September 6, 2005

List of Speakers

Greetings (Evening) (6) (2 Japanese and 4 Germans)

	Name, Affiliation		
1	Prof. Shinichi Hirano President, Nagoya University	Host Greetings	
2	Prof. Nobuo Sawaki Dean, Graduate School of Engineering	Greetings	
3	Mr. Michael Welker Hessian Ministry of Science and Art, Wiesbaden	Guest Greetings	
4	Mr. Karl Wollin Federal Ministry of Education and Research	Greetings	
5	Dr. Torsten Rossmann, Biotechnik-Zentrum, Technische Universität Darmstadt	Greetings	
6	Mr. Uwe Schröder German Embassy, Tokyo	Greetings	

Keynotes (5) (4 Japanese and 1 German)

	Name, Affiliation	**Title**	**Abstract**
Sat-Morning_1	Prof. Yuji Matsuzaki Nagoya University	Bionics and biomechanics in Japan	At the beginning of the Workshop, general aspects of the past and present status of biomechanics and bionics in Japan will be given as a brief introduction. Biomechanics research started early in 1970's in Japan while bionics has newly emerged in these years. Necessity of strong collaboration among researchers engaged in bionics and biomechanics will be stressed as a concluding remark.

Sat-Morning_2	Dr. Rudolf Bannasch, Evologics, Coordinator BIOKON – Bionics-Network of Excellence	Bionic techniques for underwater applications	
Sat-Afternoon_3	Prof. Toshio Fukuda Nagoya University	Robotics, human beings and future	
Sun-Afternoon_1	Prof. Hidenori Kimura Bio-Mimetic Control Research Center RIKEN	Effects of intrinsic noise in gene regulatory network	Dynamics of gene network can be described either in deterministic or stochastic frameworks. The relationship between the two frameworks is yet to be exploited. Sometimes, direct connections between the two descriptions are lost, or even they lead to contradictory conclusions. The most salient discrepancy between the two descriptions is that the stochastic dynamics is always “mono-stable” while the deterministic one can be multi-stable, and it manifest itself in long-term behaviors of the network. This paper aims to demonstrate this gap taking the Collins’ genetic toggle switch (28) as a platform. The convergence of time evolution of state probability to a unique stationary distribution from any initial state has been shown both theoretically and numerically. This contradicts the bistable nature of the toggle switch. The *deterministic toggle switch* can memorize the initial state persistently, while the *stochastic toggle switch* eventually cannot. We have validated this gap experimentally. Biological implication of this deterministic/stochastic gap has been discussed.
Sun-Afternoon_2	Prof. Osamu Takai EcoTopia Science Institute Nagoya University	Biomimetic nanotechnology	Living organisms produce a wide variety of materials at room temperature and atmospheric pressure. Moreover, each produced material plays a key role in each function in biological systems. "Bionimetic materials processing (BMMP)" is defined as the design and synthesis of new functional materials by refining knowledge and understanding of related biological products, structures, functions and processes. Hence the BMMP is not a simple imitation of biological materials processes, but is advanced materials processing for bionics, electronics, photonics,

			mechatronics and so on. By means of this BMMP we can prepare “biomimetic materials” or more widely “bioinspired materials”. We can also prepare “biomimetic surfaces” or “bioinspired surfaces” by using the BMMP concept. Leaves of lotus show ultra water-repellency because of the precisely controlled roughness of their surfaces. Similarly, ultra water-repellent silicon oxide films have been synthesized by microwave plasma-enhanced chemical vapor deposition (CVD) using organosilicon compounds as row materials. Furthermore, we can prepare transparent ultra water-repellent films by controlling the surface roughness precisely. This transparency is an additional significant function, which the leaves of lotus do not have, in their industrial applications. These transparent ultra water-repellent films show the typical example of biomimetic surfaces. For the preparation of the transparent ultra water-repellent films the key technology is the control of surface nanotextures. Hence the BMMP closely relates to nanoscience and nanotechnology. We can also use organosilane self-assembled monolayers (SAMs) and multilayers for the preparation of surfaces with controlled chemical and electronic properties including reactivity, hydrophobicity and isoelectric point, and with controlled nanostructures. The SAMs act as good resists for nano/micro-pattering by using vacuum ultraviolet light and nanoprobes. The BMMP is a new concept to produce new functional materials from the lessons of living organisms. Through the BMMP we can create new nanotechnology named as “biomimetic nanotechnology”. This biomimetic nanotechnology is useful for the syntheses of organic-inorganic nanomaterials, biomimetic surfaces, bioinspired materials, biotechnology, informatics and so on. It is important for us to develop the biomimetic nanotechnology based on

			BMMP for industries of the 21st century. This work is supported in part by Research Project "Biomimetic Materials Processing" (No. JSPS-RFTF 99R13101), Research for the Future (RFTF) Program, Japan Society for the Promotion of Science, and Nagoya Nano-Technology Cluster of Innovative Production System, Aichi Science & Technology Foundation sponsored by Ministry of Education, Culture, Sports, Science and Technology.

