Healthcare Systems/ Biotechnology

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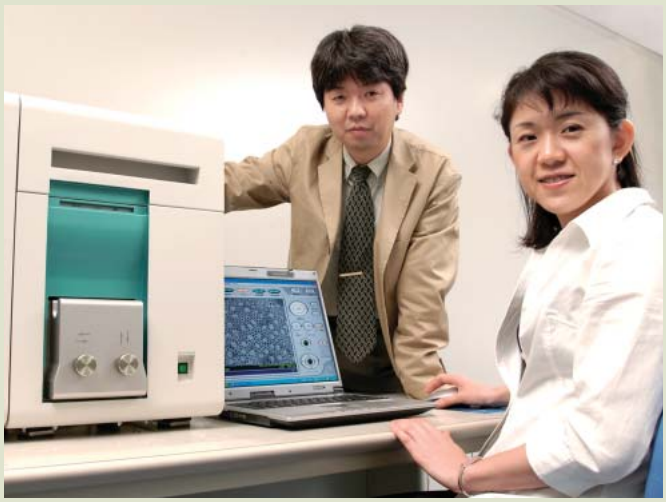
A Compact Tabletop Microscope that Anyone can Use as Easily as a Digital Camera: TM-1000

To meet public demand for "straightforward and user-friendly electron microscopes," Hitachi High-Technologies Corporation has developed tabletop electron microscope. This low-priced product is readily affordable for electronic parts manufacturers, various corporate institutes, and factories, along with colleges, high schools, and other educational establishments. This relatively small product has a 1 m × 1 m footprint and 88-kg weight. However, the product is both straightforward and enables observation with high magnification and high focal depth.



Kenichi Hirane (left), Senior Engineer, Electronic Equipment Systems Design Dept. No. 1, Hitachi High-Tech Science Systems Corporation, which has developed and manufactured the product; Sayuri Hirashima (right), Application Technology Dept., Advanced Equipment & Systems Sales Div. Headquarters, Hitachi High-Technologies Corporation, which is in charge of planning and sales

What is the Development Background?

The tabletop electron microscope TM-1000 offers much more straightforward operability than conventional electron microscopes and achieves unrivaled compact size. Hitachi has thus far provided low-priced, general-purpose types in addition to its large electron microscopes that offer the highest performance in the world*. However, there was growing user demand for more straightforward, smaller electron microscopes. This prompted the company to develop a tabletop type that is designed specifically for the most needed functions and which can be used right away by anyone, by such means as setting the magnification to 20 up to 10,000 times and limiting the specifications to observation mode for back scattered electron images in variable pressure.

Using an electron microscope typically requires adjusting the current level and acceleration voltage of the electron beam, setting various other conditions, and adjusting the optical axis each time. To obtain accurate data, most microscope operations entail handling by a skilled operator to set these conditions and make adjustments. Yet another problem was the need for readjustment and other bothersome operations when the operator changed a condition midway during operation. The TM-1000 needs no such special expertise. Anyone can easily and promptly collect the necessary data by simple button operations. The TM-1000 thus offers epoch-making straightforward operability.

What are the Features of the TM-1000?

Developed to meet the demand for simplified use by anyone and at any time in a familiar environment, the TM-1000 requires no special installation work. You can use the TM-1000 anywhere right away by simply plugging it into a 3P wall outlet of AC 100 V. Moreover, it adopts a turbo molecular pump as the vacuum pump, thus no cooling water is required. This eliminates the need for a cooling water circulator, resulting in lower running costs and higher energy-savings. The system only takes about three minutes to start up, thus providing a significant reduction from the approximately 20 minutes needed by conventional types based on an oil diffusion vacuum pump.

Moreover, conventional electron microscopes entail electron beams irradiated onto specimens. Consequently, plastics, paper, biological samples, and any others that do not conduct electricity need a metal coating. The TM-1000, on the other hand, uses a low vacuum instead of a high vacuum in which to place specimens, and converts the signals of reflected electrons into images, thus eliminating the need for metal coating pretreatment. This allows for even speedier observation.

