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A Continuing Bibliography with Indexes

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AEROSPACE MEDICINE AND BIOLOGY

A CONTINUING BIBLIOGRAPHY WITH INDEXES

(Supplement 340)

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced in August 1990 in

- *Scientific and Technical Aerospace Reports (STAR)*
- *International Aerospace Abstracts (IAA).*

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INTRODUCTION

This Supplement to *Aerospace Medicine and Biology* lists 157 reports, articles and other documents announced during August 1990 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*. The first issue of the bibliography was published in July 1964.

In its subject coverage, *Aerospace Medicine and Biology* concentrates on the biological, physiological, psychological, and environmental effects to which man is subjected during and following simulated or actual flight in the Earth's atmosphere or in interplanetary space. References describing similar effects on biological organisms of lower order are also included. Such related topics as sanitary problems, pharmacology, toxicology, safety and survival, life support systems, exobiology, and personnel factors receive appropriate attention. In general, emphasis is placed on applied research, but references to fundamental studies and theoretical principles related to experimental development also qualify for inclusion.

Each entry in the bibliography consists of a bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged by *STAR* categories 51 through 55, the Life Sciences division. The citations, and abstracts when available, are reproduced exactly as they appeared originally in *IAA* or *STAR*, including the original accession numbers from the respective announcement journals. The *IAA* items will precede the *STAR* items within each category.

Seven indexes — subject, personal author, corporate source, foreign technology, contract, report number, and accession number — are included.

An annual index will be prepared at the end of the calendar year covering all documents listed in the 1990 Supplements.

Information on the availability of cited publications including addresses of organizations and NTIS price schedules is located at the back of this bibliography.

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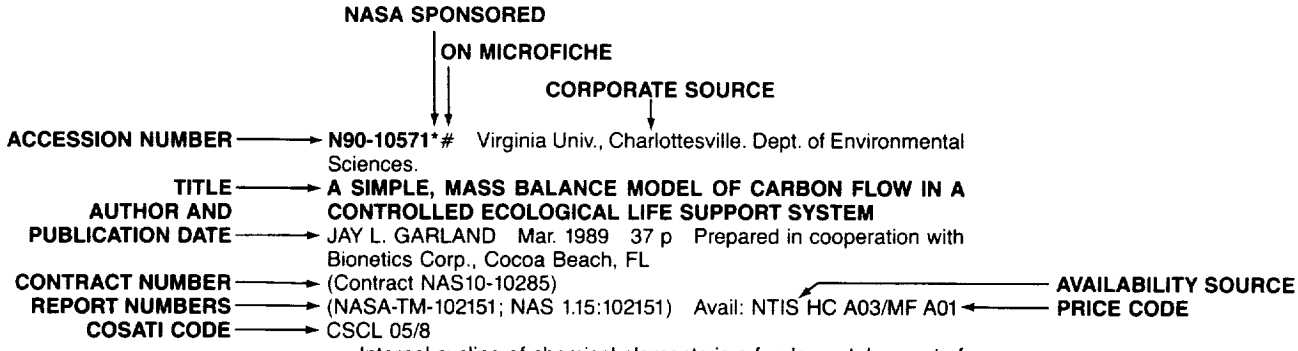
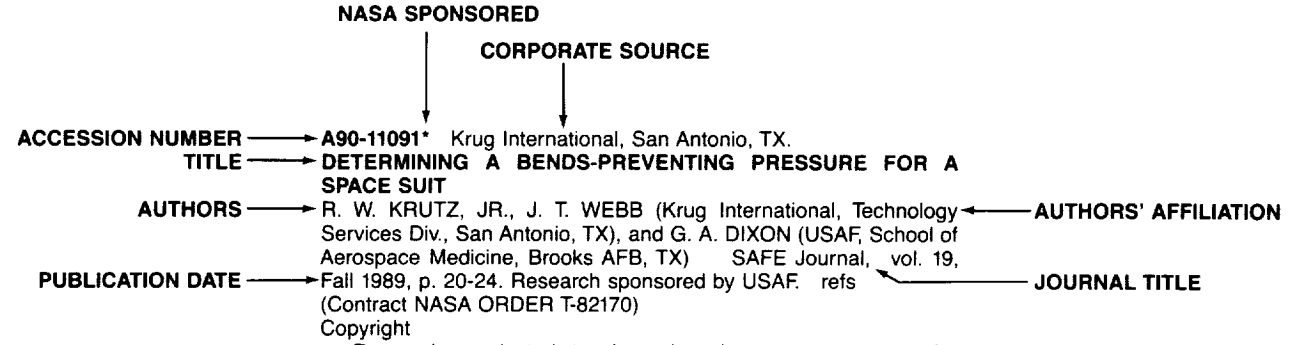
TYPICAL REPORT CITATION AND ABSTRACT



Internal cycling of chemical elements is a fundamental aspect of a Controlled Ecological Life Support System (CELSS). Mathematical models are useful tools for evaluating fluxes and reservoirs of elements associated with potential CELSS configurations. A simple mass balance model of carbon flow in CELSS was developed based on data from the CELSS Breadboard project at Kennedy Space Center. All carbon reservoirs and fluxes were calculated based on steady state conditions and modelled using linear, donor-controlled transfer coefficients. The linear expression of photosynthetic flux was replaced with Michaelis-Menten kinetics based on dynamical analysis of the model which found that the latter produced more adequate model output. Sensitivity analysis of the model indicated that accurate determination of the maximum rate of gross primary production is critical to the development of an accurate model of carbon flow. Atmospheric carbon dioxide was particularly sensitive to changes in photosynthetic rate. The small reservoir of CO2 relative to large CO2 fluxes increases the potential for volatility in CO2 concentration. Feedback control mechanisms regulating CO2 concentration will probably be necessary in a CELSS to reduce this system instability.