Session Sat-Morning-I (1 Japanese and 3 Germans) Hydro- and Aerodynamics

	Name, Affiliation	**Title**	**Abstract**
1	Prof. Cameron Tropea (T. Michel, H. Marschall, C. Tropea) Strömungslehre und Aerodynamik, Technische Universität Darmstadt	Hydrodynamics of ultrahydrophobic surfaces	Certain natural surfaces like duck plumage or leaves of the lotus plant are extremely hydrophobic. This ultrahydrophobic behaviour results not only from the chemical hydrophobicity of the surface but is augmented by the morphological structure of the surface, in which only the tips of the roughness structures are wetted. In the present study the hydrodynamics of sessile droplets on rough surfaces is studied analytically in terms of energy states and conditions under which ultrahydrophicity is attained and in particular about the stability of a given hydrodynamic condition of liquid on the surface are specified. This information is essential in order to tailor such surfaces for specific applications. Some remarks are made about extension of such knowledge to applications involving inertially initiated flows.
2	Dr. Fritz-Olaf Lehmann	The fluid dynamics of flapping insect wings and its significance for the construction of biomimetic MAVs	Exploring the physics of unsteady aerodynamics at intermediate Reynolds numbers has general implications on the energetics, control, and production of locomotory forces in flying animals and thus on the design of autonomously behaving biomimetic micro-air-vehicles (MAV). The recent progress in analytical and experimental approaches suggests that the elevated performance of biofoils results from the interaction of several distinct

			aerodynamic mechanisms such as leading-edge vorticity (LEV), rotational circulation, and the recycling of kinetic energy that appears in the wake (wake capture). The lecture focuses on two complex modifications of these mechanisms exhibiting experimental data on the fluid dynamics of wing-wing interaction during stroke reversals, and on the wing-wake control of LEV development in tandem wing systems. Both mechanisms represent promising tools for establishing enhanced flight stability and maneuverability in biomimetic MAVs that employ flapping wing motion for propulsion.
3	Dipl.-Biol. Tatjana Hubel (T. Hubel, C. Tropea) Strömungslehre und Aerodynamik Technische Universität Darmstadt	Wake structure of flapping wings	A flapping wing model with a Reynolds number Re = 27,000-140,000 and a reduced frequency k=£ 0.295 has been experimentally investigated in the low-speed wind tunnel of the Technical University of Darmstadt. This model corresponds to the aerodynamic characteristics of a goose. Previous observations of flying birds have postulated three possible gaits: a ladder structure of vortices in the wake, a continuous vortex gait in cruising flight and a vortex-ring gait in slow flight. The former two differ only in that the overall circulation (lift) varies throughout one wing beat cycle, leaving a start and stop transverse vortex in the wake. The purpose of the present study is to experimentally investigate which flight parameters influence the change of circulation.
4	Dr. Naomi Kato Dept. of Naval Architecture and Ocean Engineering, Graduate School of Engineering Osaka University	Study of aqua bio-mechanisms and those applications to ocean engineering	This presentation discusses the scientific studies on aqua bio-mechanisms and those application to ocean engineering from the viewpoints of drag reduction and propulsion mechanisms of surface and underwater vehicles and sensor technology. The study of aqua bio-mechanisms, aims not only to unveil the locomotion mechanisms of the aquatic animals analyzing the external flows and the autonomous systems having various behavior forms, but also to develop machines that are tender towards their environments with locomotion

			function and autonomous control system making reference to the aqua bio-mechanisms. The first part deals with the biomechanics on aquatic animals, especially on pectoral fin motion, and the behavior analysis such as neuronal network and sensory biology. The second part deals with drag reduction of vehicle with an undulating body, propulsion mechanisms of vehicles and biology-inspired sensors.

