VISIONS FOR BIOMEDICAL SENSORS

EXTRACTS FROM RELATED FORESIGHTS AND OTHER STUDIES

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FOBIS newsletter sep.05

Introduction

How will biomedical sensors shape the healthcare systems of the future? How can they impact the quality and cost of healthcare and what are the business opportunities in the Nordic region? A Nordic consortium headed by SINTEF (Norway) and with the participants VTT (Finland), FOI (Sweden), S-SENCE (Sweden), STC (Denmark) and MedCoast-Scandinavia is conducting a foresight study on Biomedical Sensors. The project is supported by the Nordic Innovation Centre.The project revolves around a series of workshops, the first on to be held in Copenhagen 6-7th October, the second in Oslo, 2nd November. More information is found on our web-site: *www.nordic-fobis.net*.

Inside This Issue

This issue gives extracts from already conducted foresights and other studies related to the area of biomedical sensors, to act as "eye-openerers" to this vast and important field of science and its possible impact on our society.
The material has been compiled by the project partners.

Challenges in Healthcare

"Increased longevity and larger population will require rapid development of all the health care sectors, with particular focus, on the development of fast and cheap methods in the pharmaceutical industry, the development of local and timely drug application-methods, the expansion of new methods in implant surgery as well as in the near-patient care and preventive diagnostics..

Imego magazine, Future of biosensors- 10 years from now (2002) www.imego.com

"Current national studies show that patients provided with some form of home-based monitoring are hospitalized less, and when they are hospitalized are able to be discharged earlier than unmonitored patients…"

*Carl Taylor, director of the Office of Emerging Health Technologies..*www.southalabama.edu/emergingtech/news/news-sybernet.html

"The healthcare industry has only begun to scratch the surface of this opportunity"

"Being able to remotely monitor, collect and analyze biometric patient data in a dependable and scalable fashion and make this information available to healthcare providers via secure web technology has the potential to improve patient safety and dignity, and can lead to better outcomes and real time/cost savings. "The healthcare industry has only begun to scratch the surface of this opportunity."

Kenneth Kleinberg, vice president and research director for research and advisory firm Gartner, Inc. www.southalabama.edu/emergingtech/news/news-sybernet.html

"Important factors affecting the future of health care are as follows:

- The development of Finland's public health service will be determined by the EU's specifications of the pan-European welfare policy. Globalisation can bring new, significant challenges such as new epidemics, new disease spectra or multi-cultural customers.

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- The coming changes in the needs of the ageing population are well anticipated. The changes, which are related to an urban life style, a higher education level, individualism and living alone, can cause unexpected pressure on social and health services.
- The transition of the large age groups (born between 1946 and 1953) to retirement causes serious recruiting problems for new staff.
- Bio-medical breakthroughs lead to new possibilities in examining and treating patients. Medico-technological developments will continue, cycles will accelerate and the expectations of the population will increase.
- Several routine services will be performed via electronic transactions (appointments, laboratory consultations, handling of prescriptions, consultation with medical experts)

> *"Medico-technological developments will continue… and the expectations of the population will increase"*

- An open rationing will unavoidably be needed to restrict the increasing demand for services. All rationing systems must be transparent, fair for everyone and based on medical principles (mostly on the cost -effectiveness of the treatment). The Finnish 15D quality-of-life scale has become a national standard in measuring the effectiveness of health care.
- The number of multi-problem patients will increase, especially with children and adolescents. Their needs for medical, social and educational services will increase.
- Every citizen's own role and responsibility to his or her own health will increase.
- The financing of health care services comes from several different sources: state, municipal health care systems, KELA (the Social Insurance Institution), employers, insurance companies and the private sector). The financial system must be clarified."