Author

TYPICAL JOURNAL ARTICLE CITATION AND ABSTRACT



Research conducted to determine the proper pressure for preventing bends during EVA without preoxygenation is examined. Male and female subjects with different breathing gas mixtures and pressures are studied in order to define the pressure. Visual and auditory Doppler ultrasonic signals are utilized to monitor intravascular gas bubbles. The workload, which simulates EVA, consists of a handturned bicycle ergometer, a torque wrench operation, and a rope pull. The experimental data reveal that the minimum space suit pressure needed to prevent decompression sickness is 9.5 psi.

I.F.

AEROSPACE MEDICINE AND BIOLOGY

A Continuing Bibliography (Suppl. 340)

SEPTEMBER 1990

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LIFE SCIENCES (GENERAL)

A90-35015* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
MICROBIAL METABOLISM OF THOLIN
C. R. STOKER, R. L. MANCINELLI (NASA, Ames Research Center, Moffett Field, CA), P. J. BOSTON (NCAR, Boulder, CO), W. SEGAL (Colorado, University, Boulder), B. N. KHARE (Cornell University, Ithaca, NY) et al. Icarus (ISSN 0019-1035), vol. 85, May 1990, p. 241-256. refs
(Contract NGR-33-010-101)
Copyright

Tholin, a class of complex organic heteropolymers hypothesized to possess wide solar system distribution, is shown to furnish the carbon and energy requirements of a wide variety of common soil bacteria which encompasses aerobic, anaerobic, and facultatively anaerobic bacteria. Some of these bacteria are able to derive not merely their carbon but also their nitrogen requirements from tholin. The palatability of tholins to modern microbes is speculated to have implications for the early evolution of microbial life on earth; tholins may have formed the base of the food chain for an early heterotrophic biosphere, prior to the evolution of autotrophy on the early earth. O.C.

A90-35882
ADENYL NUCLEOTIDES IN ISOLATED NEURON FRACTIONS OF THE CEREBRAL CORTEX IN THE CASE OF ACUTE AND MODERATE HYPOXIA [NUKLEOTYDY ADENYLOWE IZOLOWANEJ FRAKCJI NEURONOW KORY MOZGU SZCZURA W STANACH OSTREGO I UMIARKOWANEGO NIEDOTLENIENIA]
ALINA GROCHOWALSKA and RYSZARD BERNAT (Akademia Medyczna, Poznan, Poland) Postepy Astronautyki (ISSN 0373-5982), vol. 22, no. 3-4, 1989, p. 53-63. In Polish. refs
Copyright

The concentrations of ATP, ADP, and AMP nucleotides in the neuron core of the cerebral cortex are determined after acute ($pO2 = 2.0$ kPa) and moderate ($pO2 = 10.0$ kPa) hypoxia (lasting 5 minutes). The degree of hypoxic hypoxia is determined by the value of pO2 in the blood. Results are presented from measurements of nucleotide concentrations, adenyl energy, and the phosphorylation potential of oxidation. It is shown that in hypoxic hypoxia with lowered pO2 in the blood, ATP and ADP decrease, but AMP increases. As the pO2 in the blood decreases, the adenyl energy charge does not change, but the phosphorylation potential becomes lower. R.B.

A90-36148
RADIATION BIOCHEMISTRY OF MEMBRANE LIPIDS [RADIATSIONNAIA BIOKHIMIIA MEMBRANNYKH LIPIDOV]
ISKRA K. KOLOMIITSEVA Moscow, Izdatel'stvo Nauka, 1989, 184 p. In Russian. refs
Copyright

The book examines the effects of ionizing radiation, in doses ranging from sublethal to superlethal, on the metabolism of membrane lipids in both the radiation-resistant and radiation-sensitive tissues of animal organisms. Consideration is given to the effects of ionizing radiation on the intermembrane transport of phosphatidylcholine, phosphatidylethanolamine, and cholesterol; the synthesis and excretion of cholesterol; and the synthesis and degradation of basic phospholipids in subcellular organelles of the liver. Particular attention is given to the effect of ubiquinone-9 on the metabolism of membrane lipids and on the survival of ionized animals. It is suggested that the increased synthesis of lipids and cholesterol in the liver and in affected tissues is the first step in the regeneration of cellular mitosis inhibited by irradiation. I.S.

A90-36150
NEUROCHEMICAL PROCESSES IN THE CENTRAL NERVOUS SYSTEM DURING HYPOTHERMIA [NEIROKHIMICHESKIE PROTSESSY V TSENTRAL'NOI NERVNOI SISTEME PRI GIPOTERMII]
GEORGII A. BABIICHUK and MIKHAIL I. SHIFMAN Kiev, Izdatel'stvo Naukova Dumka, 1989, 152 p. In Russian. refs
Copyright

Results are presented on investigations of synaptic processes that develop in the central nervous system in response to hypothermia. Attention is given to the thermoregulatory reactions in warm-blooded animals induced by cooling, the effects of hypothermia on the secretion and the capture of neuromediators by synaptosomes, the synaptic processes in the brain operating during craniocerebral hypothermia, and the compensatory and adaptive changes in the processes regulating the capture of neuromediators during craniocerebral hypothermia. Particular attention is given to the possibility of using induced craniocerebral hypothermia for alleviating endogenic depression. I.S.