Other features include auto-starting, which allows you to start the TM-1000 at a single click. Brightness, contrast, and focus are automatically adjusted, so that you can begin observation right away. The control window appearing on the PC display gives simple and straightforward displays, such as "start," "stop," "magnification," and "save." Thus, you can use all these functions as if operating a digital camera.

What are the Prospects?

With such a compact design, simple operability, and the capability of speedy observation without metal coating, the TM-1000 is priced at affordable range. We intend to attract a larger circle of users so that the product will be used not only by institutes and corporations that have thus far relied solely on optical microscopes, but also by schoolteachers and students. In April 2006, we will begin selling this product abroad as well. To further promote this product, our technical theme will be, in addition to cost reduction, making technical enhancements. For example, we should develop a next generation of products intended not only for observation but also designed specifically with specific functions such as specimen analysis, specimen measurement, and other highly specialized functions.

* Ultra-high resolution field emission electron microscope "S-5500" with a secondary electron resolution of 0.4 nm at an acceleration voltage of 30 kV

The University of Texas M. D. Anderson Proton Therapy Center has Started Patient Treatment

The University of Texas M. D. Anderson Cancer Center, widely known as one of the best cancer hospitals in the world, has a new tool to fight cancer: the Proton Therapy Center, which has been established as a joint effort with the private sector. Hitachi has designed, manufactured, and installed the entire proton therapy system for the Proton Therapy Center.

Proton beam therapy is a new type of the radiation oncology that takes advantage of the unique characteristics of protons. Conventional radiation oncology generally uses photons (X-rays), which release their maximum energy at the human body surface and gradually decrease in energy as they move toward the tumor with additional energy released behind the tumor. However, protons deposit little energy when entering the body and release most of their energy at a prescribed depth in the body, called a Bragg peak, with almost no energy delivered after the tumor. This unique characteristic enables proton beam therapy to precisely target the tumor while minimizing side effects on healthy tissues. Proton beam therapy is expected to become the new standard of care for many disease sites in radiation oncology.

The Hitachi proton beam therapy system "PROBEAT" uses many cutting-edge technologies. A proton beam is extended three-dimensionally by a scattering device in the irradiation nozzle and then formed using a patient-specific collimator and compensator in accordance with the shape of the patient's tumor as determined by treatment-planning software. Patients are positioned in the prescribed position using a couch with six degrees of freedom and a gantry system that rotates the nozzle 360 degrees around the patient with sub-millimeter accuracy. Hitachi's synchrotron has the capability to accelerate the proton beam to any energy between 70 and 250 MeV, and Hitachi's patented beam extraction system enables complex beam extraction including respiratory gating. Beam monitoring and safety systems are built into the controls to ensure the safety of patients and operators.

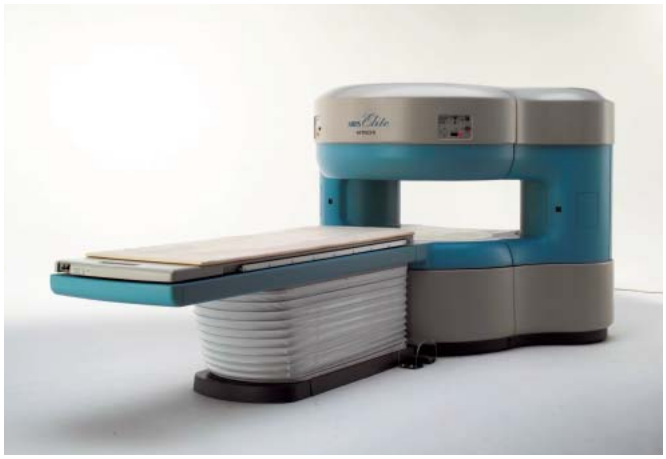
The Proton Therapy Center-Houston has three treatment rooms equipped with rotating gantries. Another treatment room has two sets of treatment options: a fixed large field nozzle with a patient couch and a small field nozzle specialized for eye treatment using a patient-positioning chair.

"PROBEAT" is U.S. FDA cleared and may be used for medical treatment. Hitachi strongly desires to contribute to society by installing proton therapy facilities throughout the world for the benefit of cancer patients.

