Plotting the Future of Mature Societies
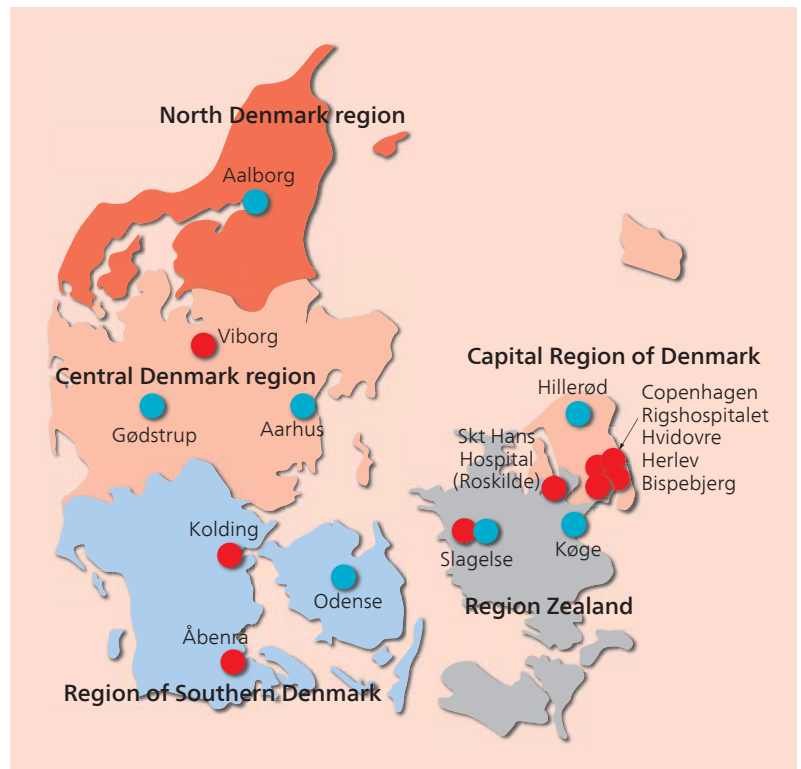
— Denmark's Super Hospital Concept —

The rising cost of social security is a challenge faced by all developed nations, with Denmark, a nation known for the extent of its welfare state, being no exception. Denmark is proceeding with a "super hospital" concept, whereby it is consolidating public hospitals across the nation into 16 sites to cover a broad range of activities. Hitachi is participating in this work, having reached an agreement to jointly develop solutions with Bispebjerg og Frederiksberg Hospital, which is responsible for healthcare in the municipalities around Copenhagen. This exercise in collaborative creation combines the hospital's healthcare data and its experience in hospital management and operation with Hitachi technology and other know-how to work on improvements in hospital management efficiency that will help realize a vision for the next generation of healthcare.

Happy Nation Benefiting from Reforms

Denmark has been called the world's happiest nation. It topped a United Nations survey of happiness indicators in 2013 and 2014, and placed third in 2015. Recognized as an example of the Northern European model of a welfare state and a leader in environmental matters, Denmark had the world's sixth highest per-capita gross domestic product (GDP) in 2014 and regularly appears near the top of international competitiveness rankings.

Underpinning this strong national performance are both a national character unafraid of change, and the benefits it is now reaping from past reforms. Further reforms are currently underway, one of those in the healthcare sector being the "super hospital" concept, a bold restructuring

Denmark is made up of five administrative regions. The super hospital concept aims to improve the operational efficiency of public hospitals by 25% by consolidating operations at 16 sites (blue: new construction, red: expansion or refurbishment).

aimed at improving the operational efficiency of hospitals by 25% by consolidating 40 existing sites around Denmark into 16 advanced medical facilities. Three specific targets have been set to help meet this objective: a 50% increase in outpatients, a 20% reduction in beds, and a reduction from 4.5 to 3 days in the mean length of a hospital stay. Specific activities aimed at achieving these are already in progress.

