happen in the future if we don't pay attention. Too much water is not good either, for instance, tsunamis and flooding, and water, although it is a very small molecule, has a lot of power and can cause mechanical destruction. So I think that while CO_2 is very important, H_2O might play a bigger role than CO_2 in the current century and people may fight to have access to water.

But maybe not all waters are equal. I'm lucky to live sometimes in Kyoto, and Kyoto's water is very important. In Buddhism water has a sacred value, but I think that this is not by chance. Most religions have incorporated water into their thinking, probably because humankind has to have a very strong connection to water. And, of course, Kyoto water is so good that we can make beautiful Kimonos and we can make good sake. So I guess now you are convinced that water is very important.

Water is a very strange molecule. It has very interesting properties that cannot be completely explained today. Of course, you know very well that the temperature for water to boil is 100°C and for freezing it's 0°C, but I'd like to point out something very special: ice floats when really it shouldn't. For other molecules, when they become solid they drop to the bottom of the liquid.

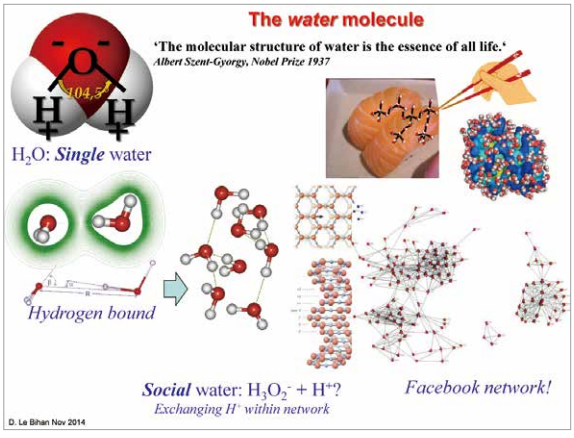
Unfortunately, this is responsible, for instance, for tragedies such as the Titanic, which was a big tragedy, but it also explains why ice floats on your whisky. Why is that? It's not clear.



Another very important property is that water is very helpful to control temperature. This is why we sweat a lot during the summertime and this is why babies are so sensitive to heat because they have a large surface and they have evaporation, which could be dangerous for them if it becomes excessive.

Water also is very important if we consider all the molecules we have in the body such as proteins and other macromolecules. The shape of these molecules comes from their interaction with water.

These are the facts we know, and we also know that water is H_2O, two parts hydrogen and one part oxygen, but D. H. Lawrence said that there is a third thing that makes it water, but still we don't know what it is, so I have to say that the water molecule itself remains a mystery.

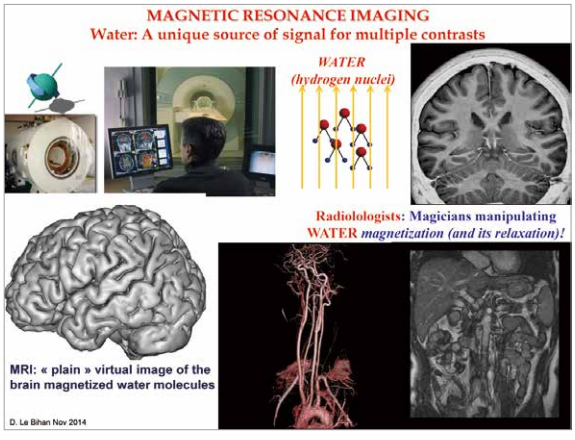


Let's see in more detail what the water molecule is about. Again, one oxygen atom and two hydrogen atoms. I call it a single water molecule, but this is dynamic, everything is moving all the time. Let's take sushi for instance. If you press sushi with chopsticks water will come out even though the fish is dead and even if it is very fresh sushi. How is that possible?

Well we have to remember that there is what we call the hydrogen bond. Water molecules are sticky, not only between themselves, but also to the proteins that are present in the fish, so all those molecules of water are always bound to other macromolecules. This is very crucial to explain life as we know it. Without those hydrogen bonds, without the special angle, 104°, between the two hydrogens and the oxygen there would be no life on earth.

But water is also social. A single water molecule doesn't exist. Water molecules have to be related. They have to communicate. They are organized like that and if we take now the statistics supporting those networks, water may not be H_2O anymore. Some physicists think that we may describe water as H_3O_2 because the molecules are sharing hydrogen atoms between themselves. If you look at the Facebook network and the water network, you can see some analogies, so we have to consider that water in tissues is organized as a network.

We should also never forget that we are water. Sixty to seventy percent of our body is made of water, and 75% of our brain, maybe 80% of our brain, is just water, so we think with water, and that's what I'd like to show you soon.

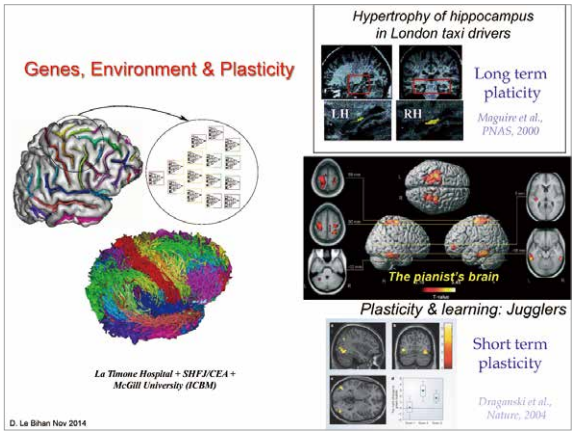


Let's go to my own research, which is using magnetic resonance imaging to investigate the human body and especially the brain. Magnetic resonance imaging, or MRI, uses a very strong

magnet and with this magnet we will magnetize water, or more precisely the hydrogen nuclei of the water molecule, but let's say water.

This is, for instance, a slice of the brain (upper right/previous slide), a vertical slice of one of my colleagues who is very much alive, very healthy, and you can see beautiful contrast between the gray and white matter, you can see some details such as vessels, and all of this comes from the magnetization of the water molecules, which is different between grey and white matter. Why? We have no idea, but it's beautiful.

With MRI technology we can see the vessels coming out of the heart and going to the brain, we can see what's going on after we have a meal with digestion and so on (lower right/previous slide), and, of course, we can see beautiful images of the brain (lower left/previous slide). But this is not a brain, this is an artificial brain, it is a virtual brain, sometimes I call it an avatar of the brain, but this will give us many, many details about how the brain is made.



Let me give you some examples. Our brains are very similar. There is only one humankind, so all of our brains are about the same. But if you look at the details, look at this red line here (left figure), which is the limit between areas linked to the motor system and areas in the back linked to how we sense things, for instance when we touch our fingers.

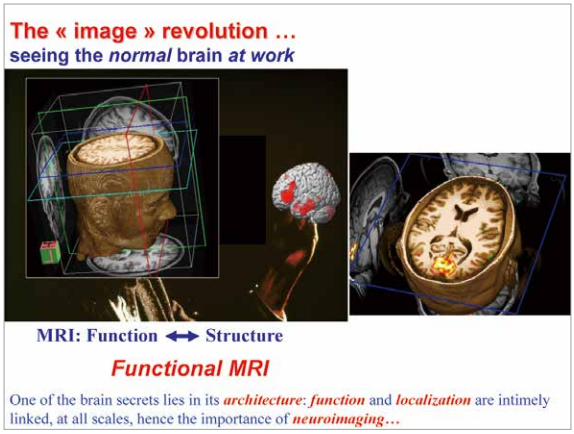
Everybody has such a structure in the brain, but the location, the exact location, and the exact shape is highly variable. So what I want to say is that we make what we want of our brain.

If we look at the hippocampus, a very small area we have in the brain, well, it's not that small, it is linked to memory. In fact, the Nobel Prize in Medicine this year was given to the people who discovered that. If we look at London taxi drivers, who are very good taxi drivers, Japanese taxi drivers are very good, also, but the study was done with English taxi drivers, they have shown that the hippocampus is bigger in size in taxi drivers than in normal, non-taxi driver people (upper right/previous slide). Just because taxi drivers use their memory to navigate, they have increased the size of their hippocampus.

Pianists also. Pianists and other musicians also have over-developed regions of the brain, which are, for instance, used for coordination between the hands (right center/previous slide).

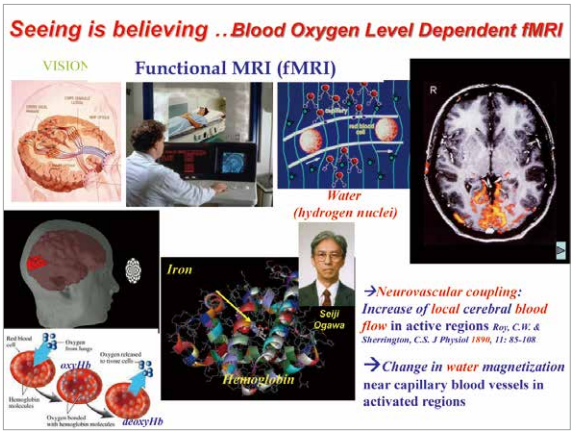
This plasticity is occurring very fast. In this example here, young people, students, were taught how to juggle every day for 10 minutes (lower right/previous slide). After just a few weeks, we can see that some parts of the brain are developing because they have to make an effort about spatial localization.

And this is going on all the time. I'm sorry to say that at the end of my talk I will have modified your brain a little bit, and I will have modified my own brain because there is already some interaction going on.



This is about the shape and anatomy of the brain. Now we can do even more and that's what I call image resolution. We would like to see what's going on in our brain when we think. In fact, we know very well that there is a link between function and localization. Each part of our brain is dedicated somewhat to a function, so if we can image the brain and see which parts of the brain

are activated, we will have some clues about what the brain is doing.



With MRI it's possible to do that now, to look deep into your brain without any **invasive techniques***, without any surgery, just normal people can go to a magnet and we can discover many things. This is called functional MRI.

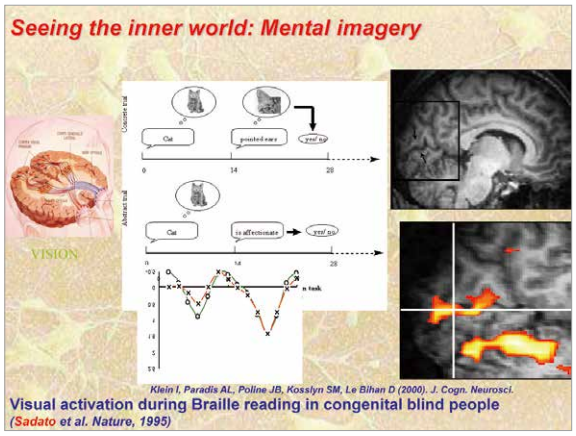
* Any surgical or exploratory activity in which the body is pierced by a device or instrument

When you look at this screen, the image comes from your eyes to the back of the brain and then it is shipped to the front part of the brain so that you can recognize what you have on the screen. Prof. Seiji Ogawa, a good friend of mine, developed a method to do that. Let me explain briefly what it is about.

We know, and this was known back in the 1880s, so a long time ago, that in the regions of the brain that are active, there is an increase in blood coming up. There is more blood in activated regions. Now, blood is red because there are red blood cells inside the blood, and red blood cells are red because inside there is a very important molecule called hemoglobin.

Hemoglobin carries oxygen from the lungs to the tissues, not only the brain, and the hemoglobin molecule contains an atom of iron and, as you may guess, in the strong magnetic field of the magnet this iron atom can be magnetized. So it's not only water but also iron.

So in brief, the small vessels we have in the brain have to be seen as containing tiny magnets. The red blood cells could be seen as tiny magnets circulating in the small capillary vessels. The water molecules that are there will sense the presence of flowing blood, so in the regions that get activated there is an increase in the blood flow and this will translate into a tiny change in the magnetization of the water molecules, which we can detect with MRI and sophisticated algorithms.



So let's do a simple experiment. If you close your eyes, and you think about a cat, you see a cat in your brain somewhere, but my question is where is that cat? There is no real cat and my question is whether the regions of the brain that are used to see the real world also used to see virtual images?

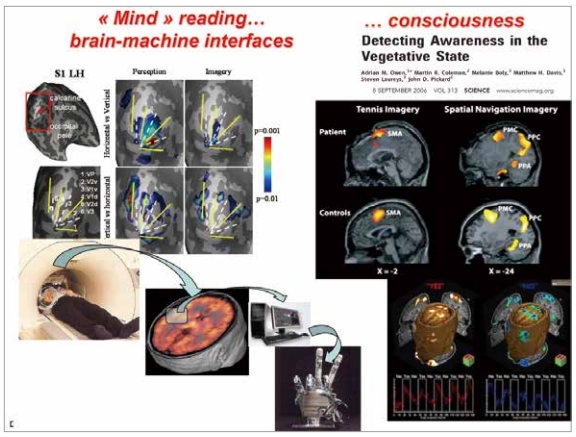
So I did this experiment. Here you say to somebody in the magnet of the MRI system the word "cat," you can say it in Japanese, it works also, and they have to think about a cat. Forty seconds later a question, "Are the ears of the cat pointed?" and they have to think again.