A90-36154
CALDERA MICROORGANISMS [KAL'DERNYE MIKROORGANIZMY]
G. A. ZAVARZIN, G. A. KARPOV, V. M. GORLENKO, R. S. GOLOVACHEVA, L. M. GERASIMENKO et al. Moscow, Izdatel'stvo Nauka, 1989, 121 p. In Russian. refs
Copyright

The book considers the role of extremely thermophilic microorganisms in the processing of deep-seated exhalations in volcanic calderas, with particular attention given to the ongoing biogeochemical processes in the Uzon (Kamchatka) hydrothermae due to thermophilic bacteria. The mechanism of the formation of microbial mats in hot springs is examined together with the physicochemical conditions responsible for the type of microbiological differentiation seen in the microbial mats of the Termofilnyi Spring (Uzon, Kamchatka). Special consideration is given to the roles of the aerobic thermophilic chemolithotrophic and the sulfur-reducing thermophilic bacteria in the production of geochemical changes in the regions of their activity. I.S.

A90-36739* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
INTRAPERICARDIAL DENERVATION - RADIAL ARTERY BLOOD FLOW AND HEART RATE RESPONSES TO LBNP
KENNETH H. MCKEEVER, MICHAEL G. SKIDMORE, LANNY C. KEIL, and HAROLD SANDLER (NASA, Ames Research Center,

Moffett Field, CA) Journal of Applied Physiology (ISSN 0161-7567), vol. 68, May 1990, p. 2208-2213. refs
Copyright

The effects of intrapericardial denervation on the radial artery blood flow velocity (RABFV) and heart rate (HR) responses to LBNP in rhesus monkeys were investigated by measuring the RABFV transcutaneously by a continuous-wave Doppler ultrasonic flowmeter in order to derive an index of forearm blood flow response to low (0 to -20 mm Hg) and high (0 to -60 mm Hg) ramp exposures during supine LBNP. Four of the eight subjects were subjected to efferent and afferent cardiac denervation. It was found that, during low levels of LBNP, monkeys with cardiac denervation exhibited no cardiopulmonary baroreceptor-mediated change in the RABFV or HR, unlike the intact animals, which showed steady decreases in RABFV during both high- and low-pressure protocols. It is suggested that forearm blood flow and HR responses to low-level LBNP, along with pharmacological challenge, are viable physiological tests for verifying the completeness of atrial and cardiopulmonary baroreceptor denervation. I.S.

A90-37820
OBSERVED GENETIC EFFECTS IN EXPERIMENTS WITH DROSOPHILA EXPOSED TO WEIGHTLESSNESS [NABLIUDAEMYE GENETICHESKIE EFFEKTY V OPYTAKH S DROZOFILOI POSLE EKSPOZITSII V NEVESOMOSTI]
L. P. FILATOVA, E. N. VAULINA, N. SH. LAPTEVA, and T. IA. GROZDOVA (AN SSSR, Institut Obshchei Genetiki, Moscow, USSR) Akademiia Nauk SSSR, Doklady (ISSN 0002-3264), vol. 310, no. 2, 1990, p. 468-470. In Russian. refs
Copyright

The effect of space flight on the recombination frequency in Drosophila fruit fly was investigated using males of D. melanogaster flies with a mei-9(L1) mutation in the X chromosome, who were heterozygous with respect to the b, pr, cn, and en genes on the chromosome-2. After a flight aboard Cosmos-1667 or Cosmos-1887 (for 7 or 13 days, respectively), the male flies were crossbred with virgin females homozygous with respect to all four genes. It was found that the exposures to microgravity for 13 and 7 days led to statistically significant decreases in the recombination frequency in the chromosome 2. I.S.

A90-38569#
DYNAMIC RESPONSE OF BLOOD FLUX OF VARIOUS ORGANS OF RABBITS UNDER SIMULATED WEIGHTLESSNESS
QIU-LU XIANG, XIAN-YUN SHEN, JING-RUI MENG, and GUANG-YUAN LIU (Institute of Space Medico-Engineering, Beijing, People's Republic of China) Chinese Journal of Space Science (ISSN 0254-6124), vol. 9, April 1989, p. 148-154. In Chinese, with abstract in English. refs

An experiment with 26 rabbits is reported, and the dynamic response curves of blood flux of various organs are given. The relations between the blood flux and the functional state of microvessels of various organs under the simulated weightlessness conditions are also analyzed using the method of microcirculation. Finally, the characteristics of the changes of the microcirculatory functions of various organs are described, and the mechanisms of these changes are discussed. Author

A90-38576#
STUDIES ON PHYSIOLOGICAL CRITICAL INDEX OF RHESUS MONKEYS DURING EXPOSING TO TRANSVERSE ACCELERATION FORCE
SHU-FU ZHANG, ZHEN-RONG WU, RU-GAI SONG (Fudan University, Shanghai, People's Republic of China), and ZHENG BAO Chinese Journal of Space Science (ISSN 0254-6124), vol. 9, July 1989, p. 195-205. In Chinese, with abstract in English. refs

Ten rhesus monkeys (Macaca mulatta) are exposed to 16 g hypergravity force while the respiratory rate and EEG are continuously recorded. Under the action of 16 g, the respiratory rate of all the monkeys increased first, then slowed down, and at the end of the centrifugation, the respiration almost ceased. The heart rate showed an initial increase (70 percent), then a gradual decrease, sometimes showing arrhythmia, heart block, etc. The brain waves appeared mainly to be the 'delta' waves with high amplitude and low frequency. Then, the wave amplitude fell gradually and was accompanied by the appearance of 4-6 c/sec 'theta' waves with small amplitude. Author

A90-38579#
OBSERVATIONS AND PRELIMINARY ANALYSIS OF THE DEVELOPMENT OF ARTEINIA EGGS RECOVERED FROM SATELLITE 8799
QI-LING ZHOU, JIAN HE, GUO-REN XING, DE-CUN ZHENG, RUI-ZHEN SU (Chinese Academy of Sciences, Institute of Biophysics, Beijing, People's Republic of China) et al. Chinese Journal of Space Science (ISSN 0254-6124), vol. 9, July 1989, p. 221-225. In Chinese, with abstract in English.