Hitachi is participating in the work, having reached an agreement in November 2014 with Bispebjerg og Frederiksberg Hospital, one of the super hospitals, to work jointly on the development of new healthcare solutions.

Shigeyuki Tani (Senior Researcher, European R&D Centre, Hitachi Europe Ltd.), who is involved in a research and development (R&D) capacity in the joint solution development project, used the following words to describe Hitachi's participation in these national reform activities in Denmark.

"Some two or more years ago, the government of Denmark issued an invitation to companies and other organizations around the world to participate in its reforms. The main thrusts of these are environment and energy, transportation, and healthcare. In response, Hitachi undertook about a year and a half of research involving consultation with a wide range of companies and other organizations, as well as the five administrative regions of Denmark, to identify where we could best focus our efforts. As a result of this work, we became involved in the super hospital concept because it had set the clearest objectives."

Innovative Capabilities Fostered by Appreciation of Social Sciences

Denmark is already known for its innovative capabilities as well as for its international competi-

Shigeyuki Tani

Hans Lindeman

Yukinobu Maruyama

tiveness. Hans Lindeman (Senior Vice President, Social Innovation Business Platform, EMEA-CIS, Hitachi Europe Ltd.), who is involved in business consulting for the project, explained the reasons for this as follows.

"Denmark is a relatively small nation, with a population of 5.6 million and a land area (excluding overseas dependencies) of only 43,000 km², and follows the Nordic model of investing heavily in areas like welfare and education. With the aim of improving the quality of life of its population, it is also proactive about adopting new technology and investing in its development, with the public-private partnership (PPP) being a common model for the provision of public services such as research, education, and healthcare. Collaborations like ours are also very common, and the nation has achieved numerous innovations through collaborative creation that involves the public and private sectors, with participation by the public as well as by corporations."

Yukinobu Maruyama (Chief Designer, Global Centre for Social Innovation — Europe, Hitachi Europe Ltd.), who is working on the project as a service designer, added the following noteworthy point about Denmark as a nation.

"Denmark is working on measures that treat not only natural science but also social science as being part of technology. Use is being made of social science in the study of public services intended to

overcome societal challenges, including the service design process and drawing on knowledge of behavior modification research, a field that combines cognitive psychology with economics. This is another reason for the interest in Denmark."

For example, bicycles place a minimal load on the environment and the capital city of Copenhagen has increased the rate of bicycle use through changes in resident behavior brought about by policies that are designed in terms of both hardware and software to facilitate the use of bicycles so that they can play a central role in transportation in the city.

Mr. Tani also commented that, "The distinctive characteristics of Denmark that relate to information technology (IT) include a low level of resistance to participation in social innovations, with widespread adoption of new technology in daily life and a high level of IT literacy that includes regular use of electronic devices by the over-60 age group and public acceptance of data sharing with a national identity number system that has operated for many years. This has led Hitachi among others to see the country as an easy place to introduce new technologies."
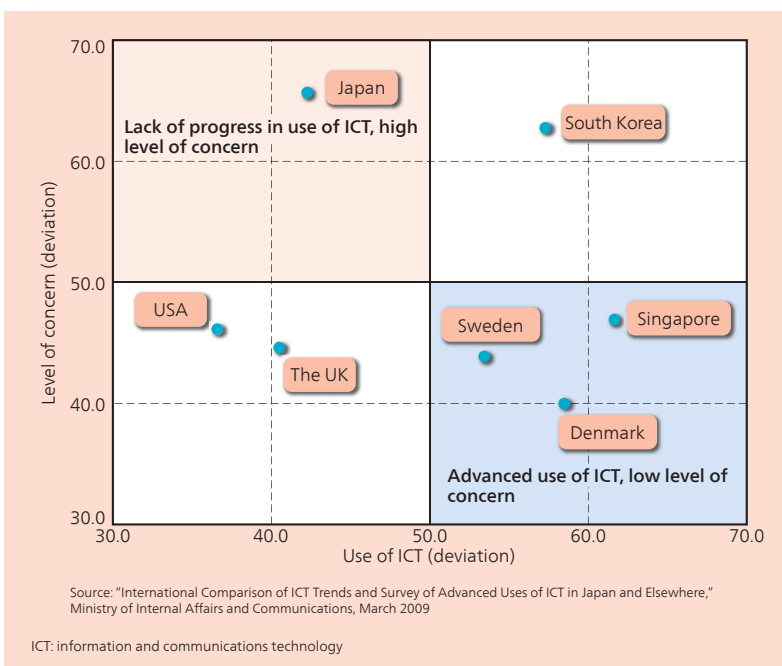
In other words, Denmark makes a good testbed for innovation.