M. D. Anderson Proton Therapy Center treatment room

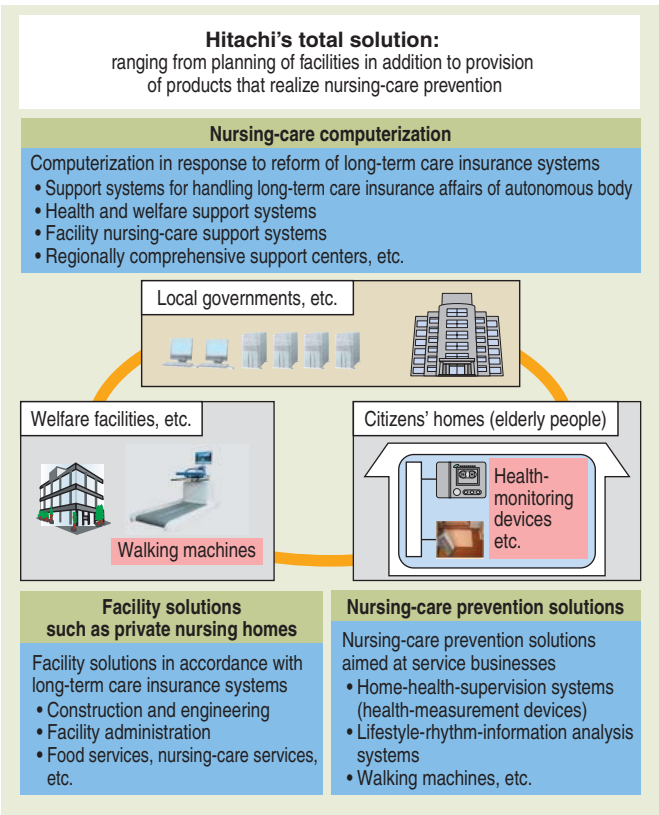
New Standard of Open MRI Systems

A new open MRI (magnetic resonance imaging) aimed at overall improvement such as in function, operability, and image quality, uses a design combining curves emphasizing "friendliness" while keeping the "openness" that is a feature of open MRIs. The new open MRI uses a power system that is best suited to an open-MRI. It enables high-definition and high-speed imaging. In addition, the new open MRI uses new systems to improve magnetic field precision, which enables using a fat suppression technique that had been difficult to use with conventional systems. Also, adopting the latest computer system helps drastically decrease the image processing time and improve the workflow.
The open MRI has a wide and light imaging space that not only mitigates the uneasiness of patients who have difficulty with ordinary MRI examinations, but also reduces the imaging noise, which is peculiar to MRI. Furthermore, the system's simple configuration makes it possible to run at a minimized cost.