Eggs of Chinese native brine shrimp, Arteinia salina, were carried by satellite 8799. The total dose of ionizing radiation received by the eggs during 8-day space flight was about 169 mrad. The flown eggs started incubation in artificial sea water and were observed, along with lab control and launch-site control groups, on days 21, 29 and 96 and 155 after the flight. It was observed again that significant delay of emergence and hatching occurred in satellite-flown eggs, and the extent of this delay appeared to have reduced gradually during prolongation of the egg storage at 42 C. The hatching rate of satellite-flown eggs and the survival curve, within 21 days, of larvae hatched from satellite-flown eggs were very similar to those seen in the earth control group. Author

N90-22202*# Texas Univ. Health Science Center, Houston. Bioprocessing Research Center.
RESEARCH IN BIOLOGICAL SEPARATIONS AND CELL CULTURE Annual Report No. 3, 1 Jun. 1987 - 31 May 1988
L. SCOTT RODKEY Jun. 1988 172 p
(Contract NAS9-17403)
(NASA-CR-172060; NAS 1.26:172060) Avail: NTIS HC A08/MF A01 CSCL 06C

During the final months, some experiments were initiated in an effort to study the nonreproducibility of cell separations that were attempted up to that time. During the final month, data was collected which clearly shows that the lack of precision and resolution in cell separations is a direct function of the inappropriate buffers that were chosen to be used in the McDonnell Douglas continuous flow electrophoresis system. The nonreproducibility and poor resolution of cell separation systems which had been an ongoing problem for many years was solved. The correct buffer is, at present, unkown. However, it is now quite clear that the next logical effort in the area of cell separations by continuous flow electrophoresis needs to be in finding an appropriate buffer system which buffers at the pH at which the system operates. Task 4, studies of recycling isoelectric focusing, progressed very well. Studies were completed in comparing the McDonnell Douglas continuous flow electrophoresis system with the recycling isoelectric focusing system and the results are unequivocal. During the year, ampholyte synthesis was refined and extended so that new classes of ampholytes are now available for high resolution work. Studies of electrodissolution were performed, as were studies of ampholyte-protein interactions. Finally, a new design of recycling isoelectric focusing hardware was built and tested. Three of the tasks within the Bioprocessing Research Center (7, 8, and 9) were performed. These studies generally encompass the area of bioreactor design and function. Studies in this category include work on fluid dynamics that occur in bioreactors, design of bioreactor control systems, and identification and assessment of stress forces on cells. Author

N90-22203* Lockheed Engineering and Sciences Co., Washington, DC.
USSR SPACE LIFE SCIENCES DIGEST, ISSUE 25
LYDIA RAZRAN HOOKE, ed., RONALD TEETER, ed., VICTORIA GARSHNEK, ed., and JOSEPH ROWE, ed. (Library of Congress,

Washington, DC.) Washington NASA Jan. 1990 107 p (Contract NASW-4292)
(NASA-CR-3922(29); NAS 1.26:3922(29)) Avail: NTIS HC A06/MF A01 CSCL 06C

This is the twenty-fifth issue of NASA's Space Life Sciences Digest. It contains abstracts of 42 journal papers or book chapters published in Russian and of 3 Soviet monographs. Selected abstracts are illustrated with figures and tables from the original. The abstracts in this issue have been identified as relevant to 26 areas of space biology and medicine. These areas include: adaptation, body fluids, botany, cardiovascular and respiratory systems, developmental biology, endocrinology, enzymology, equipment and instrumentation, exobiology, gravitational biology, habitability and environmental effects, human performance, immunology, life support systems, man-machine systems, mathematical modeling, metabolism, microbiology, musculoskeletal system, neurophysiology, nutrition, operational medicine, psychology, radiobiology, reproductive system, and space biology and medicine. Author

N90-22204 New South Wales Univ., Sydney (Australia).
EXCITATORY AND INHIBITORY BACKWARD CONDITIONING IN THE RAT Ph.D. Thesis Abstract Only
STEPHEN C. PROVOST May 1988 4 p
Avail: Issuing Activity

The experiments sought to test the explanations provided by theories of conditioning for the outcome of a backward conditioning arrangement. The experiments all employed a conditioned emotional response (CER) procedure with rat subjects. The nature of the variables responsible for the development of inhibitory conditioning in a backward arrangement was examined in Experiments 1 to 5. Experiments 1, 2, and 3 demonstrated that both the consistency of the intertrial intervals (ITIs) separating U.S. presentations, and the length of the backward interstimulus interval (ISI) separating the CS from the U.S., were involved in the determination of inhibitory strength. Experiment 4 was designed to provide evidence that might support an explanation for the role of the backward ISI in terms of formal theories of conditioning. Experiment 5 was an attempt to provide an explanation for the role of the ITI in terms of opponent-process theories of conditioning. Although the evidence from both experiments was inconclusive, Experiment 5 provided some evidence that excitatory backward conditioning was possible in this preparation. Experiment 6 confirmed this possibility with a more intense U.S. than Experiments 1 to 5, and showed that excitatory backward conditioning was not effected by the presence of a signal for the U.S. Experiments 7 and 8 demonstrated that excitatory backward conditioning also was not influenced by the consistency of the ITIs separating U.S. presentations. Opponent-process theories provide the most adequate explanation for the evidence obtained, although no single experiment provided a critical test of any theory. The fundamental issue which must be addressed by an opponent-process theory for it to provide a complete account of backward conditioning is the involvement of the ITI in inhibitory conditioning. At least one possible account, which points to the possibility of forward trace conditioning taking place when the ITI is varied, seems implausible given the results of these experiments. An alternative account, based upon Star's critical decay duration hypothesis, is suggested: Variability of the ITI may have a direct effect upon growth of opponent processes. The implications of this view for future investigations of backward conditioning, and opponent-process theory in general, are considered. Dissert. Abstr.