Use of Big Data Analytics to Improve Efficiency

Denmark provides fertile soil for open innovation, and Hitachi established its Denmark Big Data Research Laboratory in Copenhagen as part of its participation in the super hospital concept. The laboratory serves as a base for working on the priorities identified by the government of Denmark, which include energy, environment, and transportation as well as healthcare, through the collaborative creation of solutions for overcoming challenges with partners such as local government and other public agencies and also local companies. Mr. Lindeman describes the role of the Denmark Big Data Research Laboratory as follows.

"We see the laboratory as a place where the business consulting unit can team up with R&D to show customers and partners the extent of our ability to contribute, and present an outline of how the Social Innovation Business will look in the future."

The initial example of collaborative creation is the joint development of healthcare solutions with Bispebjerg og Frederiksberg Hospital. Located in Copenhagen and formed from a merger of Bispeb-

Source: "International Comparison of ICT Trends and Survey of Advanced Uses of ICT in Japan and Elsewhere," Ministry of Internal Affairs and Communications, March 2009

ICT: information and communications technology

Relationship between use of and concerns about ICT in different countries. Denmark's success in assuaging concerns about ICT has led to its being well advanced in the use of ICT.

jerg Hospital and Frederiksberg University Hospital, the hospital has a staff of approximately 5,000 and provides medical services to approximately 450,000 people in the surrounding municipalities. Design and construction of a new hospital building commenced in 2014, with a major redevelopment scheduled for completion by 2025 to transform the facility into a super hospital.

While the merger on its own is expected to deliver some management and operational efficiencies, the aim is to achieve even greater management efficiencies and service quality improvements by augmenting these with Hitachi's capabilities that include big data analytics, service design, and business consulting methodologies.

Big data analytics will build on business improvement initiatives already undertaken by Bispebjerg og Frederiksberg Hospital. The hospital has installed monitoring sensors in temperature-controlled facilities at roughly 800 locations, including freezers and medical cabinets. When Hitachi conducted an analysis of roughly one year of this temperature data, it succeeded in identifying a number of trends and features. Mr. Tani commented on the work as follows.

"By identifying overall trends as well as determining the situation at the approximately 800 locations, we estimated that the potential savings from performing optimal control were more than 5% of the hospital's total cooling bill. Based on this result, we are now working with the hospital on ways of performing dynamic optimal control of numerous temperature-controlled facilities."

Another initiative involves measuring and analyzing data on the movement of people and goods at the hospital so that it can be used for purposes such as boosting operational efficiency or optimizing layouts. Mr. Tani explained that, "Along with this use of sensors to record people's movements and its combination with other data such as information on the work performed by each employee to analyze the causes of waste, the movement characteristics obtained through this work can be used not only to make improvements to existing processes but also to design efficient layouts such as for the wards at the new hospital building currently under construction." The aim for the future is to optimize the movements of patients as well as staff.

Eliminating unnecessary movement by people is an important consideration for management efficiency. By also attaching sensors to beds, lifts, and other medical equipment to provide information

Layout of Bispebjerg og Frederiksberg Hospital, one of Denmark's super hospitals, after the completion of its major redevelopment, which is scheduled to be finished by 2025.