Open MRI system

Business-aimed Solutions in Line with Reform of Long-term Care Insurance Systems

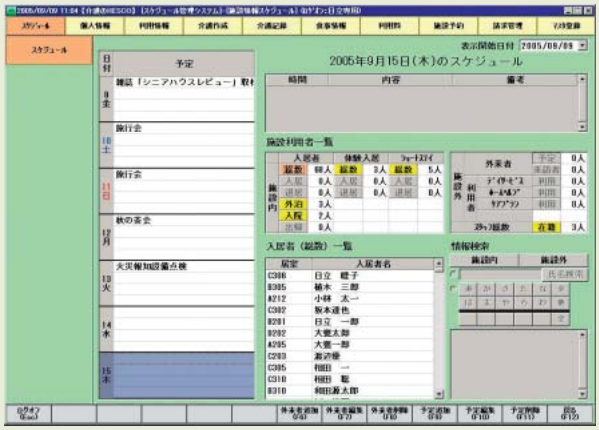


Welfare-integration solutions aimed at reform of nursing-care insurance systems

Reform of the national long-term care insurance systems has been ongoing since 2004. As an example, in all regions, making a comprehensive scheme for so-called "care preservation"—that is, supporting all elderly people requiring nursing care and controlling the degree of care—is progressing.
At Hitachi Group, utilizing the consistent accomplishments—ranging from planning welfare facilities up to construction and administration of the group—in line with systemic revisions, it is aiming at improving operational efficiency from the viewpoint of nursing-care staff at the welfare site as well as maintaining and improving quality of a comfortable life from the viewpoint of the receivers of care—while developing solutions in the fields of healthcare, welfare, and medicine.
[Main features]
(1) Handling of smooth reform of long-term care insurance systems—such as provision of systems aimed at regionally comprehensive support centers and long-term care insurance systems for local governments and service businesses.
(2) Preservation and improvement of care receivers quality of life by providing a wide range of products such as walking machines developed in advance of welfare precautions, home elevators, and nursing-care beds.
(3) Possessing private hospitals, elderly-health-care facilities run by health-insurance associations, and private nursing homes, Hitachi Group is utilizing these accomplishments in offering solutions ranging from planning, design, and construction up to operation and administration of nursing homes.

Development of Support Systems for Private Nursing Homes

A main-item menu is displayed in the upper part of the screen, and a sub-item menu is displayed on the left; as sub items, treated information is concentrated on one screen.

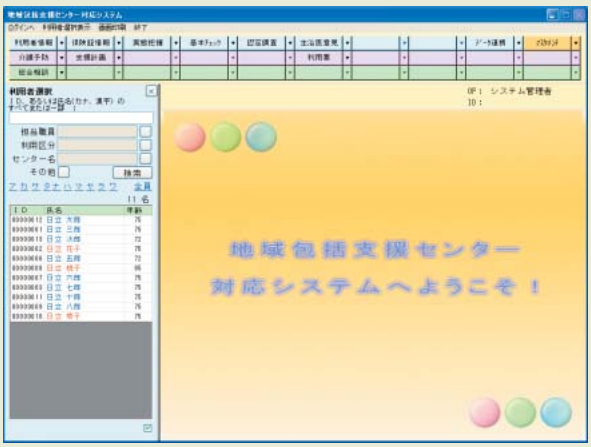


Example screen shot of private nursing home support system

Since the release of Hitachi's "Facility nursing-care support system—private nursing home version" in 2001, having been further developed and improved in order to attain high quality and diversification of services provided by operators of private nursing home, it has received favorable reviews.
As for the new version, on top of the "width of coverage range of administrative affairs of private nursing homes," the follows improvements to its operability and functionality have been added.
[Main features]
(1) Number of displayed terms on each screen have been increased and changeover rate of screens decreased.
(2) Tenant status and schedules are listed for assisting front-desk affairs so that operators can easily understand current situations of tenants and visitors.
(3) Claims and monthly earnings for accounting duties are tabulated, and financial-management support functions are improved.
From now onwards, Hitachi expects to scale-up the introduction of this improved system in private nursing homes.
(Hitachi Engineering & Services Co., Ltd.)

Support System for Regionally Comprehensive Support Centers

In line with reform of Japan's long-term care insurance systems, aimed at comprehensively supporting enhancement of welfare and improvement of health care of local residents, new regionally comprehensive support centers—as a core foundation for taking on the role of integrally enforcing comprehensive support tasks within local support businesses—started to be constructed in April 2006. Systems for improving efficiency of operations involved in the broad array of services taken on by these support centers have been developed.
[Main features]
(1) Compatibility with new prevention benefit packages
(2) Compatibility with assessment and care-plan patterns based on guidelines (assessment contents can be set optionally)
(3) Issuing consent forms for users and administration of individuals' information with or without permission is possible.
(Hitachi Plant System Engineering Co., Ltd.)