N90-22205*# Alabama Univ., Birmingham. Dept. of Biochemistry.
THE CHEMICAL BASIS FOR THE ORIGIN OF THE GENETIC CODE AND THE PROCESS OF PROTEIN SYNTHESIS Final Report
JAMES C. LACEY, JR. 16 May 1990 74 p
(Contract NGR-01-010-001)
(NASA-CR-186590; NAS 1.26:186590) Avail: NTIS HC A04/MF A01 CSCL 06C

A model for the origin of protein synthesis. The essential features of the model are that 5'-AMP and perhaps other monoribonucleotides can serve as catalysts for the selective synthesis of L-based peptides. A unique set of characteristics of 5'-AMP is responsible for the selective catalysts and these characteristics are described in detail. The model involves the formation of diesters as intermediates and selectivity for use of the L-isomer occurs principally at the step of forming the diester. However, in the formation of acetyl phenylalanine-AMP monoester there is a selectivity for esterification by the D-isomer. Data showing this selectivity is presented. This selectivity for D-isomer disappears after the first step. The identity was confirmed of all four of possible diesters of acetyl-D- and -L phenylaline with 5'-AMP by nuclear magnetic resonance (NMR). The data using flourescence and NMR show the Trp ring can associate with the adenine ring more strongly when the D-isomer is in the 2' position than it can when in the 3' position. These same data also suggest a molecular mechanisim for the faster esterificaton of 5'-AMP by acetyl-D-phenylaline. Some new data is also presented on the possible structure of the 2' isomer of acetyl-D-tryptophan-AMP monoester. The HPLC elution times of all four possible acetyl diphenylalanine esters of 5'-AMP were studied, these peptidyl esters will be products in the studies of peptide formation on the ribose of 5'-AMP. Other studies were on the rate of synthesis and the identity of the product when producing 3'Ac-Phe-2'tBOC-Phe-AMP diester. HPLC purification and identification of this product were accomplished. Author

N90-22206# Paraiba Univ., Joao Pessoa (Brazil).
PROCEEDINGS OF THE 6TH REGIONAL SYMPOSIUM ON BIOPHYSICS
1988 67 p In PORTUGESE Symposium held in Joao Pessoa, Brazil, 8-10 Dec. 1988
(DE90-619618; INIS-BR-1797; CONF-8812131) Avail: NTIS (US Sales Only) HC A04/MF A01

Topics addressed include: molecular biophysics, radiobiology, photobiology, and biophysics of processes and systems. DOE

N90-22883# California Univ., Berkeley. Dept. of Chemistry.
THRESHOLD PHOTODETACHMENT SPECTROSCOPY OF THE I + HI TRANSITION STATE REGION Interim Technical Report, Nov. - Dec. 1989
I. M. WALLER, T. N. KITSOPOULOS, and D. M. NEUMARK 1 Jan. 1990 18 p Submitted for publication
(Contract N00014-87-K-0495)
(AD-A218410; TR-3) Avail: NTIS HC A02/MF A01 CSCL 07/4

We have developed a method for probing the transition state region of a neutral bimolecular reaction via photodetachment of a stable negative ion similar in structure to the neutral transition state. In several cases, we have found that the photoelectron spectrum of the hydrogen-bonded anion AHB(-) exhibits resolved vibrational structure which can be assigned to an unstable (AHB) complex located near the transition state for the hydrogen transfer reaction A + HB yields HA + B. The results described previously were obtained with a fixed-frequency negative ion photoelectron spectrometer. Here we report considerably higher resolution results for IHI(-) obtained on a recently constructed threshold photodetachment spectrometer. In this experiment, mass-selected ions are photodetached with a tunable pulsed laser, and only those photoelectrons produced with nearly zero kinetic energy are detected as a function of laser wavelength. The threshold photodetachment spectrum of IHI(-) shows considerably more structure than was observed in the lower resolution photoelectron spectrum. In particular, we observe narrow (30 cm) peaks due to long-lived states of the (IHI) complex which lie well above the I + HI(v=0) asymptote. GRA

N90-22884# Boston Univ., MA. School of Medicine.
HEAT EXHAUSTION IN A RAT MODEL: LITHIUM AS A BIOCHEMICAL PROBE Final Report, 15 Jan. 1988 - 30 Sep. 1989
STEVEN H. ZEISEL 30 Sep. 1989 37 p
(Contract DAMD17-88-C-8055; DA PROJ. 3E1-62777-A-879)
(AD-A219361) Avail: NTIS HC A03/MF A01 CSCL 06/10

Our aim was to confirm our hypothesis that chronic lithium

treatment predisposes to heat-induced illness using an animal model. We hypothesized that lithium-treated rats would develop heat-induced illness more easily and rapidly than would controls. Rats were treated with lithium (2 mEq/kg body weight/day), or with a matching amount of water, for 20 days. In some experiments rats were offered water ad libitum, in other experiments fluid was restricted from day 14 to 20. During passive heat testing, rats were housed in a small environmental chamber (modified tissue culture incubator) in individual containers. Temperature in the chamber was maintained at 41.5 C with forced hot air, relative humidity at 30 to 50 percent. During active (exercise-induced) heat testing, animals were exercised on a motor-driven treadmill in chambers heated with forced hot air to a temperature of 26 C. Humidity was maintained at 30 percent relative humidity. Lithium treatment did not affect body water distribution, the rate of body temperature rise in either heating model, and the organ damage caused by exposure to heat (as assessed by leakage of enzymes into blood). There was a difference in the tail temperature during cooling after active (exercise-induced) heating - tail temperatures were consistently higher in lithium treated rats. We also observed that lithium treated animals consumed more water when it was offered ad libitum. GRA

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AEROSPACE MEDICINE

Includes physiological factors; biological effects of radiation; and effects of weightlessness on man and animals.