(*) Skenaariot ja strategiat palvelujärjestelmän turvaamiseksi(2004) www.eduskunta.fi

"A network based on IT can be the modern platform of the home health care, this would gradually increase the efficiency of the whole public health sector"

Vård nära dig (2004) www.kks.se/upload/publikationsfiler/vard_nara_dig_seminarie_2004_publ.pdf

Market Issues

"There is a considerable risk that large global drug companies in a systematic way buy smaller innovative companies or some key persons in order to commercialize there products outside the region where it originally have been developed. Studies of drug companies also show that these to a large extent concentrate on commercials and markets of significant incomes. The fast progress in biotechnology makes it often difficult for these big companies to be in the front line. Their strategy is therefore to control, or in some case cooperate, and at the right moment buy innovative companies. In this way the financial risks of the development of new drugs is reduced."

Health Care, Utveckling av en ny tillväxtbransch (2003) www.naringslivskontoret.se/upload/HealthCare.pdf

> *"… they are optimistic about the future, and invite others to focus on this innovative sphere"*

"Biotechnology in Norway is a young industry. Most companies were established in the 1990s, with small staffs and close ties to universities and research institutes. Annual turnover for more than half of these companies is below € 1.2 million, and close to 70% are in the early non-profit phase. Nonetheless, they are optimistic about the future, and invite others to focus on this innovative sphere."

Biotech Norway 2020 foresight project , www.forskningsradet.no/biotek2020

"A number of companies are exploring new applications in clinical diagnosis, monitoring, treatment, and biodefense. As of today there are at least three major applications driving the market; in-vivo sensing/monitoring, point-of-care diagnostics and life science research. In-vivo sensing and actuations needs can be found in a multitude of clinical applications areas.

The clue to developing a successful product is to find a particular niche which is appropriate with respect to funding possibilities, market size, approval procedures, and time-to-market. Point-of-care devices are made for doing fast analysis of minute samples of blood, saliva etc at the hospital bed, in the doctor's office or even at home. A driving force is to further develop these point-of-care devices to do advanced, complete analysis, i.e. meeting the goal of a Micro TotalAnalysisSystem (□TAS).

A growing market is the biodefence market. In the US Northrup Crumman has already developed and implemented seven hundred mail-cancellation machines. These machines analyse samples of air for anthrax spores and provides results every one to two hours.

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The challenge in both these markets are to do clinical diagnostics valid for a number of deceases and to reduce the response time, meaning that the result are ready within minutes and not hours as is the case today. In most cases this means that the sensing devices must be constructed to perform a multitude of operations on the substances in a rapid manner and that they can sense a lot of different substances. This again means that the understanding of fluid motion in very small channels must be understood and that the sensing devices are of a general character. Another important topic will be to make these sensors biocompatible, meaning that knowledge of material properties of especially polymers will be vital in the development of such sensors."

Senior Scientist, Ph.D. Jon H. Kasperesen, SINTEF ICT

"Taking advantage of such a force requires leadership that is visionary, innovative, decisive and not adverse to risk"

"The small size of the research work force (editor: in Norway) makes it difficult to achieve a critical competitive mass within some areas of research, but at the same time it offers advantages in terms of flexibility and rapid response to opportunities if the work force is well trained, motivated, creative, and mobile (both geographically and thematically). Taking advantage of such a force requires leadership that is visionary, innovative, decisive and not adverse to risk.

…

It has been suggested in some circles that perhaps the most cost effective strategy for Norway with respect to biotechnology would be simply to purchase products and services rather than make the heavy investments required to develop research programs and train people required to carry them out. The dangers of such a passive approach in creating a low level of biotechnological literacy that would relegate Norway to the periphery of the international biotech economy should be obvious."

"Norway in the international research landscape", Eric Thomposon, SARA international Centre for Marine Molecular Biology; article in the book "Leve av, Leve med, Leve for? Vår bioteknologiske fremtid" Berit Johne, Erik Øverland, Cappelen forlag.

Technological Opportunities

"Combined with the ICT revolution and innovative materials, it *[gene technology]* has opened up new vistas for biotechnological research. The most significant leaps forward will emerge where these new technologies converge...