Session Sat-Afternoon-II (1 Japanese, 4 Germans and 1 Brazilian) Plants and Insects

	Name, Affiliation	**Title**	**Abstract**
1	Dr. Deane Harder, Director Botanical Garden, Universität Freiburg	Plant biomechanics for technical applications	
2	Dr. Stanislav Gorb, Evolutionary Biomaterials Group, Max-Planck-Institut für Metallforschung, Stuttgart, Germany	Biological attachment systems as a possible source for biomimetics: What can we learn from evolution?	In their evolution, animals have convergently developed hairy attachment pads to attach themselves to a variety of substrates during locomotion. Using various microscopical techniques (Cryo-SEM, TEM, X-Ray microscopy) and force measurements on biological systems, we analysed, which structural and mechanical features of convergently-developed adhesive structures might be important for biomimetics of artificial adhesive systems. Most recent data on biological systems have demonstrated their excellent adhesion and high reliability of contact. Contacting surfaces in such devices are subdivided into patterns of micro- or nanostructures with a high aspect ratio. The size of single points gets smaller and their density higher as the body mass increases. Fundamental importance of contact splitting for adhesion on smooth and rough substrata has been previously explained by a very small effective elastic modulus of the fibre array. We provide an experimental evidence of adhesion enhancement by division of contact area. A patterned surface, made out of polyvinylsiloxane, has significantly higher adhesion on a glass surface than a smooth sample

			made out of the same material. This effect is even more pronounced on curved substrata. An additional advantage of patterned surfaces is the reliability of contact on various surface profiles and the increased tolerance to defects of individual contacts.
3	Prof. Hidetoshi Kobayashi Department of Mechanical Science and Bioengineering, Graduate School of Engineering Science Osaka University	Deployable structure observed in leaves and flowers of plants	Most leaves and flowers grow and unfold from their small buds. In the buds of leaves or flowers, various ideas to stow their bodies into narrow space are hidden. Actually, a typical corrugated folding pattern is observed in the leaves of hornbeam or common beech and five petals of a morning glory flower are rolled together in a bud. To investigate the folding/unfolding manner in plants, therefore, may be useful in designing some artificial deployable structures, such as solar panels, antenna of satellites, or deployable roofs. In this study, leaves with straight parallel folds, like hornbeam (Carpinus betulus) or common beech (Fagus sylvaticus) leaves, were modelled by using numerical methods. When the leaves are outstretched, the lateral veins are angled at 30˚ to 50˚ from the centre vein. A higher angle allows the leaf to be folded more compactly within the bud but it takes longer to deploy. This may allow the plant to optimise the timing of leaf deployment with ecological and physiological conditions. The unfolding manner of morning glory flowers was also examined. Morning glory flowers deploy in accordance with a logistic curve and the number of petals adopted in a flower may result from the compromise between geometrical and mechanical factors.
4	Dr. Per Loethman (Neinhuis, Cerman, Barthlott), Institute of Botany, Technische Universität Dresden	Structured plant surfaces: patterns, functions and biomimetic applications	Our discovery of self-cleaning properties of many plant surfaces in 1975 and their transfer into biomimetic technical surfaces since 1992 resulted in a paradigm shift in surface technologies. A short survey of the state of the art is presented. The remarkable physical effect is based on at least a hydrophobic surface layer and a complex geometry

			of combined micro- and nanostructures on different length scales. Such kind of roughness minimizes the contact area between water and surface. Water forms droplets that virtually show no adhesion and roll off at lowest inclinations. In addition droplets pick up particulate contaminations and consequently clean the surface. Super-hydrophobic and self-cleaning surfaces are of great interest for many applications. First products (facade paints) are available on the market under the trade mark Lotus-Effect® since 1999, further products are following
5	Ms. Dipl.-Ing. Dagmar Voigt (Voigt, D.; Gorb, E.; Gorb, S.) Evolutionary Biomaterials Group, Max-Planck-Institut für Metallforschung, Stuttgart, Germany	Plant surfaces as a terrain for the insect locomotion	The specific attachment devices which evolved in insects, allow these animals to inhabit virtually every ecosystem, and of course over various plant surfaces. The plant-insect relationships are very complex and show among other features, close structural and biophysical interactions. They provide a wide range of impulses for basic research as a endless source for innovative biomimetical approaches. Using a comprehensive insect species screening, several microscopic techniques (LM, SEM, Cryo-SEM, AFM, TEM), video recordings (including high speed) and biomechanical experimental testing (centrifugal and traction force measurements) we expose the insect attachment systems to the plant-surface diversity, in order to understand interrelationships and functions of the biological attachment systems. Plant-insect interactions give an example of the research methods and the adaptation of artificial attachment devices to the uneven and changing terrain.
6	Dr. Pablo Perez-Goodwyn Laboratory of Insect Ecology, Graduate School of Agriculture Kyoto University	Friction- and wear-reducing micromechanical devices in criket's stridulation mechanism.	Our study object was the stridulation mechanism of the crickets. They can produce sound by rubbing their fore wings together at high speed. One toothed file (strigil) scratches against the specialized edge of the other wing (plectrum). Both parts are present in both wings. The ultrastructure of the system reveals unique a parallel-to-the surface organization of the chitin fibril layers in the exocuticle, as well