A90-36287
SPECTACLES AND SUNGLASSES FOR AIRCREW
D. H. BRENNAN (Royal Air Force Institute of Aviation Medicine, Farnborough, England) Aviation Medicine Quarterly (ISSN 0951-3949), vol. 2, 1989, p. 93-98. refs
Copyright

This paper examines these requirements for spectacle frames and lenses to be worn by aircrew in order to avoid distraction by discomfort of visual field impairment, and discusses the hazards of solar radiation and the requirements for sun filters. Specifications are given for frames and lens materials for corrective spectacles and sunglasses and for multifocal lenses, lens coatings, and sunglass lenses. It is suggested that that corrective spectacles should utilize robust metal frames and the lenses should be fabricated from polycarbonate, for powers of less than + or - 2.0 OD, or from CR39 resin, for higher powers and bifocals. The sun filters should be made from polycarbonate of high optical quality, with a luminous transmittance of 10-15 percent. I.S.

A90-36289
PRESBYOPIA IN PILOTS
FRANK MARSHALL (Civil Aviation Authority, Eastborne, England) Aviation Medicine Quarterly (ISSN 0951-3949), vol. 2, 1989, p. 105, 106.
Copyright

The nature of presbyopia is discussed together with means of its correction in aircrew. It is emphasized that it is very important to correctly assess in pilots the focal distances to the instrument panels, since these distances can vary greatly, e.g., from 660-980 mm in BA 1-11 to 735-1000 mm in a B 747. The range from the eye to a chart holder varies from 355-530 mm in a BA 1-11 to 380-640 mm in a B 747. It is recommended that the pilot should inform the prescriber of spectacles about the distances at which he needs to read the panel. In addition, any pilot finding that he needs rapidly increasing strengths of reading glasses should be immediately tested for intraocular pressure. I.S.

A90-36290
THE OCCUPATIONAL VISUAL REQUIREMENTS OF AIR TRAFFIC CONTROLLERS
LINDA STONEFIELD (Dollard and Aitchison, Opticians, Altrincham, England) Aviation Medicine Quarterly (ISSN 0951-3949), vol. 2, 1989, p. 107-110.
Copyright

This paper considers some of the problems encountered by air traffic controllers with the onset of presbyopia. Special attention is given to the psychological impact on the air traffic controller of deteriorating eye sight, the physical difficulties encountered with presbyopia, and the problems specific to the controller's working environment. The solutions to these problems, in terms of particular spectacle correction, are suggested. I.S.

A90-36291
WEIGHTLESSNESS AND THE CARDIOVASCULAR SYSTEM
M. H. HARRISON (Ministry of Defence, Whitehall, England) Aviation Medicine Quarterly (ISSN 0951-3949), vol. 2, 1989, p. 111-119. refs
Copyright

Upon returning to earth from just a few days in space, astronauts and cosmonauts invariably exhibit an increased predisposition towards orthostatic intolerance (pre-syncopal signs and symptoms, and even frank syncope), and a reduced physical work capacity. Both are a direct consequence of specific effects of weightlessness on the cardiovascular system - effects described by the general term, 'cardiovascular deconditioning'. Although little is known for certain concerning the physiological basis of cardiovascular deconditioning, the mechanics by which the cardiovascular system responds to gravity-dependent hydrostatic pressure gradients are well described. These form the starting point for the present paper, which then reviews the effects of weightlessness on the cardiovascular system, and presents a hypothesis to explain the mechanism of cardiovascular deconditioning. The paper concludes with an account of countermeasures which may be taken to attenuate, if not prevent, cardiovascular deconditioning. Author

A90-36292
MOTION SICKNESS AND PSYCHOMOTOR PERFORMANCE - EFFECTS OF SCOPOLAMINE AND DEXAMPHETAMINE
A. LEGER, P. SANDOR, and M. KERGUELEN (Centre d'Essais en Vol, Bretigny-sur-Orge, France) Aviation Medicine Quarterly (ISSN 0951-3949), vol. 2, 1989, p. 121-128. refs
(Contract DRET-86-1032)
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Prophylaxis of motion sickness by drugs in aeronautics and space environment incurs the problem of side effects on psychomotor performance. Scopolamine and dexamphetamine in combination are known for a synergic suppression of motion sickness while side effects are antagonistic. The present study compares the effects of a combination of scopolamine (0.4 mg) and dexamphetamine (5 mg) with the effects of motion sickness on psychomotor performance and vigilance. The results show the efficacy of the medication used and are in agreement with most recent data on performance. They lead to the conclusion that the combination of scopolamine and dexamphetamine is effective in the prevention of motion sickness while psychomotor performance is preserved. Author