This is an image of the brain (right/previous slide), this way, and the back here is the visual cortex, the region we use when we see the real world. What we see in our images is that when we just think about a cat, there is a change in the magnetization of the water molecules. Thinking has an effect on the magnetization of water. This is huge.

The reason, again, is that there is an increase in blood flow in this area because it has been used by thinking of an image. So what we showed in this very simple experiment is that looking at the real world or looking at the inner world shares some networks.

Next, Prof. Sadato in Okazaki, at that time he was in the United States, did an experiment where he

asked people blind from birth, people who have never been able to see, to read braille with their fingers, and he discovered that by reading braille those people were activating the visual cortex.



So it's fantastic. That means that even if you don't use your brain as it has been designed, you can somewhat use it in a different way. In fact, my own view is that there are some circuits in the visual cortex that are shared by real vision and virtual vision, or reading braille. Reading braille is just connecting dots in space to recognize letters so it's a visual function and we can say from these experiments that blind people can see with their fingers.

But we can do something even fancier. If you think about an object, for instance, vertical or horizontal, we have to consider that at the back of the brain we have a direct projection. Of course, it's distorted, but if you see something vertical you see for instance that the regions that are activated have this shape, while if you see a horizontal object, the regions are a little bit different (upper left/previous slide).

Now if you ask people to think of a vertical or horizontal object, you can read their mind by looking at the images. For instance, here, this person is thinking about a horizontal bar. Here, this person is thinking about a vertical bar. And nowadays we can even ask people to think about letters, "H," "E," "L" and so on, and we can decode that this person is saying "Hello." So this is where we are now.

You can even measure signal activities in the brain to drive robots. This person here is playing this famous game in Japan, well, not only in Japan, but rock-paper-scissors that children like to play. He is moving his hand or just thinking about moving his hand without moving at all and the computer will pick up the signal in the motor areas, decode the signal, and send some electrical current to tiny engines in an artificial hand. And you see at a distance, it could be 1,000 km away, a hand moves just driven by the thought of the person in the magnet (lower left/previous slide).

Even maybe more challenging is this story of a young lady, 26 years old, who is in a vegetative state after a car accident. Of course, there's no reaction when you pinch her, nothing. When you ask her "What's your name?," nothing. So the group of Dr. Owen said let's put this lady in the MRI machine.

They asked the lady, "What's your name?" and there was no response; however, the MRI images showed that the regions of language, like the Broca area, light up, meaning that this lady in a vegetative state was understanding the question and was even responding to the question.

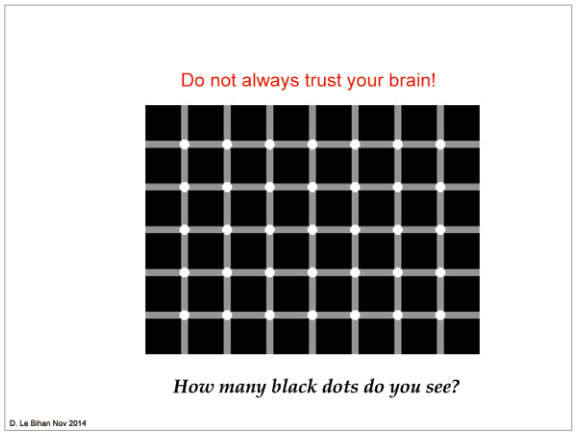
So they were very, very intrigued and said, "Could you think that you are playing tennis?" and of course the lady did nothing but they saw a response in the regions of the brain that are activated when a normal person thinks about playing tennis (right/previous slide).

"Madam, could you think that you are moving in your house and exploring the rooms?" Again, no response; however, the MRI images showed that the regions that get activated are the same as those that a normal person would activate by doing the same thing.

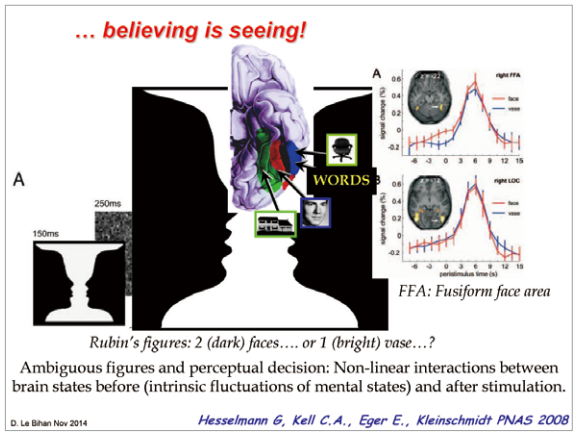
So basically, some communication was possible in this lady who was in a vegetative state. Today, it has been shown that about 20% of people in such vegetative states are in fact able to communicate thanks to this kind of experiment.

Today, we can use even EEG (electroencephalogram) just to pick up signals on the surface of the skull, so there is no need for MRI. So I think that's where imaging is driving us.

However, our brain is like a piece of software, I will not name any names, but with bugs. Here you will probably see dots that are black but in fact there are no dark dots on the image. This is an artifact created by your brain, so we are not perfect. This is also very famous: you can see a vase or you can see two faces, right (next slide)? How do you decide what you want to see?

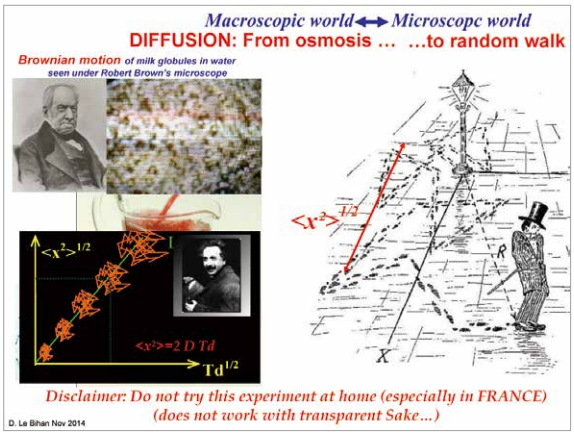


What I want to show you is that you don't decide. The brain decides before you're aware of it. So the image is shown in the MRI magnet for a very short time, 150 ms, and then you press a button. If you want to say, "I saw a vase," you press left, and if you want to say, "I saw two faces," you press right.



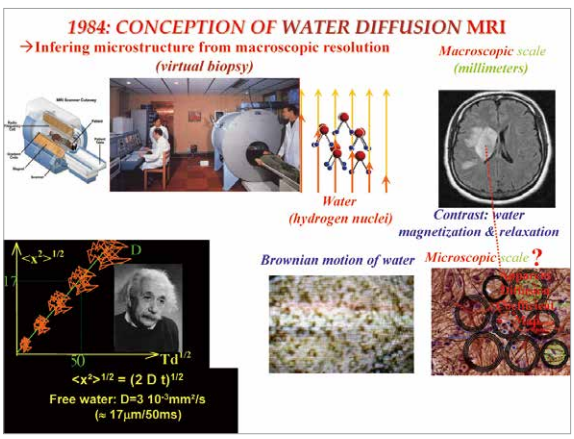
Under the brain there is one area, in red, here (center), that is dedicated to the recognition of faces, and we have to consider that the brain activity is changing all the time but we are not conscious of it. It is fluctuating. That's what we call "intrinsic fluctuations of mortal states."

At time zero you have an image, but look here (upper right graph), two seconds before the image is projected, this area could be spontaneously activated or spontaneously un-activated. If it's activated two seconds before the image comes, you will see faces. If the region is not activated two seconds before you see the image, you will say, "I see a vase." So you feel and believe that you decide but you don't decide anything. The brain is deciding for you in advance.



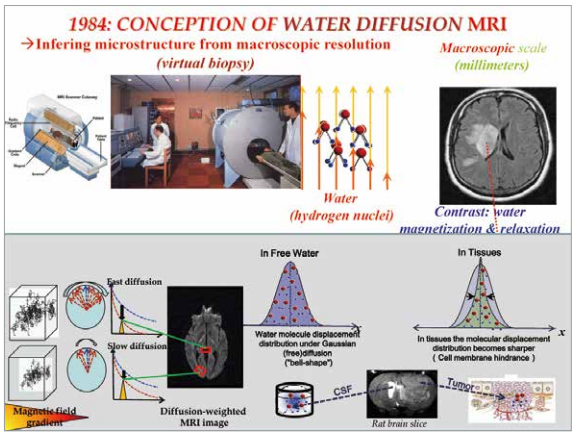
Let's switch now to something else, just to show you that water is even more important. This is an experiment that you should not do, although it doesn't work with sake anyway. If you mix red wine and water, at some point it gets mixed. This is called diffusion. The reason for diffusion was shown by Albert Einstein through his PhD thesis.

He explained this mixing by the fact that molecules, for instance water molecules, had a random walk like a drunken man trying to go home. It's just random. He made a very sophisticated model with an equation, which maybe is not as famous for you as the relativity equation $E = mc^2$, but to me it's a very important equation because it's a way to link the macroscopic world, you see the red wine being mixed, with the microscopic world, the molecules that you can't see.



So let's go back to MRI. There is a patient with a lesion here and as a doctor the question is what is it? Is it a tumor? What is it? I'd like to know, but the resolution of the image is only macroscopic, millimeter-scale, so you cannot see anything. Your dream is to have a virtual biopsy to be able to see the cells that are in this lesion, and this is what I developed back in '84 with diffusion MRI.

The idea, using Einstein's theory, was to consider that water molecules, because they diffuse, will fill obstacles such as membranes and so on. I used Einstein's model, Einstein's equation, and I made a method that can give us images of this diffusion of water. We don't see the water molecules one by one, what we see at the macroscopic scale is a message transmitted by the microscopic motion of the water molecules.

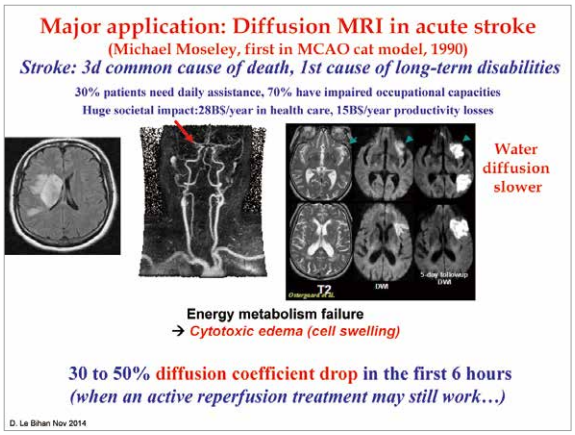


If you take water in a bottle like that, it's free of displacement (bottom), so that means that the molecules can explore a big area. In tissues such as the brain, because it's compact and there are many fibers and cells, the displacement of the molecules is reduced.

Again, I don't want to disturb you with the physics but on the image I made it was possible to have a contrast from grey to white, from black and white, showing how much movement the water molecules have. In a tumor with many cells, diffusion will be reduced. If there is cyst with a collection of water, then diffusion will be higher.

So the very first application of this came in 1990. This patient, in fact I showed you him before, had an acute stroke. That means he had a clot in an artery of the brain, as we can see here, and all the **neurons*** in the territory of this artery were dying. He was losing several millions of neurons per minute, so it was terrible.

* A nerve cell that carries information between the brain and other parts of the body



Many patients will die from this, and unfortunately even those who do not die will suffer from being severely handicapped. In fact, acute stroke is the very first cause of long-term disabilities. People will stay paralyzed for life or they will not be able to speak for life. Once they have a stroke, you have to consider it's for life.

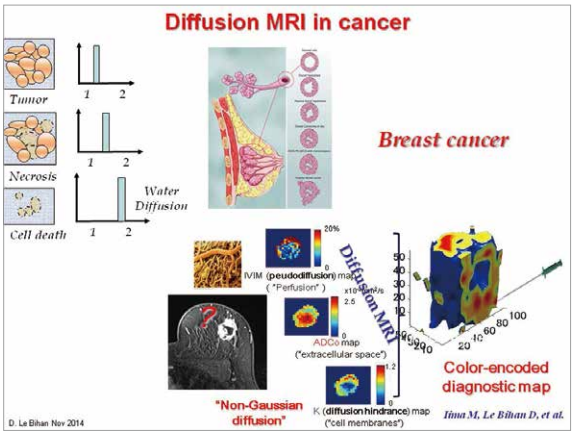
What has been shown is that in the acute phase, the diffusion of water slows down. The water movement is decreasing. Why? It's a little bit difficult to explain, but it has been shown even in patients developing a stroke. You see the white areas and even though you are not a doctor you can see that something is abnormal.

With conventional, plain MRI we don't see anything, we only see it with diffusion MRI, but the miracle is that now we have drugs called thrombolytic agents, which if given to the patient will dissolve the clot, re-establish blood circulation, the patients are saved, and the paralysis disappears and they can speak again.