			as an evident thick epicuticle (900-1200 nm), which seems very resistant to chemical treatment (NaOH). The presence of crystals in the epicuticle is remarkable. Preliminary results show a friction coefficient (μ) ranging from 0.3 to 0.4 for fresh samples, and up to 0.7 - 0.8 for dry and chloroform washed samples. When one counterpart (strigil) was replaced with a polymer-cast replica, the values of μ reached 0.7. These differences suggest the active role of lubricant substances in living condition. However, observing senile crickets, which presumably sang their whole life, no evident signs of wear out could be found. Indentation tests with a Nanoindenter (MTS SA2), suggests different hardness and E modulus for both counterparts. The plectrum (scrapper) had higher hardness than the strigil, however the strigil (file) had higher Young modulus.The outcome of this study will be examples of certain material combinations which render friction and wear reducing properties, like relative hardness of counterparts, surface energy; structural design regarding fiber's orientation; lubrication mode, and surface texturing, among others.

Session Sat-Afternoon-III (6 Germans) Structures and Functions

	Name, Affiliation	**Title**	**Abstract**
1	Prof. Manfred Hegger, Department of Architecture, Technische Universität Darmstadt	Bionic principles in architecture	
2	Dr.-Ing Lothar Harzheim, ITDC, Adam Opel AG, S1-01 Optimization and Robust Engineering, 65423 Rüsselsheim	Optimization of engineering components using the growth rule of trees and bones	The idea of the optimization algorithm had its origin in studying the properties of biological load carriers such as tress and bones. It was found that they are optimized with respect to strength and weight. The driving force is the growth rule, which leads to designs with uniform stress distribution on the surface. The engineer in his daily work often pursues the same aims as the biological load carriers i.e. to design a reliable part with a minimum of material. Consequently, it appears to be a good idea to copy the successful biological growth rule and apply it to engineering components. The shape optimization method CAO is obtained if the growth rule is simulated on the surface of a component whereas the topology optimization code SKO is obtained if the growth rule is applied to the whole component. The latter method has been applied successfully to the optimization of cast parts and has been extended to the code TopShape by adding manufacturing constraints
3	Dipl-Ing. Alexander Sauer (C. Mattheck, A. Sauer, R. Kappel), Forschungszentrum Karlsruhe	Shear killers in Nature	Natural constructions are frequently exposed to shear loading. Examples are leaves in the wind or to bird feathers during a flight. When looking at the supporting skeletons, those elements that remove the tensile fraction of shear appear to be more developed. To verify this statement, the vein pattern of a leaf is studied for mechanical suitability using the Soft Kill Option (SKO) structure optimization program. It is found that the leaf is formed in a mechanically optimum manner. The structure is stiffened by tension ropes acting as shear killers. Subsequently, an SKO parameter study is performed to investigate and determine