Norway has excellent, internationally competitive research groups in life science and biotechnology. An international evaluation in 2000 designated 10 superior groups at the University of Oslo (7), the University of Bergen (2) and the Norwegian University of Science and Technology (1).. In 2004 the Research Council allocated approx. € 70 million to biotechnology research (basic research,FUGE and innovation)."

Biotech Norway 2020 foresight project

www.forskningsradet.no/biotek2020

"The most significant leaps forward will emerge where these new technologies converge"

"The highest-ranking statements in the Sensor Foresight survey cover sensor types such as biosensors, MEMS-sensors, sensors for new energy conversion systems, and sensor application in communication systems.
With the strong Danish position in the biomedical sector, i.e. both in terms of industry and research and development, this area of sensor development is of great relevance to Denmark.
Also biosensors for 'life style' purposes in relation to the medical and food sectors, but without the strict adherence to medical needs, could be an interesting area of industrial development in Denmark.
Both in relation to biosensors and MEMS, polymers have great potential in the biomedical and food sectors, especially in sensor systems and as base material in MEMS technology."

Sensor Foresight report, Sensor Technology Center A/S 2001

***Biotechnology** uses living organisms or parts or models of living organisms to produce new knowledge, products or services. Modern biotechnology often uses genetic technology, where we define genetic technology as techniques where the genetic material (DNA) can be analysed, isolated, inserted into living cells to form new biological molecules with new properties.*

Biotech Norway 2020

"Regarding structural material production, Norway has a strong position as a producer of aluminium, silisium, ferro-alloys and plastic materials. Industry for (structural) material production constitutes 40% of land-based industry production and 60% of land-based export in Norway. But the industry for functional materials and nanotechnology , which internationally are strongly growing markets with heavy research focus, are weak in Norway. Norway needs to focus its research to be able to meet the challenge from the new material and nano-technologies. The new technologies will influence a large range of areas and industries, from energy, environment, health, ICT and transport.

"There is great expectation to nanotechnology and its potential to bring forth an "industrial revolution" similar to that caused by the steam engine and computer technology. How we manage to master and commercialize material- and nanotechnology can be crucial to the competitiveness of the industrial countries in the 21st century.

Nanotechnology is working on atomic and molecular level to design, develop, manipulate and use materials, components ands systems to produce new mechanical, functional, chemical and biological properties."

Foresight: Avanserte Materialer Norge 2020, Norges forkningsråd (Translation by I.Svagård)

www.forskningsradet.no

"**The biological revolution offers enormous opportunities to Sweden**
…and one must make good use of those in the best possible way.

Measures to promote growth of the great number of spin-off companies already existing must be investigated. In some cases, governmental efforts are of necessity in order to enhance the conditions and the requirements of these companies. Also, the conditions of the maturing companies must be studied; incentives and possibilities must exist when it comes to staying and expanding in Sweden. Today, the Swedish biotechnology industry is strong when compared internationally.

"Today, the Swedish biotechnology industry is strong when compared internationally"

Sweden is today well ahead when it comes to applications of the new biology. In some cases, a directed stimulation might also promote a development that enhances competitiveness of the industry, in areas such as;
- production of new pharmaceutical drugs,
- therapies
- diagnostics based on biomedical research such as molecular medicine
- stem cell research
- neuroscience
- microbiology, genomics, functional genomics and proteomics."

Swedish Technology Foresight, Framtidens hälso- och sjukvård (2003) www.tekniskframsyn.nu

"Biotronic can be defined as an integration of biological, mechanic, electronic, optical and chemical techniques for hybrid system with specific functions. The development is directed towards more general system based on bioMEMS (microelectromechanical sensorelement) and lab-on-a-chip technology. In the short term, 5 – 10 years, these system will allow different forms of two ways communication- (electric, chemical and/or mechanic) between biological material and artificially systems.