But this has to be done very quickly, within the first six hours; otherwise, it is too late because we are losing several million neurons per minute. So this is what diffusion MRI can allow, and in fact this is why I got the Honda Prize in 2012.

Water diffusion is also very important in cancer.

For instance, if there are many, many cells in a tissue, as in cancer, water diffusion will decrease. If the tumor is benign or if the tumor has disappeared, for instance, diffusion will increase again. In breast cancer, especially, this is very important. Many, many women are concerned because they have mammography for screening and sometimes we see something abnormal and we don't really know what it is.



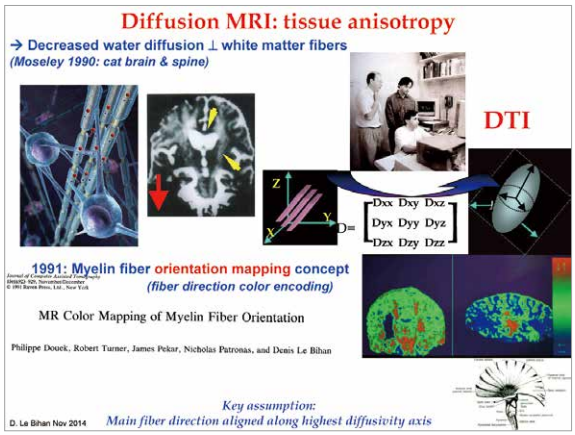
For instance, this lady had a lesion, even if you are not a doctor you can see that there is a lesion, and so she was injected with something to create contrast and this is why we can see the tumor so well. But this doesn't tell us if it is a malignant lesion or a benign lesion.

With diffusion MRI, we can obtain information with colors telling us what is the probability of each part of the lesion to be malignant. For instance, we can see that in the center of the lesion there is nothing wrong, but at the periphery it becomes very malignant, and from this we can decide where to put the needle for biopsy.

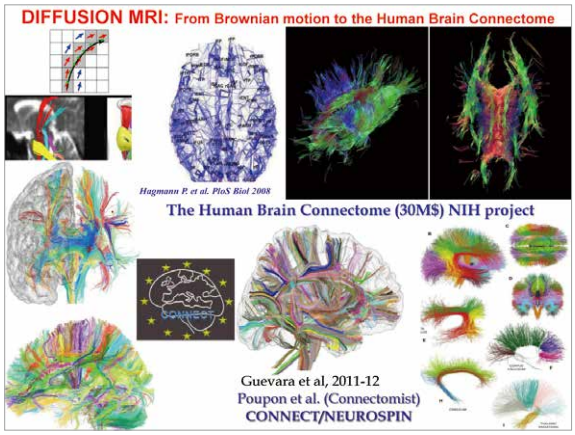
And we can even, by using computer software, isolate the lesion and see inside like the surgeons will do when they operate on the patient, but this can be done without any invasion just by measuring diffusion.

The next application is that it has been shown that in white matter, diffusion was anisotropic. What does that mean? Gray matter contains neurons at the periphery of the brain. Everything else is white matter, which are the wires that are connecting the different parts of the brain.

It was shown that the diffusion of water is faster along the fibers than perpendicular to the fibers. So my idea, long ago in '92/'94, with my colleagues such as Peter Basser at NIH, was to develop a mathematical framework whereby measuring the diffusion of water in several directions we can obtain point-by-point estimates inside the brain of the orientation of the fibers. In the direction that the diffusion is higher, we know that the fibers must be parallel to this direction.

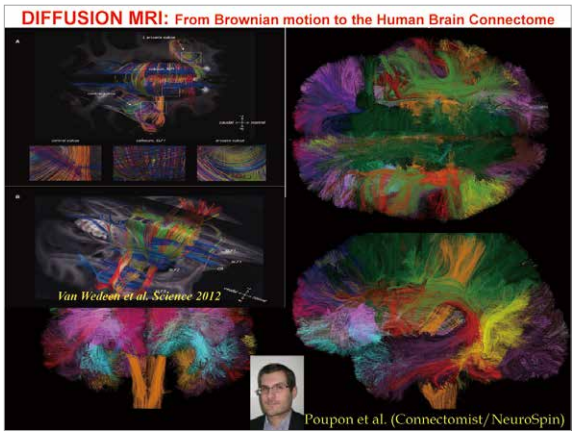


This was done in the 1990s and the idea, of course, was to obtain some connections between those voxels, those points. This is now very easy to do and this is what we call the human brain connectome. We can make beautiful images of the connections in the brain.



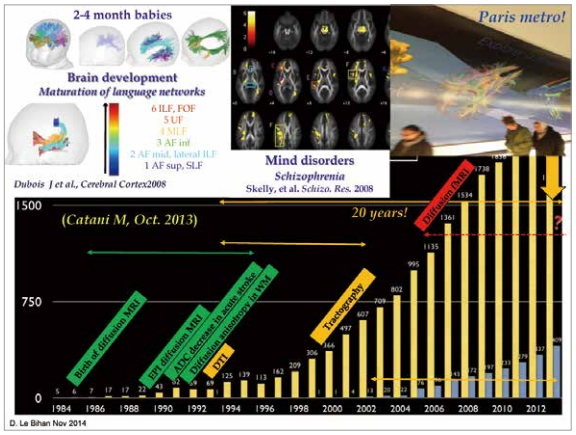
In the United States they dedicated 30 million dollars to make an atlas of the connections in the human brain. In Europe, we have a little bit less money, so we got only 2 million, but we

worked with 12 partners to make images like that, which were the first images of the connections in the human brain.



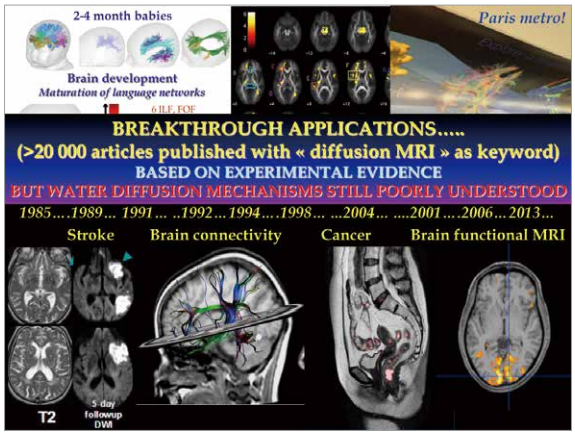
We have now more than 100 brains like that. It takes 15 to 20 minutes. You just go into the magnet, you don't even have to think about a cat, nothing, you can just sleep, and we obtain these gorgeous images of the connections in the brain.

So a very important message here is that from new idea to application in real life takes a long time, 10 to 15 years. I invented diffusion MRI in 1984 with application in stroke in 1994. For DTI, this method for the connections of the brain, 1994 was when it was invented, and it's only now that it's being used.

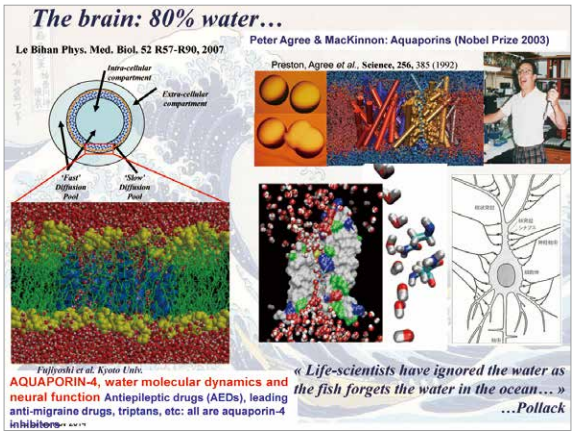


It was used for instance to see that in babies who are only two months or four months old, before they can speak, the fibers in the left hemisphere, in the future areas linked to language, are more numerous. There are more fibers already so the brain of the baby is ready on the left hemisphere to deal with language.

In some schizophrenic patients, we can see that the fibers connecting the frontal areas and the areas involved with sounds, audition, are faulty. The connections are not so good, and you know schizophrenic patients usually hear voices, so that may explain it.

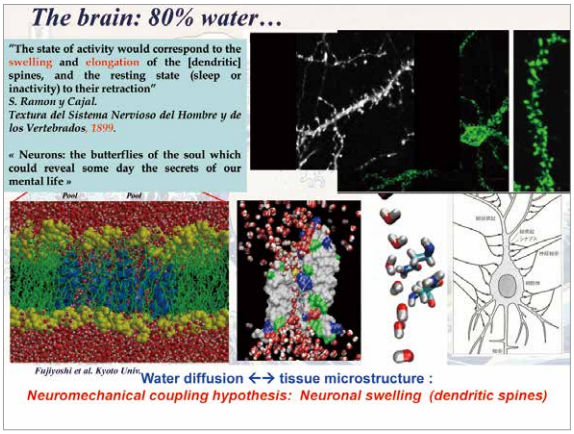


Now this technique is so popular that in one of the Paris Metro stations, they put as art a figure of the connections of the human brain. I think that it is becoming very, very popular.



So diffusion MRI has been used for many applications, for stroke, for orientation mapping of the fibers in the brain, for cancer detection, and it's used now for detecting activation in the brain. I don't have time to explain everything, but I would just like to convey the message that we should not forget water. Water is very important and Pollack said that

life scientists have ignored water as fish forget water in the ocean.



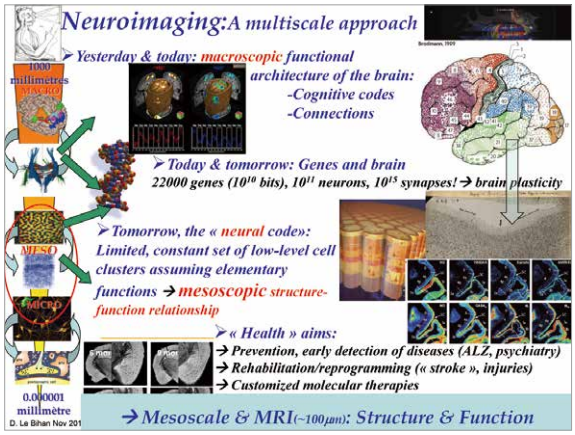
Water for instance, like in the sushi, may not be organized in the same way next to membranes, next to proteins, or elsewhere. And it's known now from the discovery of Peter Agre and MacKinnon, who got the Nobel Prize in 2003, that water molecules can cross cell membranes by using specific channels called aquaporins.

There are specific molecules that are dragging the water molecules one by one, breaking the hydrogen bonds, so nature has capitalized on water and is doing tricks to the water molecule, for instance, to break the hydrogen bond. Cells can say they want so many water molecules in or so many water molecules out. This is heavily controlled and some drugs now are designed to use those features, for instance to treat patients with epilepsy or migraine.

If we consider neurons, they have many, many dendrites, which are like antennas for the neurons but they have hundreds of them. And on each of those antennas we have some connections with other neurons. One single neuron can be connected to 10,000 other neurons.

Think about your cellphone, your cellphone connected with 10,000 contacts, it's huge. We have 100 billion neurons so the connections are huge. Ramon y Cajal, who discovered or invented the concept of neurons, said that neurons are the butterflies of the soul that could reveal someday the secrets of our mental life. I think he was completely right.

He also said that the swelling and contraction of all those structures was probably a key element to understand how the brain works, and this is what diffusion MRI can reveal also. This is what I call the neuro-mechanical coupling hypothesis, where the changes in the size of the parts of the neuron's linked to water movement can be detected by diffusion MRI, and they are pointing to maybe how the brain works.



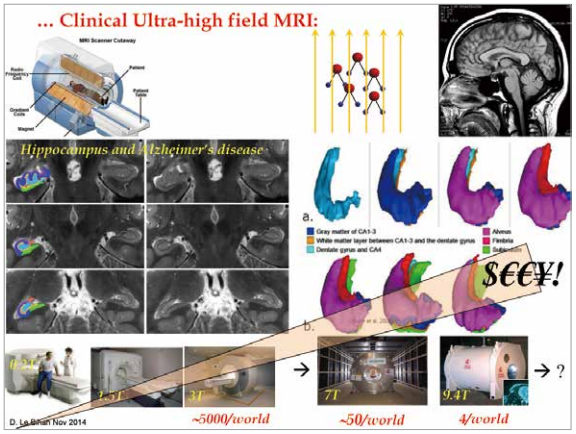
So this is where we are today (MRI image at the top). We can obtain images of brain activation, even in people in vegetative states, and we can obtain beautiful images of the connections in the brain, but that's not enough. We need to understand more. We have about 20,000 genes, but as I said 100 billion neurons with each of them connected to up to 10,000 other neurons. So genes cannot explain our brain.

We have language areas, all of us, but genes cannot say if I use this area for French or English or Japanese. This is the environment. So this is what we want to understand, what I call the neural code, how the organization in space of the neurons along the cortex make it specific for language, for vision, for motoricity. This is completely unknown today.

To do this we have to address the right scale. We have to go now to very high-resolution images so that we can understand better and have early detection of diseases. Maybe we can reprogram the brain after some injuries, that would be a dream, but I think it's possible. We will have to wait.