A90-36294* Massachusetts Inst. of Tech., Cambridge.
MICROGRAVITY ENHANCES THE RELATIVE CONTRIBUTION OF VISUALLY-INDUCED MOTION SENSATION
L. R. YOUNG and M. SHELHAMER (MIT, Cambridge, MA) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 61, June 1990, p. 525-530. refs
(Contract NASW-3651; NAS9-15343)
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Visually-induced self-motion sensation and postural reflexes were first explored in microgravity on the Spacelab 1 mission where four subjects demonstrated that visual orientation effects were stronger in microgravity than preflight. Extended testing of two more subjects during the Spacelab D-1 orbital flight confirmed this finding. The development of visual substitution for inappropriate graviceptor information occurs over the first day or two in microgravity. Additional instrumentation to measure postural

reactions failed to produce a more reliable indicator of visual effects than subjective orientation. Localized tactile cues applied to the feet changed the qualitative nature of vection and reduced its subjective strength. Author

A90-36295
MEASUREMENTS OF CERTAIN ENVIRONMENTAL TOBACCO SMOKE COMPONENTS ON LONG-RANGE FLIGHTS
JOHN W. DRAKE and DALLAS E. JOHNSON Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 61, June 1990, p. 531-542. refs
Copyright

In December 1987, 10 portable nicotine and respirable particle measuring instruments were employed on 4 Boeing 747 flights, placed in all passenger classes and zones, in randomly selected non-perimeter seats, to assess environmental tobacco smoke (ETS). Measurements integrated the nicotine particle concentrations over the duration of the 5-h Tokyo-Hongkong-Tokyo flights and over each half of the 14-h New York City-Tokyo flights. Number of cigarettes smoked per minute in sample areas explained a significant proportion of variability in the observed nicotine and respirable particle levels. The all-daytime Tokyo-Hong Kong-Tokyo flights with a different seating configuration showed higher levels of ETS variables. The cause cannot be identified from the six flight segments studied. Levels of ETS observed in these 747-100 and -200 flights (with all air conditioning packs operating) were lower than those observed in narrow body 727/737 aircraft, on short flights, in prior related tests. The 747's five air conditioning zones are reasonably effective in keeping ETS within the respective zones, and discharging it with relatively little entry into non-smoking areas. Author

A90-36296
FLIGHT ATTENDANTS' DESYNCHRONOSIS AFTER RAPID TIME ZONE CHANGES
SAKARI SUVANTO, MARKKU PARTINEN, MIKKO HARMA, and JUHANI ILMARINEN (Institute of Occupational Health, Vantaa, Finland) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 61, June 1990, p. 543-547. Research supported by the Finnish Work Environment Fund. refs
Copyright

The aim of the present study was to measure perceived effects of rapid time zone changes on flight attendants' sleep length, quality, adaptation, and recovery time, and to clarify the individual factors related to perceived desynchronosis after time zone changes. The mean age of 285 female subjects was 35.0 years and that of 57 men was 34.1 years. The data were gathered by means of a questionnaire filled out by all Finnish flight attendants who worked on transmeridian routes. The quality of sleep, perceived adjustment, and recovery times were dependent on the flight direction and on the number of time zones crossed. The effects of age, neuroticism, and sex partly explained the variation of perceived desynchronosis, which increased linearly with increasing age and neuroticism. Author

A90-36297
CORRELATION OF PLASMA NOREPINEPHRINE AND PLASMA ATRIAL NATRIURETIC FACTOR DURING LOWER BODY NEGATIVE PRESSURE
JOHN F. SCHMEDTJE, ABRAHAM VARGHESE, ADDISON A. TAYLOR (Baylor College of Medicine, Houston, TX), and JOLANTA GUTKOWSKA (Montreal, Clinical Research Institute, Canada) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 61, June 1990, p. 555-558. refs
(Contract NIH-RR-05425)
Copyright

Plasma atrial natriuretic factor (ANF) is released in proportion to intraatrial pressures. Plasma norepinephrine (NE) levels are considered to be an indirect reflection of sympathetic tone. These two mediators were studied during human regulation of intravascular volume in the course of exposure to fluid shifts associated with a model of gravitational stress, lower body negative pressure (LBNP). Blood was drawn from 10 normal subjects before and after exposure to 2 min of a graduated increase in LBNP to a level of 55 mm Hg followed by 5 min at 55 mm Hg. Plasma ANF was measured by RIA and catecholamines by HPLC-ECD. NE increased from 358 + or - 44 pg/ml to 511 + or - 48 pg/ml ($p = 0.03$). Although ANF only decreased from 27.3 + or - 2.4 pg/ml to 23.5 + or - 2.9 pg/ml ($p = 0.33$), a statistically significant negative correlation was observed ($r = -0.70$, $p = 0.02$) between the changes in NE and ANF induced by LBNP. The modeling of physiologic responses to gravitational stress in this experiment revealed a negative correlation between changes in sympathetic tone (as reflected by plasma NE) and ANF levels. Author

A90-36298
A CASE OF G-LOC IN A PROPELLER AIRCRAFT
JAMES A. ROSS (Royal Australian Air Force, Base Medical Flight, Bullbrook, Australia) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 61, June 1990, p. 567, 568. refs
Copyright

The occurrence of +Gz-induced loss of consciousness (G-LOC) is well recognized in high-performance aircraft. A case of G-LOC is described involving a co-pilot on a flying instructor's course in a propeller-driven aircraft, the CT-4. The cause of G-LOC is attributed to a combination of a lack of recent G exposure, not commanding the aircraft, fatigue, and a possibly less-than-optimal straining maneuver. This case reinforces the problems of G-LOC in any aircraft capable of performing aerobatics. Author

A90-36738
ABDOMINAL PRESSURE TRANSMISSION IN HUMANS DURING SLOW BREATHING MANEUVERS
J. MEAD, K. YOSHINO, Y. KIKUCHI, G. M. BARNAS, and S. H. LORING (Harvard University, Boston, MA) Journal of Applied Physiology (ISSN 0161-7567), vol. 68, May 1990, p. 1850-1853. refs
(Contract NIH-HL-19170; NIH-HL-33009)
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Measurements are presented of intraabdominal pressures in human subjects, standing or supine and performing three types of maneuvers: (1) relaxed expirations made through pursed lips from near-total lung capacity to functional residual capacity, (2) quiet breathing, and (3) expulsive maneuvers consisting of modest simultaneous voluntary contractions of the diaphragm and expiratory muscles. Pressures were measured in the stomach and the rectum with air-containing balloon-catheter systems, and in the stomach with a water-filled catheter system. Results showed that the abdominal pressure in humans is essentially hydrostatic during quiet breathing and slow breathing maneuvers. I.S.

