

FOR IMMEDIATE RELEASE

**Hitachi High-Technologies has Developed a New Wearable Sensor that Measures
“Organization Activation Level” Correlated with Collective Happiness**

Contributing to organization productivity by increasing the happiness of a group

Tokyo, Japan, February 9, 2015 — Hitachi High-Technologies Corporation (“Hitachi High-Tech”) announced today that it has developed a new wearable sensor that gathers and analyzes data on human behavior, and uses this data to measure the “organization activation level,” which strongly correlates with work productivity. This product takes advantage of the technology developed by Hitachi, Ltd. (“Hitachi”), which quantifies the “happiness level” of a group from the distinctive patterns of physical movements.



The “new wearable sensor”

Increasing happiness is one of the most important issues for any society. Recently, the Cabinet Office has been studying “Well-being Indicators” for Japan, with a focus on subjective well-being⁽¹⁾, and the Ministry of Education, Culture, Sports, Science and Technology is promoting a research program aimed at achieving a “Happiness Society”⁽²⁾. Furthermore, in recent research, human happiness is reported to have a significant effect on work productivity⁽³⁾. Up to now, however, in order to quantify happiness and vitality, it has been necessary to rely on questionnaires based on self-reporting. For this reason, it has been difficult to quantify in real time, and objectively evaluate, the effects that management policies and workplace environments have on the happiness and vitality of employees in a company organization.

The new wearable sensor developed by Hitachi High-Tech can quantify the “organization activation level” by gathering data on human behavior and calculating the activation level of each individual⁽⁴⁾. All the individuals’ data are then aggregated and averaged out to calculate the organization’s figures. The calculated “organization activation level” can support to improve business operations and increase productivity. This was possible with taking advantage of the predictive model developed by Hitachi to quantify the collective happiness of a group from distinctive patterns in physical movements.

- more -

The predictive model that quantifies the collective happiness was invented by Hitachi through analyzing huge volumes of human behavior data obtained from wearable sensors, identifying distinctive patterns in physical movements that have strong correlations with a group's happiness, and quantifying as "happiness level". Furthermore, Hitachi identified that the quantified happiness has a strong correlation with productivity of the organization.

Hitachi High-Tech used these conditions to develop a new wearable sensor which can objectively and efficiently evaluate the effectiveness of management policies and workplace environments in a company, where it had been difficult to achieve such objective evaluations in the past. Users can thus apply the service that makes use of the wearable sensor as a new management support tool.

Hitachi High-Tech will provide this service in a variety of fields as a new solution in the "Human Big Data/Cloud Services"⁽⁵⁾ that it is already offering.

Furthermore, Hitachi will use these technologies to support customers in a broad range of business fields in their efforts to improve business performance and support measures to increase happiness of regional residents.

- (1) Cabinet Office, Economic and Social Research Institute (ESRI): "Measuring National Well-Being — Proposed Well-being Indicators—"; December 2011
- (2) Ministry of Education, Culture, Sports, Science and Technology, Japan Science and Technology Agency: "Call for Proposals for Innovation Creation Program (Center of Innovation (COI) Bases)"; June 2013
- (3) Shawn Achor: "PQ: The Positive Intelligence Quotient - When you feel happy, everything goes okay"; Harvard Business Review (Japanese Edition), May 2012; pg. 58; Original (English Edition): "Positive Intelligence"; Harvard Business Review, January 2012
- (4) Human has a tendency to synchronize its physical movements strongly with the people around them. Individual activation level therefore is the measured figure of the person wearing the sensor, who is influenced by the people around him/her. It is not the measured figure of the person wearing the sensor independent from the external influences.
- (5) "Human Big Data / Cloud Services"
Services that use sensors in the form of name tags to measure the physical movements of individuals in the organization, communications with other users, current locations, and paths of movement. These huge volumes of human behavior data are subjected to integrated analysis with existing "big data" - for example, on operations and business performance - to support improvements to work operations and business performance.

■ Unique Features of the new wearable sensor

The new wearable sensor developed by Hitachi High-Tech can obtain human behavior data and calculate individual activation level. It obtains distinctive patterns of physical movement of each individual, and after calculating the activation level, "organization activation level" is calculated by aggregating and averaging the results of multiple individuals. The display of new wearable sensor indicates the duration of physical movement and trend of individual activation level, and the wearer can confirm the result in real time.

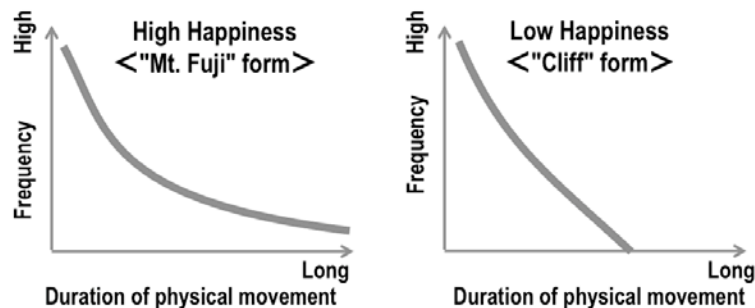
The day-to-day changes in the "organization activation level" are provided on a cloud service, and they can be viewed on the browsers. Some of the data obtained by the sensors during this period, including the users' physical movements, can be downloaded from the Internet. By reading this

data using Excel or a similar application, the users themselves can analyze behaviors with correlation to improvements in their own productivity. The analysis results can then be used in a variety of ways: for example, to improve project management, R&D management, and management in the integration of organizations; to improve productivity in service operations at call centers, logistics centers, and distribution outlets; and to increase customer satisfaction.