So how to do that? Well, MRI is about magnetization of water molecules using a strong

field, so just to give you an idea, this is a magnet that you have on your fridge, 0.005 Tesla, which is the unit for magnetic fields.



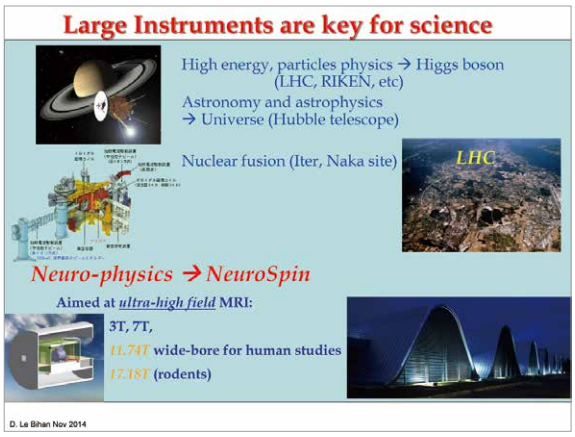
In hospitals, magnets are usually 1.5 T, so 30,000 times the earth's field. Nowadays, including in Japan, we can find machines working at 3 T or 60,000 times the earth's field, and there are a few machines, you will have five this year, in Japan working at 7 T or 140,000 times the earth's field. There are even a few machines working at 9.4 T. So you see there is a race for high field. Why?

For instance, look at the hippocampus (left center/previous slide). This area of the brain that is over-developed in London taxi drivers. In fact this area, which is linked to memory, is the first to be hit in Alzheimer's disease, so if you have a way to see this area very well in great detail in patients at the early stage we think that we may help them with diagnosis and then be able to slow down disease progression. We don't have a treatment, but at least we can delay symptoms.

These are images, for instance, of the hippocampus obtained at 7 T (right center/previous slide), but our dream is to go to an even higher field. The problem is that to see it costs a lot of money, so we have to share and physicists know very well how to share their instruments.

That's the LHC where the Higgs boson was discovered recently, and at Riken in Japan I also know there are huge facilities. For nuclear fusion, you know that in France we have the ITER site to produce energy from nuclear fusion. Japan is also one of the leaders for this.

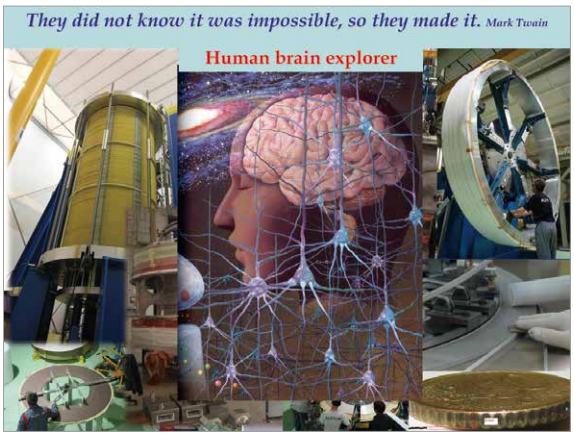
So this is how I decided to convince my bosses and the administration, the politicians, if you like, to build in France a place where we could have a very high-field MRI system, and the target is 11.7 T, so 220,000 times the earth's field.



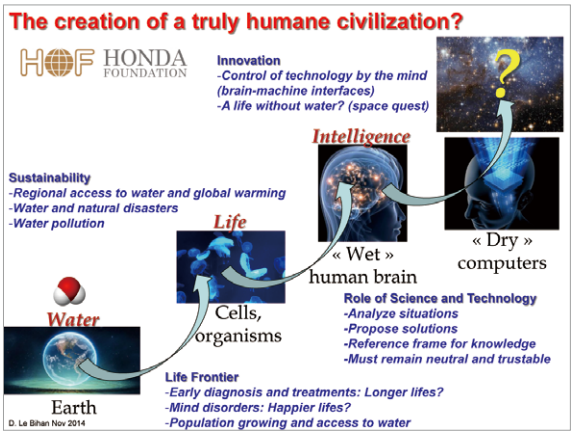
This is the magnet (next slide). It's huge: 5 m in length and 5 m in diameter. It will be the first in the world of this intensity to scan the brain. It was designed by the physicists at my institution, the Atomic Energy Commission. It's under completion now and it will be installed in NeuroSpin. It will be cooled down to -271°C, so 1.8 K, in order for this magnet to get the right field strength.

So it is today being built in a factory called Alstom in France where they make the French TGV and where they are also making for you in Japan some special magnets for nuclear fusion. This is how the magnet looks (left). It's almost finished now. It's incredible.

And just to show you the precision, this is a coin, this is a French coin (lower right/next slide), a European coin, and the black line here is the position of each of the 170 pancakes that we have to put in the magnets. The location is extremely precise and this is crucial. We are building what I sometimes call the "Human Brain Explorer," and we will get these magnets in about one year from now. Many people thought it was not possible so I like that they didn't know it was impossible, so they made it. That's our case.



To finish I'd like to comment on the motto of the Honda Foundation, which I like so much: "Creating a truly humane civilization." Sustainability is crucial. I hope I've convinced you that water is absolutely necessary. Global warming might change access to water, people may fight, and wars could be started because of access to water. Water is also connected to natural disasters.



Water appeared on earth and this is how life could be created. Life came thanks to water, cells, organisms, so the life frontier is about this kind of life.

We need to have early diagnosis and treatment of diseases to have longer lives, but longer lives are good only if we have happy lives, so we have really to understand mind disorders and see how we can cure them.

The population will be growing so access to water will be even more of a challenge. Water has permitted life and life has permitted intelligence to come and this is what I call the "wet" human brain; brain works with water. And in science and technology, of course, we use our brain to analyze situations and to propose solutions.

I think scientists should be considered as a reference frame for knowledge but only if they remain neutral and trustworthy. This is not always easy, but the next step, which is a little bit scary, is that from water to life to intelligence, we are steering to what I call "dry" intelligence, dry computers.

Maybe dry computers at some point will not need us anymore so we have to be extremely careful about how we control these technologies and how we interface with water. But maybe this life without water will be necessary if we want to explore the universe, and with those words I'd like to show that the vision of the Honda Foundation is really, really timely.

In English, maybe it is not so easy to go deep into the roots of this vision, but if we consider that life, the heart, is very important, this is something we cannot find in dry computers. We will have to be sure that we are able to preserve our emotions and our way of living. This is our direction, this is where we are going, this is not something we have achieved, this is what should drive our research.

Diversity, biological, that's very clear, but now we have to respect cognitive diversity, how people have different ways of thinking. We should respect them and we should focus on young people because they are our future. We have to show them that diversity is important.

We should also invest and protect old people because they have a huge quantity of knowledge that we can learn from, and they have to be able to share it with us, so we should do our best to protect the well-being of old people.

Thank you very much for your attention.

Q & A

MC: We would now like to take your questions. Does anybody have a question?

FUKUNAGA: I am Fukunaga of the Tokyo Abduction Research Group. I would like to thank you for that extremely interesting talk. My question is, does the hydrogen bonding process that makes a water molecule separate from or stick together with another water molecule create a network that makes atoms or molecules other than oxygen and hydrogen within the living organism stick together or separate in the interaction of, for instance, protein? What kind of non-water molecule or atom in the living organism makes such a fluctuating interaction with water? My question is in regard to this point.

LE BIHAN: I'm not sure I understood everything you wanted to address, but I have to say that, of course my talk was mainly on the water molecule, but water molecules in fact are responsible for the shape of many other molecules. With MRI, especially with high field, we are now trying to see ions such as sodium and we are also trying to see metabolites, neurotransmitters. In the brain, it's very important also to see how the different molecules activate neurons.

My vision is that water molecules are responsible for the shape of those molecules, and as you pointed out, there are a lot of dynamics in all these problems, and I think this is something we forget.

People usually have a fixed view of the system. For instance, the brain, neurons, connections but people don't realize that everything is moving all the time and water molecules have a very crucial role.

Maybe that's not exactly the question you wanted to cover but we have not enough time for me to go through everything.

FUKUNAGA: I understand what you just said. But what I would like to ask is whether the hydrogen and oxygen atoms of H_2O, or the H_2O molecule—components of water—have a fluctuating interaction with other atoms and molecules, i.e., separating from or sticking to them, for example, when they form the shape of atoms or molecules inside the organism such as nitrogen, phosphorus, magnesium, and potassium. Is there a direct interaction?

LE BIHAN: I still don't understand.

MC: Thank you very much. In the interest of time, let us take just one more question.

Questioner: Thank you very much. The development of medical equipment and medicine plays a tremendously significant role in prolonging human life. On the other hand, recently, the issue of death with dignity concerning a woman in the United States brings to light the question of balance with how one lives, whether a long life is everything or not, and that is a difficult question to resolve. I would like to ask your opinion about striking a balance between development in medical equipment and medicine, on one hand, and death with dignity and life support, on the other.

LE BIHAN: So are you talking specifically about breast cancer or other kinds of cancers as well?

Questioner: Not only in regard to cancer, but medicine in general.

LE BIHAN: So the problem today is, I think, and I'm talking about breast cancer because I think it's a very important issue, women when they have something abnormal on the mammography they may have surgery or they get invasive treatment. But sometimes there is nothing wrong.

This is very costly, psychologically for the women, of course, but also for the economy because they have to go to the surgery and they have to get invasive treatment. Sometimes we have to remove the breast, or maybe there is no cancer.

With these imaging techniques we think that we can help surgeons make decisions. For instance, in our images, if it is red, it's cancer and we have to operate. If it's green, it's not cancer so we may only have to monitor for maybe six months or one year. If it's orange then we are not completely sure so this is when you have to do a biopsy and use a needle to

take a sample.

The problem is that if you use a needle there will be a trace later, so when the lady has a mammogram one year later, you see a trace of the needle and sometimes it's difficult to sort out if it is cancer coming or just a trace of the needle. We believe that such diffusion MRI methods have the potential to sort the women who have cancer from those who have no cancer.

The problem is that MRI is very expensive so we cannot use MRI as a screening modality. So the idea is to reserve this diffusion MRI for women who are at high-risk genetically because we know that they have a high chance to develop a cancer so maybe they could have his technique available, or for women who have suspicious lesions on ultrasounds or mammograms.

MC: Is that okay?

Questioner: Thank you very much.

MC: Then that concludes Dr. Le Bihan's lecture. Thank you very much.

MC: Thank you very much.

Panel Discussion

Panel Discussion

SUNAMI: I am Sunami, professor at the National Graduate Institute for Policy Studies. The mandate to bring together in one direction this gathering of minds from different fields all over the world is an absolutely impossible task. Today, we've been listening to lectures on a vision of the future based on various cutting-edge research, and one conclusion that can be made is that perhaps, from hereon, development will no longer be linear as heretofore, but will change somewhere into a non-linear, dynamic type of development.

In this sense, since minds representing diverse fields are gathered here, I look forward to a dynamic panel in which discussions are, in a sense, non-linear and any idea can just pop out.

Since our time is limited, allow me first to deliver to you the message that has arrived from Dr. Haken who was supposed to attend this symposium. I will read this message which is in English, and request the interpreter to do it in Japanese.

Dr. Hermann Haken

Born in Germany in 1927. The 13th Honda Prize laureate in 1992.
Professor emeritus at the University of Stuttgart. Former Consultant to the German Sciences Foundation

On the occasion of the 35th HONDA PRIZE Commemorative Symposium I am sending all of you my very best greetings.

I had planned with great enthusiasm to participate at your important event, but sudden illness prevents me from coming. Nevertheless, I wish to quote main conclusion of my intended talk on "Sustainability and Synergetics":

"The formation of public opinion as governor of politics is essential.
We know from many examples of Synergetic Systems:
The effort of small but active groups as initiators of new developments can be decisive and can lead to the cooperation of all nations (big and small) in politics aiming at sustainability of life on earth. This underlines the importance of the activities of the Honda Foundation."

I wish your Foundation further great success.

Hermann Haken

SUNAMI: Let us now move on to the discussion. Later on, I would also like to raise Dr. Haken's message in the discussion, but let me first explain how we will proceed. Based on the presentations that the respective participants have listened to, the message, and the various thoughts that have come up which we shall introduce one by one, we shall subsequently proceed towards a discussion.

The latter half shall be a Q & A from everyone, in which we shall take questions as we proceed with the discussion. I would appreciate it if you could prepare your questions or comments now.

SUNAMI: Okay, so we will start our discussion. Why don't we ask you first, Dr. Clemens, to initiate the initial reactions?

CLEMENS: Thank you for staying here after the lectures. My comment is about this program and the message of the president. Exploring sustainability is the direction scientists or engineers should go to face global environmental issues. I think that is an important point.

You don't know me that well because I have given no lecture, but I have developed a material that is being used in a new type of aircraft engine, which can reduce emissions of CO_2 and NOx and also reduce fuel consumption.