Temperature-controlled cabinet (refrigerator) at Bispebjerg og Frederiksberg Hospital. An analysis of temperature data from approximately 800 sensors identified potential savings of more than 5% of the hospital's total cooling bill.

about their movements, it is possible to eliminate waste in the use of equipment and to implement systems that dynamically indicate the best location for bringing together staff, equipment, and other medical supplies. Through the use of big data analytics that combines sensor data with the various

data generated in the operation of the hospital, Hitachi aims to support the efficient movement of people and goods at the integrated and enlarged super hospitals.

Designing Ideal Healthcare

The joint development of healthcare solutions is taking account of service design considerations and making use of ethnographic analysis. This is a methodology that can uncover latent issues by having researchers visit the work or living place being studied to make detailed observations of people's activities. Hitachi is conducting an ethnographic analysis of doctors, nurses, pharmacists, and other hospital staff in collaboration with Bispebjerg og Frederiksberg Hospital.

With an ability to identify underlying issues that are difficult to uncover through the quantitative study of measurements or other data, ethnographic analysis draws on social science to augment data-oriented efficiency improvement.

Mr. Maruyama emphasized the significance of incorporating service design methods by saying, "The tendency when designing a new hospital building, for example, is to focus exclusively on things like work efficiency and optimization. In this project, however, we were engaged in the development of a major social model, namely the super hospital concept, and the way in which Bispebjerg og Frederiksberg Hospital expressed what sort of hospital they wanted to create in the form of their initial model cases can be seen as an im-

portant determining factor in the overall success of the concept. Accordingly, we sought to develop a solution that indicated the direction that healthcare would take in the future by adopting an approach that involved a "vision design" describing what they wanted to achieve with reference to the underlying issues uncovered by ethnographic analysis as well as the trends and other issues going on in society as a whole."

Improving management efficiency is not the only objective of collaborative creation with Bispebjerg og Frederiksberg Hospital. Rather, it is an initiative that represents one vision for healthcare in relation to global society from a broader scope and long-term perspective. To achieve this, it is important that the development of new healthcare solutions continues as a business rather than ending once the demonstration project finishes.

Mr. Lindeman said, "Consequently, we embarked on measures for highlighting the factors that have an impact on hospital management, where the Social Innovation Business Platform and Hitachi Consulting Co., Ltd. are taking central roles. In addition to proposing management improvements based on this analysis, we also plan to establish a model for how Hitachi can earn revenue from the management improvement solution. I believe that moving from proof of concept to proof of value is essential if we are to make ongoing improvements and achieve social innovation."

## System-wide Optimization of Healthcare Using Symbiotic Autonomous Decentralized Systems

As noted above, the super hospital concept involves consolidating the regional base hospitals into 16 sites. To achieve this, it is necessary to build systems that allow not only for coordination and other information sharing among regional base hospitals and general practitioners (GPs), but also the future use of telemedicine.

As Mr. Maruyama said, "We see the key to this as being Hitachi's concept of symbiotic autonomous decentralized systems. Getting to the final stage of the super hospital concept will entail the staged integration of a variety of systems along with their expansion and growth, including the merging of multiple hospitals. It is in situations like this that involve links between different functions and the sharing of information under different rules that the concept of symbiotic autonomous decentralized systems can demonstrate its value."