Example screen of support system for regionally comprehensive support centers

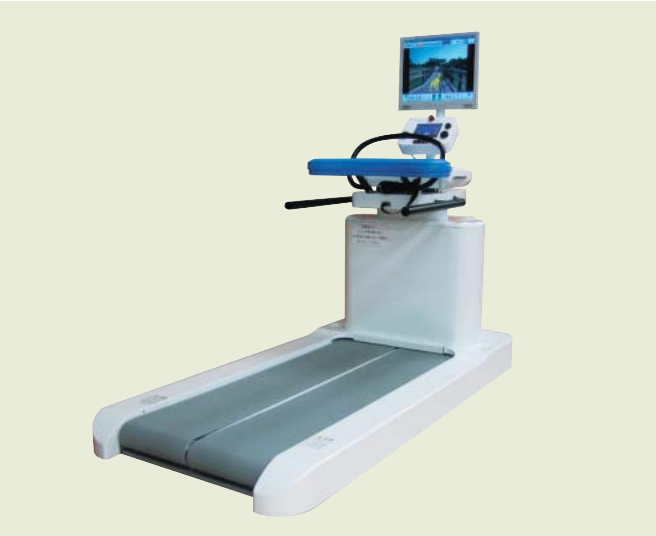
Hitachi's New Kind of Walking Machine

Since April 2006, large-scale reform of long-term care insurance has been undertaken in Japan. It can be said that this is a systemic overhaul—where the keyword is systems emphasizing prevention—and targeting the establishment of comprehensive nursing prevention systems. Under these circumstances, a walking machine with added on functions, such as evidence supervision for handling compensation by long-term care insurance, that enables training for muscle strengthening and trip prevention with one machine has been developed. Adhering to the basic functions of conventional walking machines, the new machine is a product that offers improved performance.

[Main features]

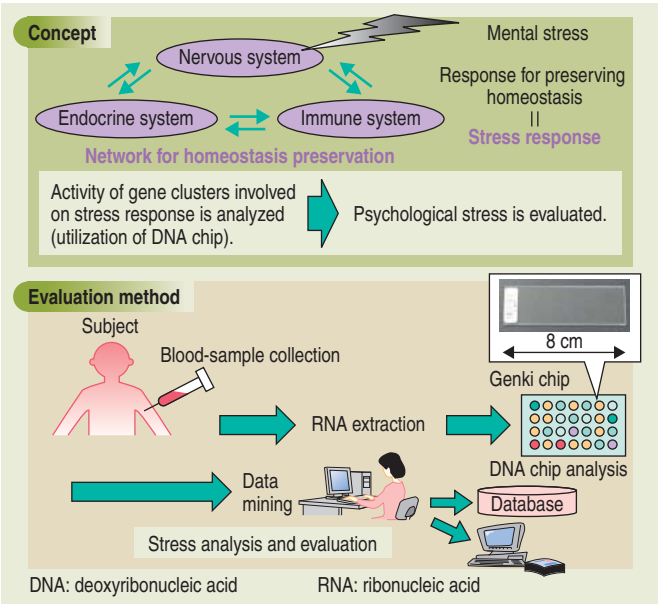
(1) A two-belt walking surface allows speed-difference training in response to the status of the left and right legs.
(2) Muscle-power training for walking that puts load onto the walking belt is possible.
(3) Generating falling stimulus enables training of sense of balance.
(4) Improvement of stamina by interval-training function is possible.
(5) Individual-authentication function by means of IC card
(6) Evidence-management function by automatic accumulation of training data
(7) Fitted with video-image system for firmly fixing the training improvements
(8) Communication capability with external devices (heart monitors, etc.)

(Hitachi Hybrid Network Co., Ltd.)



Hitachi's new kind of walking machine

Development of a Genki Chip for Checking Heart Condition



Concept and evaluation method of Genki chip

As regards the inside of the human body, the control systems for running immunization, nerves, and endocrine secretion are mutually coordinated so that the body's homeostasis and health are maintained. When a person is under psychological stress, the endocrine system and immune system are influenced from the nervous system via the homeostasis network, and distortion of the whole network is thus generated. There is a response to try to reverse this distortion, that is, a "stress response." By treating activities of the endocrine system and immune system accompanying this stress response as activity of genes in leukocyte, it is possible to examine the influence of the mental stress.

Based on this concept, a Genki (literally, "vitality") chip—which evaluates mental stress by checking genetic expression in peripheral blood—has been developed in collaboration with the University of Tokushima. At present, gaining attention as an objective method for evaluating functional foods, and so on, this chip is being utilized by food manufacturers.

Liquid Chromatograph/Mass Spectrometer Offers New Solutions for Qualitative & Quantitative Analysis of Protein Biomarkers

A new LC (liquid chromatograph)/LIT-TOF MS (linear-ion-trap time-of-flight mass spectrometer)—which is a successor of "NanoFrontier L"—has been developed by Hitachi High-Technologies Corporation.