I think this is something that is really sustainable because the problem in our world is we use too many of our resources and also we endanger our resources by producing emissions like CO_2.

I took some notes during the presentations and all of them were very good, very to the point. So maybe if I'm allowed to start something I will make some comments.

Mr. Reddy, in his presentation, spoke about freedom from slavery, freedom of religion, and also freedom from discrimination. These are points that were formulated a long, long time ago; however, if you really see how the world works it's a big difference.

I was surprised when you mentioned freedom from slavery and you gave a comment about how it is in India these days with so many people in danger of doing slavery work. Then there is freedom of religion, and in my opinion, because if you look at

what's going on in the Near East now with this Islamic war and so on, I think in Europe, especially, we have had really a good time since we had this so-called Age of Enlightenment when we separated politics from religion.

I think this was very important for the progress of Europe because we had a lot of the wars in Europe concerning religion, but this was key so in the last 200 years we've had no wars on religion. Maybe in Ireland, where they have problems; however, separation is good when you separate politics from religion.

Freedom from discrimination is also an important point. We spoke about women, the role of women in our society, and the fact that women have not reached a point in their recognition in our society. Women still earn less money doing the same work, do not have the same chances to have as good an education that men have, and so on.

Maybe one point on your presentation with CO_2 and water, I think CO_2 and water they are really related, and this comes back to my research because if you have too much CO_2 in the environment, you have a change of the climate, and this is what you see everywhere now, especially now in Europe.

In the last 10 years, we have had a lot of change in the climate so we have lost a lot of money by damage. Things that never happened

before have occurred in Europe, like heavy rains, flooding, and so on.

These are related to the increase of CO_2 and this is where my invention comes in, or where I have helped a little bit. People know that more than 3.5% of the change of climate is related to air traffic, more or less. Just to give you a number, more than 600,000,000 tons of CO_2 is released into the environment per year. One ordinary car runs at four tons per year, but when you multiply that by the number of cars, you get enormously high numbers of CO_2 emissions.

Maybe one point from my side because you told us that this diffusion of water molecules is very important for the human body. In my case, because I'm a materials scientist, I do not like diffusion at all because diffusion at high temperatures leads to very serious problems with materials. Very simply said, if you have a rotor blade and it's rotating, you have a force on it, and during high temperatures, with the help of diffusion of the elements, the blades become longer. This is something that is not allowed.

So, this is my statement, maybe, for the first round.

SUNAMI: Okay, thank you. Now I would like to invite Dr. Le Bihan. You're welcome to use Japanese if you want to.

LE BIHAN: So, if we have to talk about sustainability, I would like to talk about sustainability of the mind. I think what makes humankind a little bit special compared to the other animals on earth is that we have developed a writing system.

It started in the caves long ago and the first humans, as we know, started to use drawings to communicate and to transmit information from generation to generation. Then the real writing system came, and then we had books, and books were a tremendous invention to transmit knowledge over generations.

Nowadays, we have IT. We have Facebook, Google, Microsoft, and we have clouds, so we can store a lot of information. But my point is that we can only transmit what we are aware of. We can transmit only what we are conscious of. There are many things that we use to communicate that we don't know how to translate.

For example, when we exchange email over the Internet, it's very easy but you don't know exactly how people will react to what you write. I think all of us probably have some experience of emails that we really regretted sending, for instance, and that's easy to explain.

How people communicate is mainly outside of language. We use, for instance, facial expressions, and there is eye contact, which is very important because we know that autistic people, for instance, are not able to get eye contact, and so this kind of transmission of knowledge has to be preserved.

We should not forget that if we increase the number of robots, for instance, that we should be able to program something that is closer to how the human mind works.

I've seen experiments done at MIT, I think, where they had robots imitating human behavior. For instance, if you look happy, the robot will be kind to you, but if you speak with nasty words, the robot will react in a nasty way. And it was very funny to see that the robots have no emotion but because of this kind of behavior the people were responding as if they were talking to real human beings.

So we have to be extremely careful that we should preserve our way of communicating until at least we have understood very well how the mind works, which is not for tomorrow.

SUNAMI: Thank you. Okay, so Dr. Reddy.

REDDY: This is a very interesting topic. I have so many different random ideas that I would like to share with you, but let me just stick to two. They are not related to each other.

The first one is I was asking what makes us not so humane? Why is society not humane today? I believe that's maybe not a fair question because I think we are a lot more humane today than we were 500 years ago, 1,000 years ago, except we don't know all the things that they did at that time.

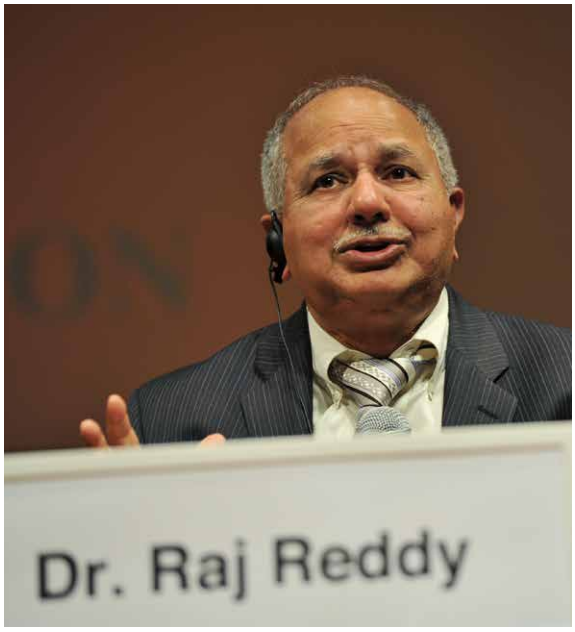
Looking at the specifics, for example, we now have terrorism and people are going around killing others. I thought maybe it's just a religious thing, even among the Muslims, the Shiites and Sunnis are blowing up each other, and the same thing happened at 9/11, and the same thing is happening with ISIS and ISIL. I don't agree that Europe in the last 10 or 20 years has been free of wars and things like that.

Take Bosnia-Herzegovina, for example. It's kind of a complete disaster. I could not believe a civilized society would behave like that in this day and age. It's part of Europe, right? We can go back to the Holocaust and even the First World War and the use of chemical weapons, and people seem to behave in ways that a thinking reasonable person would not behave, right?

But this seems to be something about the way our brain is built, and that's why I want to go back to Dr. Le Bihan. We are aggressive human beings. There seems to be some aggression in all of us and under certain appropriate conditions we forget everything else we have learned and we become aggressive.

The question is is there some way we can zap those water molecules to get rid of the aggression? That's one kind of thought.

The other one is more positive and uplifting. It turns out, if you look back at what happened 500 years ago, 1,000 years ago, 2,000 years ago, in Japan, not much existed. It is very difficult to find anything even 100 years ago because people have not been keeping most of it and whatever is there is in archives so most of us cannot have access to. Some documents are there and ultimately they will stay in those basements and they will ultimately rot in a few hundred years more and they will be lost.



Finally, we have the technology, we have the opportunity to capture our culture, our heritage, our knowledge, and everything we do everyday. That is, in the old days people used to think of books and music and movies as different media and different things. Not anymore, they are all bits and we can capture them and store them forever.

And not only the famous musicians, not only the famous movies, I can make a movie and store it on YouTube and it will be there, I'm hoping, for 1,000 years. So if you take a newspaper, a newspaper after it's published, two days afterwards, it's worthless and no one keeps it. But they are all born digital so they can be captured and stored forever.

One of the great things about information storage technology is I paid 2 million dollars in 1972 to buy 40 MB of memory. Today, I can buy 4 TB of memory, which is 1 million times more, for 100 dollars, so memory costs are becoming cheaper. To give you a number to remember, it's doubling every year, which means in 10 years you get a thousand-fold improvement in magnetic storage. In 20 years, you get a million times improvement, and that's going to continue for at least 10 more years or 20 more years.

The cost of memory is getting cheaper, so now you can afford to store everything, and we should be doing that. That is, we should be capturing all the books and all the music and all the newspapers and all the movies and make them available free for the whole society forever.

It doesn't have to be free today. Caruso's songs I should be able to listen to for free today, but if it's making money, let them keep it as copyright. But if it's not making money they should let it become public domain.

There are ways in which we can do this, and I don't want to take up much more time, but the important thing is there are so many things that we can do to make society more humane and we should do those.

SUNAMI: Thank you. Now, I would like to ask Dr. Andersson.

ANDERSSON: Okay, I will tag onto one of the points made by Prof. Le Bihan on communication and the complicated nature of communication.

There is somehow a rather common confusion of information and knowledge in the discussion about communication. We are all teachers and we know that you cannot assume that if you have given absolutely correct information over an email to a number of students that it will actually be transmitted in the true sense.

Teaching and learning is a very complicated process and one has to be skillful as a communicator in much more sophisticated ways than any information technology has mastered. Teaching and learning is kind of a transformation of information into knowledge, and knowledge to me is models and theories and sometimes even superstitions, but basically its models and theories that are the soul of teaching and learning.

Therefore, I don't have such a great trust in the information revolution or in the communication revolution. It contains aspects like persuasion. You have to persuade, and John Maynard Keynes actually wrote a number of essays on persuasion where he showed that the trick in getting people to understand his theory had nothing to do with printing the books in very abstract ways.

He said that you have to persuade, you have to convince people that they must give up their old ideas and they must learn these new theories, these new models, and that's very time-consuming and hard work, and it depends on very intensive personal communication where movements of hands, contact with the eyes, iterating the same information over and over again, and getting people to be friendly with what you are saying are kind of tricks of the trade.

So beware of seeing the information and communication revolution as the solution to the problem of getting learning as a basic aspect of our future. And even more, creativity and innovation are important aspects of development.

SUNAMI: Thank you. Dr. Reddy, are you ready to say something?

REDDY: It's a short comment. Dr. Andersson, I agree with what he has just said, except that I don't want to read into his comment that you should not be reading books or attending classes because your teacher will communicate.

Whether we like it or not, the information transfer process is imprecise and there are experiments that were done where somebody said something, it was copied many times, and then

ultimately it's called hearsay in legal terms. Hearsay is not admitted because when something is transliterated by many people it's not the same thing anymore. Therefore, we have this problem.

But nevertheless we educate people in society, we communicate, somehow the imperfect knowledge is communicated, sometimes maybe some innovation happens or maybe other things happen, but we have to be aware of the problem that is impreciseness of communication. That doesn't mean we shouldn't write books.

ANDERSSON: I'm a great friend of books, but my feeling is that it's only after teaching verbally and tutoring that I have managed to get the students to actually read the bloody books that they should've read at the start. It's an interaction between reading, tutoring, having lectures and seminars, and so on, and there is no substitute in the form of looking at a screen and becoming skillful.

Especially if you take a field like music, there has not been any successful first-rate musician who hasn't had intensive tutoring as part of going from information to knowledge and from knowledge to skills. The same is true of the lab physicist or the lab-oriented chemist or the doctor in a hospital. They have to be in this very important process where information from books and from screens and so on are a very small part of the total learning experience. That's what I would like to say.

SUNAMI: It's very nice to hear from an economist nowadays about the importance of reading books rather than modeling.

Dr. Le Bihan?

LE BIHAN: I agree with what you said and I would even go further away, that now you have so much information available that the brain cannot handle it. You have to model it, so we take only what we want. The problem is that, for instance, I have seen that the brain needs to have many inputs to keep memories and to understand.

In the good old times, as we say, teachers were using the blackboard, they would write things, equations and things, they would talk, and students had to write quickly because it would disappear. This was a way to get imprints in their own brain.

Today, you have a PDF and this is awful because you feel that you can see many things, maybe to prepare for an exam it's enough, I'm not sure, but just a few months or years later what will you keep? Nothing.

I think the problem with information technology is that we are invaded by so much information that we really don't know anything. For instance, let me give you an example. I'm sure some of you live in a house, and you have a set of stairs in your house. If I ask you, for instance, to imagine the stairs, you can see the stairs very well because you see them every day. But if I ask you how many steps

you have in your stairs, usually you cannot respond, even if you have used the stairs for 20 years. The brain has recorded some information that is useful, but the number of steps is not so important information.

We are filtering information so even if we have hundreds, thousands, millions of books, we will retain only what we want and this is why we need to have people communicating so we can share common knowledge and we have to be very careful about that.

SUNAMI: Let me explore that a little bit more. Last week I was in Scotland and on the way back from Scotland I was on the airplane watching movies as I usually do on a long flight and there was a movie called Transcendence. It's a Hollywood movie talking about the singularity problem in 2045, and you see the huge expansion of big data that transforms the world and everything that we know.

And there are big discussions in Europe, for instance, about how big data changes the way we produce new ideas and new knowledge, science 2.0, right? Because we do networking and you're communicating. How, in your field, do you view the impact of big data? Will it change or transform your field? What is your vision or what do you think the influence will be?