Symbiotic autonomous decentralized systems

Ethnographic analysis in progress. Detailed observation of doctors, nurses, pharmacists, and other hospital staff can identify underlying issues that are difficult to uncover through quantitative study.
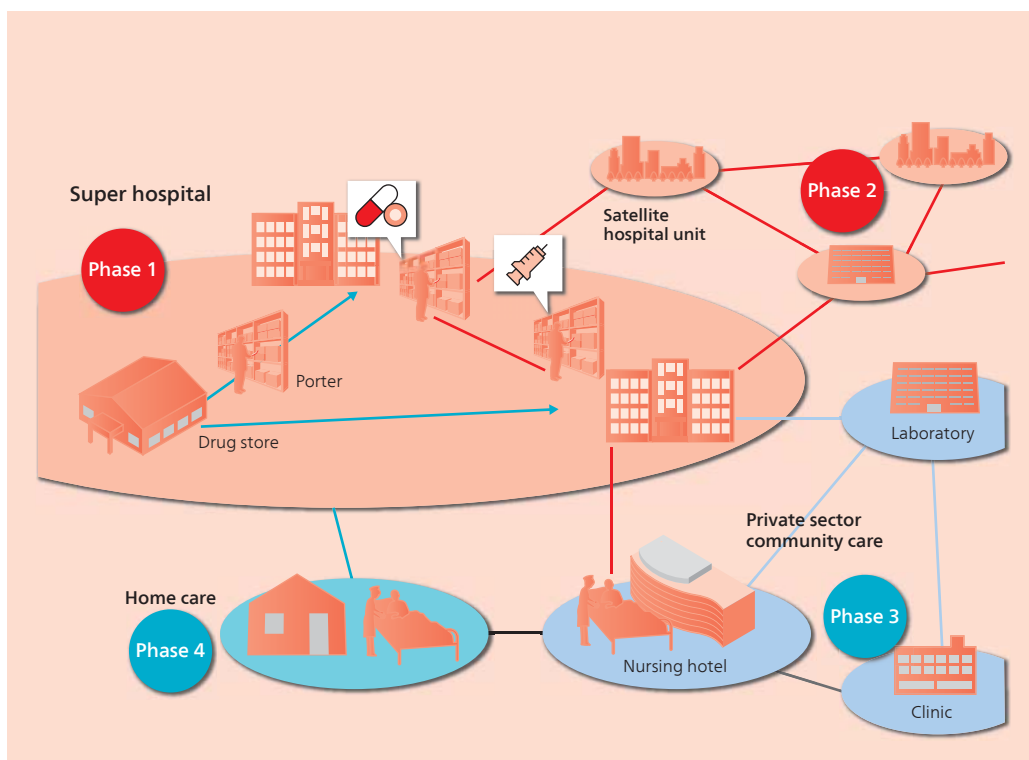
Overview of expansion and growth beyond the hospital itself under the "super hospital" concept. There is a need for integration with existing systems of different types operated by external organizations based on the symbiotic autonomous decentralized systems concept.

concept is a system concept for achieving overall optimization in a symbiotic manner by having multiple systems designed for different purposes share information while continuing to operate autonomously. I believe that this concept is always at work when achieving improvements in both the efficiency and quality of healthcare.

While the super hospital concept has only just got underway, there is much to do if its objectives are to be achieved and high expectations for Hitachi's technologies and ability to develop solutions.

Mr. Lindeman said, "There is much that Hitachi can provide, including improvements to management efficiency and the use of IT and other technologies to overcome challenges, particularly the prospect of using telemedicine in the future. I see three levels to how we can continue to build on this project we are undertaking in Denmark. The first is the successful completion of our joint development of solutions with Bispebjerg og Frederiksberg Hospital; the second is to roll out these solutions to other medical institutions in Denmark. The third level is then to take the know-how from Denmark and apply it in the global market."

Mr. Tani said, "The global deployment of solu-

tions is likely to involve places such as China and the Middle East where healthcare will develop further in the future, and mature societies such as the nations of Europe that, like Denmark, are facing the challenge of rising social security expenditure. While keeping in mind the prospect of horizontal deployment, our initial aim is to contribute to healthcare reform in Denmark through our work with Bispebjerg og Frederiksberg Hospital on the collaborative creation of new solutions that tie in with their management strategy."

As maintaining the health of the public is an issue that bears directly on the nation's finances, the reforms being undertaken by Denmark can be seen as a bold strategy for taking on challenges faced by all mature societies. There is immeasurable potential for creating value through the combination of data and knowledge acquired through the operation of hospitals with Hitachi's IT and other technologies and its proprietary service design methodologies. The concept has started to make progress toward the achievement of global healthcare innovation that arises out of collaborative creation.