			influencing parameters and their relevance to the formation of shear killers.
4	Dr.-Ing. Iwiza Tesari (C. Mattheck, I. Tesari, K. Bethge), Forschungszentrum Karlsruhe	Notch shape optimisation with pocket calculator	Notch stresses can be interpreted as bending stresses due to the deformation of the notch contour line which are superimposed to the nominal stresses. This dual nature of the overall stresses allows to generate an uniform stress state along the notch contour by increasing the superimposed bending stress in the same way as the nominal stress decreases. This was possible till now by CAO (Computer Aided Optimization) which simulates tree growth. However a Finite-Element-program and CAO-software were necessary. By this deeper understanding of the nature of notch stresses a simple pocket calculator can do the job and still follow the design rules of nature. Fatigue tests on shafts by swelling bending proof the success by drastic increase of the number of load cycles until failure.
5	Dipl.-Ing. Roland Kappel (C. Mattheck, R. Kappel, A. Sauer, I. Tesari), Forschungszentrum Karlsruhe	Rope controlled lightweight design	Biological structures consist of mechanical load carriers, which are highly optimized in terms of mechanical strength and minimum weight. A lot of parts of these structures act as tension ropes, even if this cannot always be identified immediately. The advantage of tension-loaded components is that they cannot fail by kinking or buckling like pressure-loaded ones, if their aspect ratio is too high. The non-woody banana leaf consists of non-stiff materials. However, by tricky arrangements of ropes and shell elements, structural stiffness of the stalk of the banana leaf results. Mechanical applications of the banana trick reveal a rope-dominated ultra-lightweight design, which is different from normal steel structures, because their unstable failure modes are avoided. Mechanical designs according to the banana leaf do not exhibit any instabilities and failures by predictable bending modes under overload. Although an absolute minimum of material is used, the structures were found to have an extreme high stiffness in

			prototypes
6	Dipl.-Ing. Michael Hermann, Thermal Systems and Buildings, Fraunhofer Institute for Solar Energy Systems ISE, Freiburg	Fractherm - fractal hydraulic structures for solar absorbers and other heat exchangers	Heat exchangers are important components of technical systems, both those using fossil fuels and those based on renewable energy sources such as solar absorbers. The energy efficiency of such a heat exchanger very strongly depends on how uniformly the heat transfer fluid flows through the channels and how large the pressure drop of this component is (energy demand for the pump). In nature also, networks of flow channels often have to provide energy-efficient heat and/or mass transfer (bloodstreams, veins of leaves). In contrast to conventional technical channel configurations, the natural constructions are usually neither serial nor parallel, but mostly multiply branched structures (“fractals”). At Fraunhofer ISE, an algorithm called FracTherm was developed which provides a given area with a suitable fractal hydraulic structure after determining the inlet and outlet points.

Session Sun-Morning-I (5 Japanese) Biomedical and Biomechanical Engineering

	Name, Affiliation	Title	Abstract
1	Prof. Taishin Nomura Department of Mechanical Science and Bioengineering, Graduate School of Engineering Science Osaka University	Modeling of motor coordination during human gait and pedaling	Human gait and pedaling show dynamic stability, and they may be modeled as a dynamical system with a stable limit cycle. In this talk, two specific topics associated with modeling gait instability are addressed. The first topic deals with corrective motor responses to mechanical perturbation during human steady biped gait, referred to as the stumbling reaction. The reaction is analyzed in relation to basin of attraction of the limit cycle of the human biped model and a humanoid. We then discuss a mechanism that could increase human gait stability. In the second topic, disordered interlimb coordination, which was observed clinically in patients with Parkinson disease during lower limb pedaling of an ergometer having left and right pedals that are allowed to rotate independently, is reproduced using a simple two coupled biological oscillator. A neural mechanism leading to the coordination disorder will be discussed in terms of the dynamical disease.
2	Prof. Goro Obinata Center for Cooperative Research in Advanced Science and Technology Nagoya University	Model based approaches for designing assistive devices	Model based approaches have been widely used for analyzing walking patterns, wheelchair propulsions, and another human movements. One of the approaches is based on the rigid link model of a particular person and the calculation of its inverse dynamics. Moreover, the measurements of the target movement are used with the model to evaluate the consumption energy and the generated tensions of the muscles. The method is attractive because it is noninvasive and powerful to analyze human movements; on the other hand, it is difficult to apply to design problems of assistive devices or to planning problems of human trainings. Simulation studies which solve forward dynamics of human movements are required to estimate the results of the design or the training. Such simulation techniques are useful because the burden