LE BIHAN: I have positive and not so positive views about it. Big data, especially to understand the brain, is crucial, and maybe you know, in Europe now they have what is called the Human Brain Project. It's a very, very rich program and the idea is to get as much information as possible from many, many brains to understand the brain. So it's great and we have to do it because the only way for us to understand is to have a lot of information.

But what I usually say to my colleagues is that the information will not create the model. We have very smart computers with many, many data, but you need to have a program corresponding to your model. If there is information that is not modeled, you will not see it. It is like dark matter, if you like: we don't see it and we don't feel it, so we don't know it is there, but in fact it is a lot of the energy

we have in the universe.

So I think it's the same. The problem with big data is that we promise to retrieve the information but we need models. Unfortunately, so far, computers, to my knowledge at least, cannot really do that. Of course, you can use some learning processes, algorithms, that are able to see some information and classify information like vector machines and so on, but it's not the same as creating a model like we have in physics, for instance, that comes out of the human brain. We are not ready for that.

SUNAMI: Dr. Andersson.

ANDERSSON: Well, there have been some tries at using neural network theory to, so to say, have an endogenous production of a theory or a model. Unfortunately, when you look into these, it turns out that they are critically dependent upon certain assumptions at the bottom. There must be some triggering mechanisms that somebody has come up with in order to get it going. The model is there, although it looks very implicit. So that's one part of it.

However, we have a school in financial economics that claims that we have already the consequences of enormous information flows in the stock market. The stock market is said to be a "super brain" because it aggregates all the wishes, demands, projections, and so on of all the investors into a price.

Unfortunately, it's not very stable so even if it works we have the stability problem.

My problem with these mass data, for instance, the mass data in the transit traffic system, is that if it's transmitted to people who are very reactive on each other and on this dataflow, they can actually generate catastrophes because they might be moving in massive conformity just to cause the problems that this massive set of data was assumed to solve.

If we were completely independent of each other and not interdependent individuals in a social system, then it might work, but we are, fortunately or unfortunately, social creatures who imitate and react on each other, and that can very often cause very severe instabilities in a rapid process.

SUNAMI: Dr. Clemens.

CLEMENS: I'd like to step back to memory because I like your statement in your presentation that we should take care especially of old people because there is a lot of information stored. I've also problems with my father-in-law. He's now 79, and he has started to lose his memory. It's some type of Alzheimer's disease.

Because there's a lot of memories stored in his brain, I think they are still there, do you think in maybe 10 to 15 years it will be possible to read out such information from a brain?

LE BIHAN: That's a tough question. I think it might be possible to retrieve some information in some time, but 10 to 20 years I think is too short. We are not ready to do that. The problem is that it's like when you have recorded information on a tape, for instance. You need a device to read the tape. If you've lost the device or if you have no device what do you do?

So today, in the brain, the only way we know to retrieve information is to talk, right? We don't have anything to pick up the information. We don't even know what memory is exactly about.

If you want to retrieve information, we have to communicate, so you have to regenerate something, but as I said, for instance, look at your stairs in your house. You think you have a memory of your stairs but if you are asked a question about them you cannot respond, so that means that you didn't memorize the stairs properly.

I think that we have to be very careful about what we call memories. If there is an accident and you have 10 people next to the scene of the accident and you ask them what they have seen, usually you have 10 different versions, right? If everybody had in their brain a camera, well, only one person would be enough, right? But we have to average out 10 different responses to get a clear response.

So I think that what memory is exactly is not so clear. It has been proven now that some of what we call memories are in fact reconstructions. Very often, children claim they remember something they did when they were 3, 4, or 5 years of age, but we know that memory is not very clear at that time. Actually, they heard their parents telling them what they did at that age. At some point this became "I remember what I did" when in fact, no, this was told to them.

So I think we have to first understand really how memory works and what it is before we can retrieve it artificially.

SUNAMI: As you know, there is a worldwide effort now on the problem of dementia and I think the Europeans and the US and Japan are collaborating to find the answer. There's so much economic loss and social problems associated with this, right?

LE BIHAN: Yes, but I think so far the idea is that if you lose your memory you cannot live in everyday life. If you forget, for instance, how to drive a car or where you are then you cannot live. So I think the urgent question is to have those people not lose their memory. It's not to extract information stored in the brain to transmit to other people.

This is your question, and I'm sure at some point we will be able to do that, to suck up the information and transmit it, but we don't know the rules, we don't know how it works.

But dementia is a very important problem, especially in Japan because you are lucky to have long lives. And it is the same in France, people have long lives, and in many advanced countries now, but if you have a long life and you cannot profit from it because you have lost memory or you have strong cognitive impairment what is the point to have a long life?

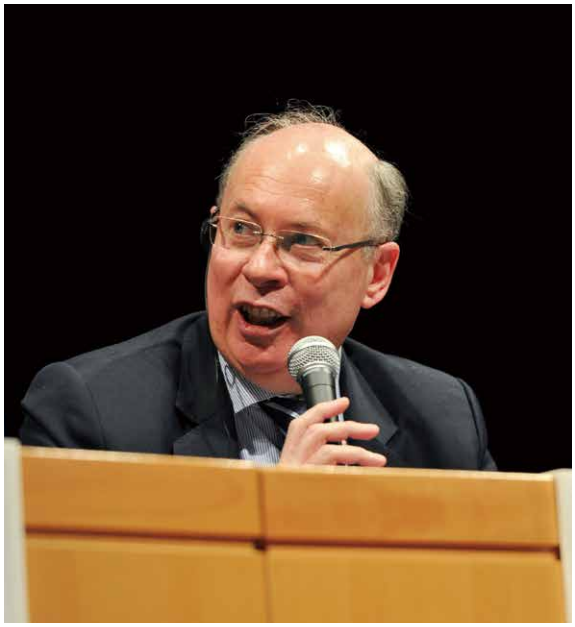
We should really focus on trying to maintain the brain level. The brain will decline with age, but that's okay as long as we can think properly.

SUNAMI: So, Dr. Reddy, what's your reaction to the world with big data? I mean you are working on a lot of cultural heritage or diversity problems, but they really come from this idea that we have controlled this big data and can manage it, right?

REDDY: Basically, I agree with many of the comments but with a complementary, additional thing. It turns out there is no question we have a data glut problem. Because of that, you know, we are not even able to process all the stuff that we are supposed to and a lot of things just stay there.

That problem has always been there, it's just that we were not even exposed to it before because all those books were in the library and we never got to read them. Now, they are all in a PDF and I have them on my Kindle, but they still can't be read.

Having said that, I want to caution you not to throw the baby away with the bathwater, as they say. It turns out there are a lot of things we used to have to remember, the skills that Dr. Andersson talked about, where we go from information to knowledge to routine skill, but that is no longer necessary.



You don't have to remember your multiplication tables. You don't have to remember your phone numbers; they are already on your contact list. You don't have to remember a lot of things you used to have to remember.

More importantly there are a lot of things that you might know but you forget, and sometimes you may not even know but you want to find out. All it takes is a Google search. There is not a day goes by where I don't search for some piece of information I used to know and I know I ought to know.

Ten times a day I find something that I should remember. I don't try to remember anymore, you know, I'm not trying to, and that's okay. You don't have to remember multiplication tables anymore. You don't have to remember phone numbers anymore because they're there.

So in that sense, we need to kind of compliment the fact that we have this big data and somebody else can search and give you some potential uses of information, which is very important.

For example, yesterday I was coming here on flight Japan Airlines 9. In the past, for any amount of money I couldn't find out, but now all I have to do is type "JL 9" into the search box and it tells me exactly where the plane is, when it's going to land, all of the information.

It comes out of a data glut. Every plane, all the

information is there. I don't need to know it, but nevertheless if there is a tool I have and I can use it effectively then big data is good. There's a data glut, but I don't have to deal with it. Somebody else is dealing with it.

SUNAMI: Okay. Yes, Dr. Andersson.

ANDERSSON: I think at this point we agree that it's good to have a toolbox, and if that toolbox is very easily accessible and I see the information systems as parts of a toolbox then it works much, much better now than it did long ago.

I would like to return to the issue that was mentioned on the growth of people who are annoyed at development, who might like to fight in Iraq or Syria or who might join an extremist movement in France or in Sweden or in Norway or in Denmark or in any other democratically, very well-functioning context.

We've done some studies of this and it turns out that the growth of extreme-right movements in these countries is driven primarily by the loss of traditional jobs and the impossibility for those who lost them to find an employer who would like to hire them to do the new jobs.

With the transformation of the economies in Europe, we are bound to have this kind of growth of extremist movements, and some of them are actually then immigrants who have come from Syria and Egypt and Iraq and so on and they are doubly confused about the future, so they might even accept a job with ISIS as a very attractive, although extremist, alternative to being unemployed.

I think one of the sustainability problems in this change process is to have the machinery and institutions that will generate new jobs for the people who are losing them when the old activities are abandoned in society.

SUNAMI: That's a very important point. My professor, actually, when I was doing my PhD at Columbia, did a study on innovation across the different sectors and which sector is more innovative than the other sectors. As it turned out, education is a sector that is less innovative. We haven't changed the way we teach people for years. We are very much in that sort of a rare realm where education becomes very important to make this kind of transition to be more sustainable.

So would you care to comment on education because tomorrow the Honda Foundation will be hosting the Young Engineer and Scientists getting together for the next-generation engineers and scientists?

Yes, Dr. Reddy.

REDDY: This is a very important question. Basically, if you think of education in the last century, basically, what the teachers used to do is teach us all the things that are known, known facts. These days all those facts are already available on the web. The question now is what is the role of education?

I'll give you a simple example going back to Dr. Le Bihan. There is all this data and all the other things. If I did not know that I could find some information, I would never know it. So it is not the case that I don't have to know the calculus, I just need to know the basic principles of calculus so that I can apply more advanced ones when I need to do it by just-in-time learning.

The issue is how to restructure education so that you no longer have to simply give facts that are already available. What you need to do is give them the reasoning abilities to do problem solving and apply knowledge to solve the problems you have.

The question is how do you do that?

I was giving the example of flight information. I have a problem, I need to know what's going to happen. I knew that I could type it and get the information and that is the problem-solving process. So we need to begin to give every child, every person, a series of skillsets to survive in the 21st century. That is not learning all the facts because the facts are there.

LE BIHAN: If I may say something. We have two things to learn. We have to learn how to learn, so the processes, but we have also to learn how to memorize. So, at least in France, when I was a student, a child, there was some conflict about people who are good at math. For instance, with mathematics you learn how to think, except calculation, and you don't have things that you learn just by heart. You have to think to make some new ideas arrive. While if you go to people who specialize in history or geography, they have to learn by heart many, many things.

But we need both; we need to memorize. I've been studying a little bit of Japanese and for kanji, for instance, to write kanji is very important to memorize. If you just look at kanji on a computer you will never memorize them and you will never learn what they mean. I admit it is my problem.

I think we need everything. This is how the brain works. As I said, many inputs, and we need to consolidate our memories. So even learning by heart things that you can retrieve with Google doesn't hurt because it is training your memory. And you know for people who get Alzheimer's disease, for instance, we try to maintain their memory even by learning mundane things, it's good enough.

So I think we have to balance how to learn things that you can find and things that you can't find, but today if you lose your smartphone and if you have put all of your phone numbers there, you will have nothing and you are dead.

REDDY: I want to reinforce what Dr. Le Bihan said. There are three phrases used: "learning to learn," "learning to think, reason, and solve problems," and the third one is "memorization is equivalent to," what Dr. Andersson called "skills."

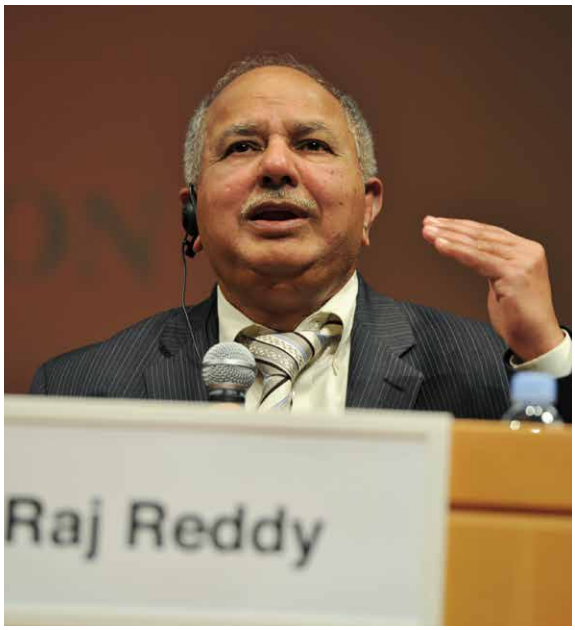
Supposing you needed to do something and there is no substitute for learning kanji unless you practice them so all the three skills are needed. Except now what used to be thought of needed skills in the 20th century are no longer the skills you need in the 21st century.