The most important applications will be found within medicine, for example diagnostic, drug delivery and control of biological processes. In the long term, 20 years, there should be advanced interfaces which make it possible to connect natural and artificially biological systems with systems from" the microelectronical silicon world". These can lead to integrated systems of connected biological, biomimetical and nanoelectromechanical systems and processes.

"The most important applications will be found within medicine, for example diagnostic, drug delivery and control of biological processes"

In the long term it is likely that implanted biosensors can continuously measure different substance in the body, for example natural variation of glucose and hormones. With these sensors it could also be possible to measure specific biomarkers in the body caused by exposure of harmful substances i.e. biological or chemical agens. Even more advanced would be to connect these devices with drug delivery systems."

FOI-R--0842--SE (2003) Biotekniken-ett expansivt forsningsområde med intressanta applikationer för totalförsvaret. www.foi.se

Future scenarios & Today's news

Scenario

" Wrong decisions"

Serious incidents with genetically modified bacteria and gene therapy were followed by scandals in research institutions. The crisis made many researchers and other actors look for new opportunities within surveillance, risk analysis, crisis handling and international organisations for regulation and control. Three Norwegian EU advisers are sitting today, in April 2020, in Brussels discussing how it could go so wrong. How could the judgment of both science and government institutions fail so fundamentally? Norwegian biotechnology went to pieces.

Biotech Norway 2020 foresight project

www.forskningsradet.no/biotek2020

"The biosensor on the chip has done a quick analysis and found traces of designer-drinks in his blood"

Scenario

"Lillebror ser deg"

En indre stemme vekker Pettersen som vanlig. Han er litt sliten etter gårsdagens firmafest, men stabler seg på beina og kommer seg opp sengen. Brikken har allerede begynt å registrere minustid. Så nå og må han på jobb. Bildøren åpner seg automatisk når Pettersen nærmer seg. Nanobrikken som Pettersen fikk implantert i forfjor og som alle nyfødte barn får ved fødselen, har identifisert at, jo da, dette er den rette eieren av bilen. Han setter seg inn, men kjerra vil ikke starte. Biosensoren på brikken har gjort en rask analyse og funnet rester av designerdrinkene i blodet hans. Da er det bare å vente...

Foresight Avanserte Materialer Norge 2020, Norges forkningsråd, www.forskningsradet.no

Scenario

"Tidlig diagnose"

Ny teknologi muliggjør på stadig flere felt mulighet for tidlig diagnose, i de fleste tilfeller screening av sykdommer man er disponert for. En stor etisk debatt er tilbakelagt der man konkluderte at alle har rett til å kjenne sin DNA og derigjennom arvelige anlegg for ulike disponeringer. Dette har fått ringvirkninger når det gjelder helse/livsforsikringer, videre er flere utpressingsforsøk blitt foretatt overfor kjente personer. For helsevesenet har dette skapt både problemer ved økt pågang av pasienter med minimale sykdommer, men også nye muligheter for styrking av metodikk for tidlig diagnose av sykdommer som på senere stadier vil medføre store samfunnskostnader. Internasjonal industri har identifisert metodikk for tidlig diagnose som en fremtidig økonomisk gullgruve. Norge var tidlig inne med tung forskningsaktivitet i regi av GE-Amersham sammen med regionale universitet-, hospital- og instituttmiljøer, dette inntil GE i 2012 flyttet aktiviteten til USA og nedla forskning og produksjon i Norge.

Foresight Avanserte Materialer Norge 2020, Norges forkningsråd, www.forskningsradet.no

DAGBLADET Fredag 6 mai 2005, stort forsideoppslag:

"Hemmelig sykdomsliste gir deg forsikringstrøbbel

Stortingsrepresentant ble nektet livsforsikring.

Helserisiko: Forsikringsselskapene har ei felles hemmelig helseliste som forteller hvor stor risiko du har for å bli syk. Den fører til at tusenvis av nordmenn får rådyr forsikring eller ingen i det hele tatt."

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