■ Outline of “Happiness Level” Measurement

(1) Identifying distinctive patterns in physical movements linked to the collective happiness

Hitachi has been involved in research and development targeting technologies for objectively measuring human behaviors since 2004. Recently, it developed a method for monitoring the status of organizations and finding ways of improving a company’s business performance by analyzing huge volumes of human behavior data obtained using wearable sensors (“Business Microscopes”) in the form of name tags, which are equipped with acceleration sensors and face-to-face sensors⁽⁶⁾. Recently, Hitachi used these wearable sensors to gather acceleration data that illustrates some 5 billion points of physical movement for 468 employees working in ten organizations in seven companies (a total of 5,000 man-days), and analyzed correlations with data that indicates the group’s “happiness level”. Looking at the acceleration data, it focused on duration of physical movements, and investigated correlations with the group’s “happiness level”. The group “happiness level” uses data calculated based on the Center for Epidemiologic Studies Depression Scale (CES-D)⁽⁷⁾, a self-evaluation scale for depressive tendencies that was developed by the National Institute of Mental Health, and which is used extensively throughout the world. By tabulating data for individual groups (organizations) and examining the relationships with frequency distributions for the duration of physical movements in those groups, it became clear that in groups with a high level of happiness, the frequency distribution for maintenance time was illustrated by a gentle curve with a long, extended “skirt” (much like the shape of Mt. Fuji), while in the case of groups with a low level of happiness, the line was much straighter, dropping sharply like a cliff.



Collective “happiness level,” and time during which physical movements were maintained

(2) Devising a model to predict “happiness level” based on behavior data

Hitachi devised a model for predicting the group’s “happiness level” as calculated from the CES-D based on the group’s acceleration data obtained from the wearable sensors, and using the two physical movement patterns (“Mt. Fuji” and the “Cliff”), which illustrate the level of happiness. When this approach was applied to actual data, Hitachi confirmed that it was possible to predict the collective level of happiness with a high degree of accuracy, based on the group’s behavior data as obtained from wearable sensors⁽⁸⁾.

(3) Strong correlation between happiness and work productivity

Hitachi discovered a strong correlation between the collective “happiness level”, as measured by the wearable sensor, and work productivity. A total of 215 employees working at two call centers wore wearable sensors for 29 days (total: 6,235 man-days; approximately 6 billion data points measured), and by looking at each call center and each day, it was found that when the collective “happiness level” was higher than the average, the daily order receipt rate was 34% higher than in cases where the “happiness level” was lower than the average.⁽⁹⁾ Furthermore, it was found that in the case of four R&D projects (four fields; 85 members; Total: 17,000 man-days; approximately 17 billion data points measured), the collective “happiness level” for the first two months of the projects predicted sales in business based on that research five years in the future (correlation coefficient: 0.99). This suggests that in addition to indicating the group’s productivity, the level of collective happiness can also be an effective tool in organizational operations.

An article on this technology is scheduled to be included in the March Edition of the Harvard Business Review (Japanese Edition; Diamond, Inc.), to be published on February 10, 2015.

- (6) Kazuo Yano: “Invisible Hand of Data: Wearable Sensors Uncover the Laws of Human, Organizations, and Society”; (Soshisha Publishing Co., Ltd.); July 2014
- (7) Center for Epidemiologic Studies Depression Scale (CES-D): Users answer a total of 20 questions regarding feelings and behaviors over the past week (including happiness, concentration, good condition, enjoyment, hope, restful sleep, conversation, being bothered by things, appetite, depression, fatigue, worry, loneliness, and sadness), and then evaluate themselves based on the results.
- (8) A total was obtained for response values for 20 questions. Questions were divided into two categories - those that had a positive effect on happiness, and those that had a negative effect. Totals were obtained by assigning positive and negative codes to each category. In the CES-D index, a lower figure corresponds to a higher level of happiness. In order to make this easier to understand, we reversed the codes used in the CES-D index, and added 30 to give a positive value. This was used as the “questionnaire happiness level.” The predicted value for this questionnaire happiness level, based on sensor data, was then used as the happiness level.
- (9) The correlation coefficient was extremely high, at 0.92. The probability of this result occurring by coincidence is less than one million to one.

■ Notes regarding trademarks

- The terms “Business Microscope” and “Human Big Data” are registered trademarks of Hitachi, Ltd.
- “Excel” is a trademark or registered trademark of Microsoft Corporation in the United States and other countries.