For example, I come from India where the sounds are the same but the letters are different. In 20 different languages there are 20 different scripts. Europe is safe that way because they only use one script. The problem is I don't want to learn all 20 scripts, and so what I do is I have the same letters transliterated into my language. I know how to speak with intonation, everything, so when I see it in my language I can figure out what to say.

So it turns out, depending on the technology, depending on where you are in time, we need to be able to say what should you memorize and what should you not have to memorize.

For example, this kanji character-learning thing may go away in the following sense. All I need is a smartphone and I take an image of it, it reads it, and tells me what it is. Then I don't have to actually learn the letters. And it can be done today.

The same is true with respect to translation. I'm in a meeting in another country. I don't know how to speak. All I need is my smartphone to transmit it, translate it, and then play it back to me. This technology was demonstrated in the last 3 or



4 years. We can do speech-to-speech translation now, and that doesn't mean we don't need regular translators, but there will come a point in time where no matter what language you grew up with, you don't have to learn all the other languages because you can listen.

SUNAMI: Okay, Dr. Andersson.

ANDERSSON: I once studied a famous mathematician Polya, who was from Stanford, and he kind of summarized his learning as a teacher. He wrote a book called *How to Solve It* and what he claimed I found very useful as a complement to what you said.

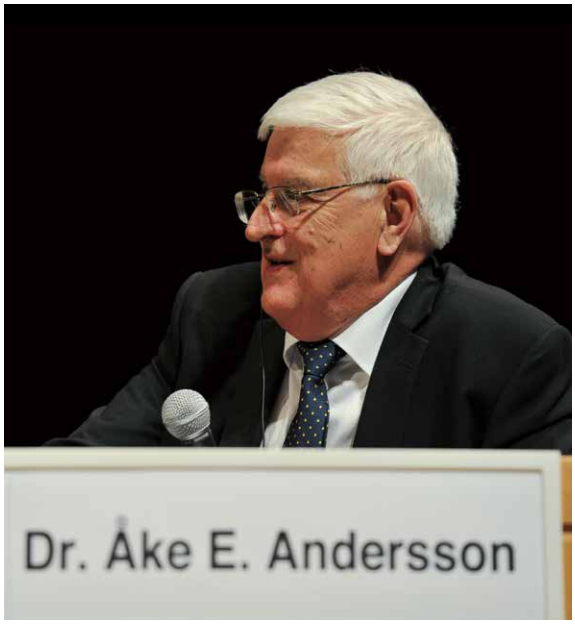
He said that, first, the trickiest thing to get people to understand is how to not only elegantly but also productively generate problems. Formulate problems. How can you formulate a problem that nobody has formulated before in a way that it is amenable to analysis?

Once you've done that, and if you are a student you have learned to see this as the basic part of creativity, then you come to the question, how can you solve it? How can you solve this formerly unknown problem because there is obviously nothing in the toolbox to be used directly?

So he said you can use analogies. There are analogies maybe from very strange parts of the knowledge field. You might be a physicist who wants to do something that no physicist has done, so maybe you should go into the deep cellars of mathematics or chemistry to dig up something that seems to be similar and sufficiently similar.

And I found this is a very nice way of opening up some students' eyes. They come and ask what they should write their dissertation on, and they want me to formulate the problem, and I tell them the only important thing is that they do something completely different from what I've been doing and then they look very confused.

But some of them come back after a couple of months and have actually by themselves formulated a new problem, and then we can start discussing what analog structures are available to solve this problem.



LE BIHAN: In fact, we know today that the brain works a lot by analogy. What learning is, basically, is having an experience about what should be done and what should not be done. If I say for instance "cat," you can think about a cat because you have seen one. Otherwise, there's no way, right?

Children, especially, when they learn, they learn by analogy so they try to compare different situations and try to mimic. Sometimes it is not appropriate and they make a mistake, so they learn not to do it again. And it goes very well.

For instance, some people have shown also that the way Einstein's vision came was just by analogy. If you look at the two articles he wrote about relativity, in the one in 1905, it's not $E = mc^2$, it's E/c^2, where E is some kind of mass. Even Einstein himself didn't catch what he found. And in his paper on the general theory two years later, then he revised the equation to $E = mc^2$ and said that this mass must be the mass.

So, I can see what he was thinking, from what I could read now, just by comparing different fields or different ideas and trying to propagate knowledge from one area or one field to another one, and I think that is really how the human brain works. So we don't have a digital brain; we have an analog brain.

SUNAMI: Okay, now I would like to invite questions from the floor.

FUKUNAGA: I am Fukunaga of the Abduction Research Group, and I'm making a presentation at the Cognitive Science Society. I once heard about the following discussion. This has something to do with Dr. Andersson who, it seems, earlier made the important remark that a complex system is the shortest algorithm.

This is something I heard from a chaos researcher, that in one's brain one can knead a pie, in Mathematics the so-called baker's transformation, a transformation activity in which chaos comes out. A complex system comes out. One kneads a pie by stretching it far or near. This so-called baker's transformation is a process that occurs in one's brain. There exists this kind of complex system through which the brain scans broader knowledge. I heard from this researcher that the brain, making the most of this chaos, might be scanning broader knowledge.

I think it fits splendidly with what Dr. Andersson earlier said that the complex system is the shortest algorithm. Is the professor's view compatible with my present example? Do you think it is a comparable example?

SUNAMI: Dr. Andersson.

ANDERSSON: There is one problem for me in answering this question, and that's I know too little about the brain, so I think that part Dr. Le Bihan will have to deal with.

The basic idea or the basic relation between complexity and chaos is a very sophisticated discussion that's now going on among mathematicians because it turns out that complex systems are at the heart of Godel's theorem. This means that there are certain problems where you cannot actually prove that a statement is correct, but you can know intuitively that it is correct somehow.

And that's especially in situations where, let's say, a number series is so complex that it can only be described as chaotic, and yet you can somehow grasp, or the brain can grasp, that there is some structure to it even if you can't get a computer, for instance, to solve the problem or even if there is a well-behaved algorithm around.

Already Turing struggled with this problem and made a version of Godel's impossibility theorems adapted to general computing. So this is a very, very complicated issue as far as I'm concerned...

LE BIHAN: May I just complete your response with the brain side?

Well, it is obvious that the brain is complex, but we should take the words or the definition. We know today that complexity is really how the brain works. In fact, in a sense, if you go to the bottom, to the molecular level, if you sum up all the molecules, you cannot create the level which is above the molecular level, so there is some synergy, something new that is coming out of each element at the molecular level.

Then when you go to the cellular level, again, if you put all the neurons together and everything, that's not enough, something else is coming, synergy is coming out of the collections of the neurons. Then you have regions and again and again, so each level is not the sum of the elements at the level below. This is complexity.

Also we know that the brain doesn't work linearly. It's highly nonlinear. Some people even think that it's similar to quantum mechanics, if you like. When I talk, for instance, about the fluctuation in the brain, this is what we see now. There are fluctuations and the system is somewhat chaotic. There are some fractals that have been used, for instance, to describe the electric waves produced by the brain.

But we are not aware because what we feel in a conscious state is only a very small part of all the machinery that is permanently occurring in our brain. And as you know very well, when we're completely asleep and we start to dream, the fourth level of sleep, we are totally unconscious. We are dreaming, but then this is the time the brain is the most active. A lot of information is processed at this time and this information processing shapes the brain. This is how we make our memories and this is how we learn, so the brain is really a model of complexity in a real sense.

SUNAMI: Okay, let me call Prof. Suzuki.

SUZUKI: I am Masuo Suzuki, a councilor of the Honda Foundation. I study Theoretical Physics and so I have a lot of comments regarding the earlier discussion. But I will not touch on those to save time and ask instead a general question.

On today's theme of Creating a Truly Humane Civilization, discussing the future based only on the present state of affairs gives us quite a narrow perspective. Learning from history—and there's a saying that history repeats itself—in thinking about a future sustainable civilization, and citing Japan's culture as an example, we can point to such stable cultures, in the spirit of "mottai nai" or not allowing anything to go to waste, although the aristocratic culture of Heian period, and the very plebian culture, such as kabuki and painting, of the Edo period flourished.

From the perspective of discussing the future based on what we learn from history, are there precedents in Europe that can serve as our reference when we think of a future sustainable society? I would like to address this question to wise panelists from Europe and India.

SUNAMI: Who wants to go first?

LE BIHAN: This is a very interesting question, but I think it's not specific to Japan. There are periods where things are stable, like if we take the Middle Ages period, for instance. In Japan and in France it was completely different, but it was somewhat stable. You had the organization with the shogun and everything, but at some point some chaos started and this is how you change from one system to another one, from the Middle Ages to the modern time.

In France, it was exactly the same. In the Middle Ages the system was very, very stable with the king and the people and everybody had his own territory and that was very stable. At some point, for some reason, people started to think differently and the system had to change.

I'm not sure history is repeating itself, it's just that for some time we had something stable as a society and then we switched to another system. This has happened in Asia, in Europe, of course the United States has a much more recent history, but I think it's not reproducing the same. It's evolution, but you have steps where everything looks stable. That's what I feel.

SUNAMI: Okay. Anybody? Yes, Dr. Andersson.

ANDERSSON: Well, I think that there are certain things to be learned from history and that's especially true for the countries who have not yet become industrial societies. We know that Japan got a remarkable rate of growth because they were, like Sweden, latecomers into industrialization, so we could benefit from all the errors and mistakes that had been done or experienced in Britain.

It was very common in Sweden, and Japan, to

make trips among innovators to Britain, or a little later to Germany, to see how they have organized production or how they have been working.

And today it's even more useful to look at the history of the countries that have had a very rapid expansion like we had earlier. Now we are a slow grower, but earlier we were very fast growers because we were imitators and learners.

Today, in Africa for instance, some of the countries who have started their industrialization process benefit from benchmarking and going to and seeing what other people have done before them, and using the useful organizational principles and the useful technologies and so on, and thus they grow much faster than we could do.

China is a good example of very systematic learning from history, but one shouldn't go too far back to learn. I don't think it's meaningful to go back to the Medieval times, for instance, in Europe and try to learn anything except negative things.

You can see how it works when power is monopolized by small groups and hierarchies become too stable and not inclusive and so on. Otherwise there is not much to be learned by going very far back. But going, let's say, 100 years back can be a very useful type of historical study for developing countries.

SUNAMI: Thank you. Any other comments?

Questioner A: Thank you. I have also watched the movie "Transcendence" and got to thinking about singularity these last 3 to 4 months. In chess, between Kasparov and Deep Blue, Deep Blue won in 1996 and 1997, and presently, in the battle between chess and man, teams are formed and those teams fight against one another. In Japan, last year and this year, five professional shogi players played against five software programs, and won only once in each year if my memory is correct. The humans did poorly in that competition.

The difference between chess and shogi is that there are more pieces in shogi, and since you can reuse a piece taken any number of times it's complicated, but it is said that even in the world of shogi, the computer has also caught up. Interestingly, the shogi player who lost to the

computer last year, was in a slump when he studied using that computer software and played with it, but this year, his performance has improved remarkably. This year, that computer software was lent to shogi players and the one who studied it thoroughly and polished his strategy won.

As I thought subsequently about the relationship between man and computer, in the end, even a professional shogi player learns unexpected moves from the computer software. One can learn from the computer by way of gaining new ideas that are different from what one has studied so far. Earlier there was talk about big data, with big data, the world that is invisible to man expands rapidly in such a way that a medical doctor, for instance, makes a diagnosis from computer results that he/she does not fully understand.

In this way, I would imagine the relationship between man and computer changing dramatically. May I hear somebody's opinion on this?

SUNAMI: Okay, so I will ask Dr. Reddy.

REDDY: What you say is very true. It turns out there was a phrase coined by J. C. R. Licklider in 1962. He is the grandfather of the Internet. He is the one that actually started the work, started the research in that area, and he also coined the term "intergalactic

computer network" or something like that.

One of the other phrases he coined was the phrase "man-computer symbiosis," so essentially any time you can have a human being and a machine who have worked with each other, understand who is good at what, they will always win over a computer or a person because they bring to bear the best of both worlds in some sense.

In particular, for most of the games of the kind that you're talking about, chess, Go, and so on, it is now possible, given the terabytes or petabytes of data available, to put inside every chess game that has ever been played and every move for every condition. That's not the same as all possible moves, which is more than the number of atoms in the universe, but every game that's ever been played can be put.

If you have that, then all that you have to do is do a table lookup or a search, in the Google search sense, to just look at that particular move and say does it lead to a win or not and then do it.

If you come up with a new position that nobody has ever seen before, what you do? That point is where the computer's power comes in. It can actually explore millions of possible moves and find out what is the best solution. Once it finds the best solution it becomes part of the folklore and every chess player will learn that particular thing saying, "If I know this, I can make this move."

And as we know, Grandmaster chess players know 50,000 different patterns, whereas most of the rest of us maybe know 1,000 patterns, and that's the difference. They have so much more knowledge and when they find a new position, a new winning strategy, it becomes their winning thing.