			of subjects can be reduced during the design or planning phase. However, simulations of human movements are difficult since the degree-of-freedom of the body is high and the mechanism of brain and nervous system which generates command signals to muscles has not been clarified yet. To cope with this difficulty, an optimization method for the trajectory planning of redundant manipulators is applied to wheelchair propulsion problem which achieves a given task with high efficiency. A genetic algorithm is used to optimize the redundant variables of upper extremity. The advantage is that the procedure does not include any forward dynamics computation; therefore, the computation for optimizing is quite effective.
3	Prof. Kazunori Hase Nagoya University	An integrated model of cardio-vascular-neuro-musculo-skeletal system for human movement studies	The purpose of this study was to construct a mathematical integration model which can reproduce the variation of blood pressure, cardiovascular dynamics, and body movements during physical exercise. Also, a computer simulation technique was adopted to clarify that mechanism. Pedaling exercise was assumed as an objective human movement, and a musculoskeletal model reproducing pedaling motion with given rotation speed was constructed. A mathematical model integrating the musculoskeletal and cardiovascular systems was established by referring to previous cardiovascular models with continuous time system and by adding cooperation mechanisms between both systems such as characteristics of the central command and the peripheral chemoreceptor. Additionally, a simple model which can calculate the flow of arterial blood from blood pressure was embedded in the integration model so as to consider oxygen supply corresponding with blood pressure variation. Simulation results such as blood pressure variability and cardiac cycle wave closely agreed with characters of the experimental results. Simulation result also pointed out importance of the

			shift in the baroreceptor set point.
4	Prof. Hiroyuki Honda Department of Applied Chemistry, Chemical Engineering and Biotechnology Nagoya University	Heat Immunotherapy using magnetic nano-particle	Hyperthermia such as the use of hot water, capacitive heating, and inductive heating etc. is one of the promising approaches in cancer therapy. However, the inevitable technical problem with hyperthermia is the difficulty of the uniform heating of only the tumor region until the required temperature is reached without damaging normal tissue. Therefore, some researchers have proposed 'intracellular' hyperthermia and developed submicron magnetic particles for hyperthermia. This idea is based on the principle that a magnetic particle can generate heat by hysteresis loss under an alternating magnetic field (AMF). Accumulation of magnetite nano-particles in tumor cells can be enhanced by their surface charge. Therefore, we also have developed 'magnetite cationic liposomes' (MCLs) using magnetic nano-particles. An intracellular hyperthermia by direct injection of MCL to tumor tissue has been demonstrated against animals having several types of tumor, such as B16 mouse melanoma, MM46 mouse mammary carcinoma, T-9 rat glioma, Os515 hamster osteosarcoma, and VX-7 squamous cell carcinoma in rabbit tongue. Our hyperthermia is a novel cancer immunotherapy, which could induce necrotic cell death via heat shock protein expression and resulted in a strongly induction of antitumor immunity
5	Dr. Naoe Hosoda Eco-Device Group, Ecomaterials Center National Institute for Materials Science	A challenge to a biomimetic joining technology	Disassemblability of joints is an important requirement for environment- friendly products. The most conventional metallurgical joining technologies were developed with importance placed only on high joint strength. Therefore the joined part is difficult to separate. The natural world offers valuable suggestions for this purpose. Especially, it is superior to have the mechanism of self destruction. Tree shed easily the leaves by an abscission layer, in case of need. We propose and

			demonstrate a new joining technology having mechanism of self destruction by abscission layer.

Session Sun-Afternoon-II (3 Japanese and 4 Germans) Neurosystems, Intelligence and Robotics

	Name, Affiliation	**Title**	**Abstract**
1	Prof. Dr. Gerald Langner Neuroacoustics, Dept. of Biology, Technische Universität Darmstadt	A model of temporal processing in the auditory system. Keywords: hearing, computer simulation, neural networks, functional mapping, periodicity, pitch	In spite of the fact that the auditory system is the best available acoustic signal processor, so far computational modelling in neuroacoustics has concentrated on the auditory periphery. The first auditory stage, the cochlea, may be considered as filter bank performing a kind of frequency analysis. However, this is only the first step of complex hierarchical processing. On the basis of our neurophysiological investigations, a spiking neural network has been simulated which implements temporal processing in the central auditory system. Essential elements of this network are oscillatory and integrating neurons in the brainstem and coincidence neurons in the auditory midbrain. In the brain the result of temporal analysis is represented along a neuronal axis orthogonal to the frequency axis, as shown by different methods of mapping auditory midbrain and cortex in various animal, including man
2	Prof. Dr. Volker Graefe (Rainer Bischoff, V. Graefe), Head of the Intelligent Robots Lab, Faculty of Aerospace Engineering, Bundeswehr University München, D-85577 Neubiberg	A biomimetic approach to the realization of robot intelligence	Throughout the design of our intelligent humanoid robot's information processing we followed a biomimetic approach. For example, we decided that its sensing should be based exclusively on those senses which have proved their effectiveness in nature, such as vision, tactile sensing and hearing. An intelligent robot's architecture is traditionally based on accurate measurements, numerical models and control theory. We based our robot's system architecture on the concepts of perception, situation, skill and behavior instead – concepts that are used to describe human and animal behavior as well. Furthermore, our robot's communication with