Searching for biomarker proteins in serum, urine, and cells to elucidate disease mechanisms is important in regards to drug discovery and in vitro diagnostics. A mass spectrometer is one of the most efficient tools for identifying biomarker proteins. Recently, it has become more important to analyze biomarker proteins not only qualitatively but also quantitatively, because change of their representation is attracting more attention. Accordingly, Hitachi's new LC/LIT-TOF MS offers both quantitative and qualitative analyses; it is thus anticipated to greatly contribute to the discovery of new biomarker proteins.

The most remarkable feature of this new LC/LIT-TOF MS is its high-speed ADC (analog-to-digital converter). The ADC is controlled by Hitachi's unique method. With this LC/LIT-TOF MS, it is possible to detect quantitative alteration of sample ions. This feature accomplishes wide dynamic range of the MS (>5,000) and offers precise quantitative analysis.

As compared to "NanoFrontier L", there are three main modifications in the new LC/LIT-TOF MS. First, a new ion-thermalizer increases productivity of fragment ions with low mass number, which are hardly generated in MS/MS with ion-trap mass spectrometry. Second, a modification of TOF increases mass resolution. Third, the sample-trapping column of the NanoLC (nano-flow-rate LC) is upgraded to a new monolithic capillary column, which remarkably improves performance of separation of sample constituents. As a result of these upgrades, the new LC/LIT-TOF MS offers more precise qualitative analysis than its predecessor.

Other than the improvements described above, it goes without saying that the new LC/LIT-TOF MS inherits characteristics of "NanoFrontier L." One of them is the excellent repeatability of gradient elution with a flow rate of 50 nL/min by direct-flow NanoLC, which generates gradient elution by Hitachi's original "DEGS (dual-exchange gradient system)." MS that connects LIT and TOF is also a distinction and realizes detailed analysis of amino-acid sequence by multiple MS/MS by LIT and high mass-accuracy TOF.

(Hitachi High-Technologies Corporation)

New LC/LIT-TOF MS

Model SU-70 Ultra-high Resolution Field-emission Scanning Electron Microscope

Electron microscopes to be used in the leading-edge fields of nano-technologies must not only produce high-resolution images but must also support the incorporation of various types of analytical equipment. Model SU-70 offers high-resolution SEM (scanning electron microscope) images with minimized charge-up effects and edge effects thanks to Super E × B and a large current mode most suitable to analytical equipment using a Schottky effect emission gun as an electron source. Also, a new field-free mode enables an electron lens system to generate a leakage-free magnetic field, which allows distortion-free electron back-scattering pattern analysis and image observation of magnetic samples.
Resolution: 1.0 nm/15 kV, 1.6 nm/1 kV (deceleration mode: optional)
Stage: 110 × 110 mm (5-axis motor drive, standard)
[Major column-mountable analytical equipment]
• Energy dispersive X-ray analysis
• Wavelength dispersive X-ray analysis
• Electron back-scattering pattern
• Cathodoluminescence
(Hitachi High-Technologies Corporation)

Model SU-70 ultra-high resolution field-emission scanning electron microscope

Model TM-1000 Tabletop Microscope

Magnification	20–10,000 × (digital zoom: 2 and 4 ×)
Accelerating voltage	15 kV
Specimen traverse	X: 15 mm, Y: 18 mm
Maximum sample thickness	20 mm
Detection system	High-sensitivity semiconductor BSE (back-scattered electron) detector
Auto image adjustment functions	Auto start, auto focus, auto brightness
Power source	Single-phase AC 100, 110, 115, 200, or 240 V (±10%), 500 VA

Model TM-1000 tabletop microscope

A compact tabletop electron microscope has been developed to meet demands for the electron microscope that can be kept at hand and is readily usable.
[Main features]
(1) Tabletop size and energy-saving design. No circulatory cooling water is necessary.
(2) Simple and easy operation: Ready to use in only three minutes start-up time. Fully automated operation allows just one press the start button to obtain image after specimen exchange.
(3) No coatings required for specimen accommodation and observation: Quick observation without any sample preparation such as metal coating. “Charge-up reduction mode” enables to reduce interference.
(4) 3-dimensional morphological survey possible with greater depth of focus: Higher resolution and greater depth of focus are not available on optical microscope.
(Hitachi High-Technologies Corporation)