So basically coming back to the discussion on cognitive science and cognitive memory, the evidence now is, if you look at what happened with Kasparov and Deep Blue, the evidence is that it won mostly by brute force. A little bit of knowledge and a lot of brute force search.

The evidence now, at least looking at the brain research, is that a lot of the stuff in the brain is brute force, namely it can recognize there are different parts of the brain, 10,000 faces, each one has a separate computer that detects your mother and father and your brother and everybody, it's completely differently localized.

At the same time that doesn't mean there shouldn't be a complexity model that tells us this concept is understandable, it's simple in this context. That's where mathematics comes in. It doesn't mean the brain uses that particular structure, but it's better to understand it.

Similarly, for example, not everything can be formed into a mathematical principle that Dr. Le Bihan was talking about. A lot of the things that we know currently are all completely statistical models. It is not precisely formulatable as a model. I think you mentioned quantum mechanics. Quantum mechanics is mainly probabilistic mechanics and so the issue here is that the brain may be operating on a quantum mechanical basis and that may be an interesting possibility.

LE BIHAN: When I was a student learning IT at the end of the 70s, I remember very well my teacher gave us a definition of a computer: "It's something stupid with a very, very good memory." And in fact I think for our brain it's exactly the opposite. We don't have such a strong memory but we can think.

The advantage of the brain is that it is highly parallel. We have millions and millions of cells that can do processing in parallel, and so far, even with the best computers we have we are very far from that.

Now there is evidence also that the brain is using the Bayesian theory so waiting for different outcomes and comparing with what has been learned in a completely non-conscious way to decide what is the best behavior.

In fact, the brain we should consider is a machine to protect ourselves, to avoid dying, and so it's a learning machine. It is always learning. Even for old people, we are always learning and we are trying to decide what the best is for us. Sometimes we make mistakes, of course, but our brain is here to protect us, to preserve our life.

SUNAMI: Can I just invite one more question because we are running out of time and then we will go back to Dr. Andersson.

SUNAMI: The lady over there, you raised your hand earlier. Do you have any question?

Questioner B: I am presently raising a child. Since birth, this child has been surrounded by IT and PCs, which, with all due respect, if I may guess their ages, was a very unlikely environment for the professors here. I would be very glad if you tell me, for instance, that contact with nature is very important as an experience in early childhood, but in your opinion, at what age should a child start to have contact with a computer?

SUNAMI: Dr. Reddy.

REDDY: Always, but that doesn't mean that they shouldn't go out into nature. As Dr. Andersson was saying, you spend only 7% of your life, maybe 10%, working, so 10% of the time let them work with IT, 90% you do whatever else you want to do.

LE BIHAN: Yeah, I think we have to be careful to teach our children that life is not all in computers. There is real life and more than what we call social networks like Facebook. I hate this word because there is nothing social about them. We have to be extremely careful.

On the other hand, I talked about genes and the brain. If you give to a child a smartphone, in a few minutes he or she knows how to operate it although he or she cannot even read the manual. So genes are not responsible for us to use our smartphones.

So I think that if such devices are used in a good way, it can benefit the development of our children. For them, we have to realize that it will be like a pencil is for us today. One thousand years ago this would be a very strange instrument, right?

So we shouldn't make a mystery about such devices and we should make them just part of daily life. As you say, there is nature and communication, and these should not be forgotten. Unfortunately, there are teenagers playing games, for instance, on the Internet and for them this is society. That's very dangerous, of course, so we have to be careful.

SUNAMI: Dr. Andersson.

ANDERSSON: I would just like to ask a question to the brain specialist. I have been wondering if

Haken's idea of fast and slow processors might not be useful in understanding the workings of the brain because if you have a nonlinear system like the brain is, it would be chaotic most of the time. And we know that we are not chaotic most of the time. It happens now and then but on the whole people are quite predictable.

I discussed this once with a famous differential equations guy who wanted to model the brain, and he actually said that in order to model the brain with his mathematical tools he had to separate it into two parts: one that was slow and one that was fast. I wonder if this is the case that the brain is actually subdividable into two interactive processors, where one is kind of stabilizing the other part?

LE BIHAN: Well, it's not completely that way. There are different scales, as I said before, different scales in space, so from molecules to cells to network, and it's the same with time.

There are different timescales at the molecular level, at the cellular level, so, yes, we can see that, for instance, in the electric waves produced by the brain. There are different frequencies. But it's not only two. Some processes are slow, some are fast but they are interacting all the time, and even if chaos is present it doesn't mean that the brain is globally chaotic.

It's like the weather. We know that there is a lot of nonlinearity in the weather but we can predict it somewhat, and so it depends on the timescale you are talking about.

SUNAMI: Okay, Dr. Reddy.

REDDY: So there is a Nobel Prize that was won by Kahneman on slow thinking and fast thinking and it is another way of talking about cognitive science.

What we know is there are things you memorize and if you memorize them you immediately recognize them; therefore, they become fast thinking. Things that you don't know, that you have to reason about, that's kind of slow thinking. There's nothing magical about them. It's all been known in psychology and cognitive psychology for many years.

SUNAMI: Thank you. I think we are almost running out of time, so I think we should close now, but before we go there is one sort of important question that you raised, and I have some questions that I have been collecting.

How do you make us more humane, in a way? Is the innovation of eco-technology a solution? You know, you talked about the separation of state and religion, or state and faith, and that's sort of the beginning of the rise of modern science, yet now we are facing so many complex problems including religion and other sorts of things. Would anyone like to comment on this? Let's take turns to make a short, brief statement. Dr. Reddy.

REDDY: The only solution I know is education

about ethics, and Dr. Andersson mentioned that so maybe he should talk more about it, but mainly until we train the next generation about what is right and what is wrong, and put them in the shoes of the people that are being tortured and build up their empathy, we are not going to have a humane society because most people have not been taught. They think they can do anything and get away with it.

LE BIHAN: I think maybe I will respond with a question. If we say "more humane," what is "humane," first? I think it is a big question. Researchers now, some of my colleagues, are trying to understand what makes us different from animals, for instance. Is there a difference or is it just continuity?

I know especially for the brain, people are focusing now on if there is a way to understand what makes humans different from nonhumans, and that I think is an important question because if you want to be more humane we should understand first what humans are. And that's not so easy. In fact, that's a very difficult question.

CLEMENS: I think maybe it's quite simple, the answer to getting a truly humane society. I think if you give everybody a chance for the future that will solve all the problems. I think the problem is that you have areas in the world where people have no future, especially young people.

I agree fully with you that what we really need is a full education, a good education, for young people. And then we also need a transfer of money because in Europe, or here in Japan, everybody's living at a high standard. If you give the others a little bit of our high standard, I think we can solve a lot of problems.

ANDERSSON: I think that the keyword is "tolerance" because you know the old saying in France about brotherhood, I think that's a devastating idea because brotherhood means you care for your brothers and you don't care for the ones who are not your brothers or sisters. Tolerance means that you can accept anyone and you will look upon anyone as a human being and accept the deviations. I think that's the first thing.

The other thing is, as you said, to provide a place in society for everyone. Everyone should be needed somehow. You can be needed by being employed or you can be needed in some other way, but everyone should have a feeling that he is needed. Otherwise, he will migrate to any society, criminal or whatever, where he will be needed.

The third thing is something I don't know, but I heard a lecture on. That was a lecture by a biologist, I think he was a zoologist, who said that what makes humans unique compared to the other primates is that this is the only part of the primate system that has an inbred capacity to educate, that each of us, starting already with our babies, starts educating our babies and goes on teaching them how to solve simple problems all the time by imitation and so on.

So tolerance, a place in society, and proper use of our inbred capacity to educate each other, especially the younger generations, I think these are three parts of a humane society.

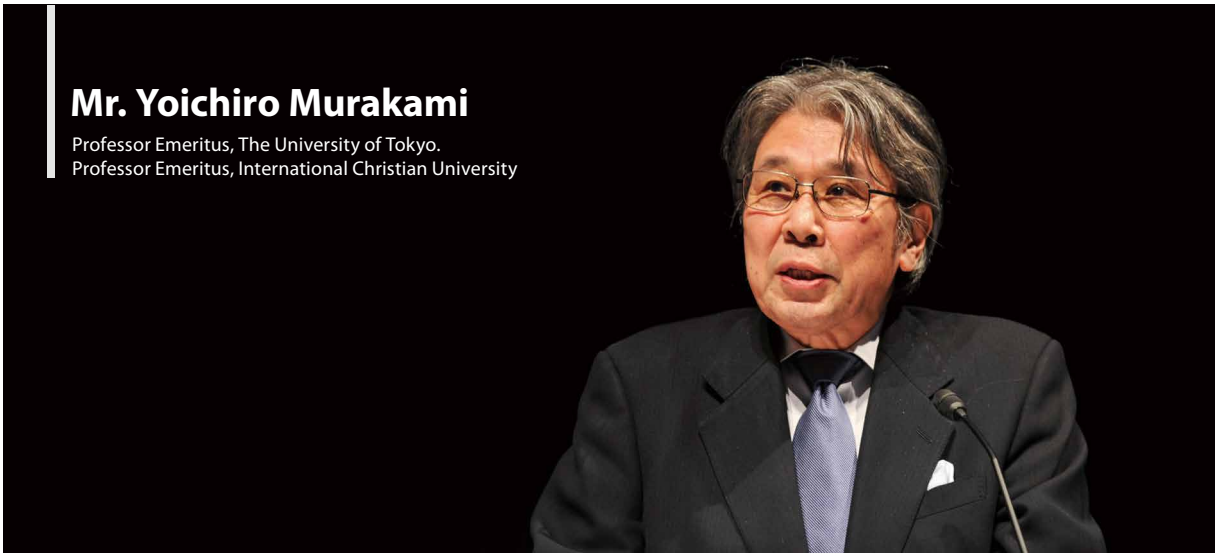
SUNAMI: Thank you very much.

SUNAMI: Since time is up, let's conclude the panel discussion here. Let us give the panelists a big hand.

SUNAMI: Thank you very much.

Closing Speech

Mr. Yoichiro Murakami



Closing Speech

I am Murakami, just as introduced. As one of the current councilors of Honda Foundation, I have been involved with this foundation from its incipiency and am one of the persons to have close association with Soichiro Honda. It is indeed with pride and gratitude that I participate in the 35th Honda Prize commemorative symposium and deliver this closing address.

At any rate, first, I would like to express my gratitude to the four participants of this symposium from around the world who are laureates, one of whom, Dr. Clemens, who is this year's laureate, will be joining us at the award ceremony on the 17th. Regrettably, Dr. Haken cannot physically come here now but I am sure he is with us in spirit. Including him, these are the five gentlemen to whom I would like to express my gratitude.

I would also like to thank Mr. Kojima who delivered the keynote speech, Mr. Sunami who displayed excellent skills as a moderator, and also the members of the secretariat who exerted considerable effort in the planning, preparation, and administration of this symposium. Likewise, I would like to thank everyone who patiently stayed with us throughout the long five hours.

As everyone very well understands how complex, diverse, and multi-faceted the problems we confront in this symposium are. When it comes to nature, disasters have intensified, and there are problems such as desertification, diminution of forestation, reduction of fertile soil, depletion of water resources, exhaustion of energy resources, let alone global warming. When it comes to social problems, we have the population problem, namely, its increase in the south and decline in the north, and the issues attendant to market-based economic and social systems.

Furthermore, there is the North-South gap, and gap within countries in the south and within countries in the north. Alongside the problem of disparities, there is also displacement, and while there are positive aspects to the information revolution that we have been discussing earlier, there are also negative aspects. Moreover, thinking about problems in the human environment, threats to the very existence of man and problems concerning those cannot be ignored. Perhaps I should call it a spiritual crisis, but the actual situation in Japan is that suicide is increasing, now advancing to the 5th cause of death.

Each problem does not exist by itself, but creates a network where an extremely complex

interrelationship exists among other problems. Therefore, if one draws a vision of the future, one can only paint an extremely complex picture, and will have to think of multiple scenarios. So we refer to the scenario of "The Next 40 Years" by the Club of Rome that was mentioned in Mr. Kojima's keynote address in the early part of this program. The scenario has an aspect that is rather tragic.

As demonstrated or expounded in this symposium, I believe only man's wisdom can change such a tragic vision of the future into one of hope, and is the sole factor that can save mankind and earth from its own destruction.

Thirty seven years ago, Honda Soichiro, who was gifted with sharp insight and humanism and who was driven by his belief in such hope and salvation, carried on with a social movement which includes this symposium. We carry on his cherished desire by encouraging everyone to join us in forging ahead with task in the next 35 years. I express my heartfelt gratitude to everyone.


本田賞 35回
記念シンポジウム
「人間性あふれる文明を創る」
HONDA FOUNDATION
Prof. Atsushi Sunami
Dr. Helmut Clemens
Dr. Denis Le Bihan
Dr. Raj Reddy


本田財団のミッションとアプロー
Our Mission and Approach

公益財団法人 本田財団
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