			humans mimics dialogues between humans. It is situation-dependent, multimodal and primarily based on spoken natural language and gestures. The robot was tested in a long-term experiment where it interacted with the public every day for six months. As a result of its biomimetic design it proved to be adaptable and dependable and it was perceived as intelligent, cooperative and human-friendly to a much higher degree than robots designed according to traditional engineering approaches.
3	Dr. Harald Luksch, Center of Bionics, Institute of Biology II, Rheinisch-Westfälische Technische Hochschule Aachen	Neurobiology, computational intelligence and bio-hybrid-systems	The central nervous system of organisms has been shaped by evolution to guarantee survival in a complex environment. Hence, neuronal architecture and algorithms provide powerful solutions to computational problems such as analysis of large data streams, resource allocation during processing, and optimal interpretation of noisy signals. We have analysed circuitry for the orientation to visual and auditory stimuli and present computational models and robotic implementations. In addition, we have started to reconstruct neuronal circuitry in a biohybrid system, i.e., attempt a direct coupling of neuronal and technical information processing devices.
4	Prof. Toshiyuki Nakagaki Hokkaido University	How does an amoeba tackle some geometrical puzzles?	We demonstrate that the true slime mold, a giant amoeboid organism, is able to solve a maze and other geometrical puzzles. Discussion is made on its possible way of solving the exercises based on pattern formation in spatially distributed biochemical oscillators**.**
5	Dr. Toshiharu Mukai (Toshiharu Mukai and Zhiwei Luo) Bio-Mimetic Control Research Center, RIKEN	Soft swimming robots using artificial muscle	In this presentation, we introduce soft robots we are developing using artificial muscle (IPMC actuator) in a trial for next generation robots with flexibility. We have developed a snake-like swimming robot using a patterning technique which we developed in order to realize complex motion in one IPMC actuator without losing flexibility. The robot is 14 cm long and has 7 degrees of freedom. It can swim forward and

			backward by wriggling its body, as well as rotate by making asymmetric wriggling. We also developed a ray-type swimming robot, fins of which are composed of IPMC actuators and can produce various traveling waves with different wave lengths and frequencies. In these robots, we give phase-shifted sinusoidal voltages to each segment to produce traveling waves. Interesting findings are that even though we give the same amplitude to each segment, resulting wave amplitudes are different depending on the segment position. The amplitude increases along the body, resulting in small amplitude at the head and large at the tail. This wave pattern can be seen in real swimming animals, so now we have a hypothesis that their muscles produce the same force at each position, even though the resulting amplitudes of wriggling increase from the head to the tail.
6	Prof. Dr. Oskar von Stryk, Department of Computer Science, Technische Universität Darmstadt, www.sim-opt.de	Bionic Robot Arms and Legs	Industrial manipulators obtain high position accuracy using rigid joint actuators and rigid links resulting in heavy masses of arms. Also the legs of the currently best walking humanoid robots consist of rigid joint actuators and rigid links. Current robot arms and legs stand in remarkable contrast to animals and humans where each joint is actuated by highly redundant and elastic actuators resulting in a much better relationship from payload to arm weight and and a high motion quality by intelligent control. In the talk we discuss a bionic drive for robot arms consisting of elastically coupled actuators, its difficulties and advantages and current results. Furthermore, a newly proposed bionic robot leg design for biped locomotion as well as benchmark scenarios for intelligent autonomous, legged robots in soccer games will briefly be discussed.
7	Prof. Makoto Kaneko (Mitsuru Higashimori) Hiroshima University	Design and experiment of the 100G capturing robot	How much acceleration can a robot produce? Pursuing a robot with an extremely high response is a challenging matter. We have designed and developed the 100G (G: gravitational

			acceleration) capturing robot that can catch an object dropping in air. This robot keeps the world record in maximum acceleration. Since the capturing time is so short, roughly 30ms, we can not see what is actually happening through our eyes. Only a high speed camera can chase the actual motion of the robot. The basic design of the robot is precisely explained. The arm/hand coupling mechanism is specially introduced for the robot. Experimental results will be shown with video demonstration. The highlight of the experiments is to catch a dropping ball with the help of the 1ms-vision system as well as the Ballet Arm.