A90-37763
PREREQUISITES FOR THE OCCURRENCE AND THE PROGRESS CHARACTERISTICS OF LUMBOSACRAL RADICULITIS IN FLIGHT PERSONNEL WITH JOINT-TROPISM ANOMALIES [PREDPOSYLKI VOZNIKNOVENIIA I OSOBENNOSTI TECHENIIA POIASNICHNO-KRESTTSOVOGO RADIKULITA PRI ANOMALIIAKH SUSTAVNOGO TROPIZMA U LITS LETNOGO SOSTAVA]
IU. K. CHURILOV and R. V. POLETAEV Voenno-Meditsinskii Zhurnal (ISSN 0026-9050), March 1990, p. 61, 62. In Russian.
Copyright

The correlation between preexisting joint-tropism anomalies (i.e. an atypical orientation of spinal-arc joint surfaces) and the existence and the progress of lumbosacral radiculitis was investigated in 200 aircraft personnel hospitalized for various ailments in an air force research hospital. Results of clinical and X-ray examinations showed that complicated joint-tropism anomalies could be closely correlated with the presence and the development of lumbosacral radiculitis. Unilateral radiculitis was observed in patients with complications caused by asymmetric joint-tropism anomaly in which the angle of displacement in one of the arc-process joints was equal to 90 deg. Cases of chronic lumbosacral radiculitis were coincident with such spinal anomalies as 20-deg or greater scoliosis, greater than 175 deg rectification of lumbar lordosis,

and a pathological rotation of a vertebra by more than 25 deg.
I.S.

A90-38500
SIMULATION OF G(X) FORCES USING HORIZONTAL IMPULSE ACCELERATORS
RICHARD P. WHITE and MARTIN G. VOGEL (Systems Research Laboratories, Inc., Dayton, OH) SAFE Journal, vol. 20, Summer 1990, p. 33-39.
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Analysis of G(x) loadings applied to a test subject during the use of a horizontal impulse accelerator (HIA) indicated that the loadings might not realistically simulate an ejection environment. The results of an analysis that was conducted in order to determine the reasons for what seems to be the unrealistic simulation of G(x) acceleration during ejection are presented. Means of generating a more realistic simulation of G(x) acceleration during ejection by use of an HIA system were also investigated. The analysis of this investigation is discussed. R.E.P.

N90-22207*# National Aeronautics and Space Administration, Washington, DC.
AEROSPACE MEDICINE AND BIOLOGY: A CONTINUING BIBLIOGRAPHY WITH INDEXES (SUPPLEMENT 334)
Feb. 1989 50 p
(NASA-SP-7011(334); NAS 1.21:7011(334)) Avail: NTIS HC A03; NTIS standing order as PB90-912300; $11.50 domestic, $23.00 foreign CSCL 06E

This bibliography lists 254 reports, articles and other documents introduced into the NASA Scientific and Technical Information System during February, 1990. Subject coverage includes: aerospace medicine and psychology, life support systems and controlled environments, safety equipment, exobiology and extraterrestrial life, and flight crew behavior and performance.
Author

N90-22208* National Aeronautics and Space Administration, Washington, DC.
AEROSPACE MEDICINE AND BIOLOGY: A CONTINUING BIBLIOGRAPHY WITH INDEXES (SUPPLEMENT 335)
Feb. 1989 58 p
(NASA-SP-7011(335); NAS 1.21:7011(335)) Avail: NTIS HC A04; NTIS standing order as PB89-912300, $11.50 domestic, $23.00 foreign CSCL 06E

This bibliography lists 143 reports, articles and other documents introduced into the NASA Scientific and Technical Information System during March, 1990. Subject coverage includes: aerospace medicine and psychology, life support systems and controlled environments, safety equipment, exobiology and extraterrestrial life, and flight crew behavior and performance. Author

N90-22209 New South Wales Univ., Kensington (Australia). Centre for Biomedical Engineering.
THE EFFECTS OF LINEAR ACCELERATION ON PERCEPTION AND NYSTAGMUS Abstract Only Ph.D. Thesis
MINGJIA DAI 1988 3 p
Avail: Issuing Activity

The role of otolith function was tested in two different experimental paradigms. One involved measurement of the perceived posture of the subject with respect to inertial space. The other paradigm involved the measurement of vestibular induced eye movements. All the experiments were conducted on a fixed-chair centrifuge. Perceptual experiments were conducted in three groups: normal subjects, bilateral vestibular neurectomy patients (BSNPs), and unilateral vestibular neurectomy patients (UVNPs). Two mathematical models of roll-tilt perception in different situations were devised. The perceived horizontal (PH) for normals was accurate; BVNPs showed a reduced response to the roll-tilt stimulus; UVNPs showed a static PH shift (visual bias) directed towards the operated side and a response asymmetry in roll-tilt perception. The visual bias and response asymmetry diminished with time but was still marked for some UVNPs six months after the operation. Independent measurement of ocular torsion showed that the visual bias was associated with ocular torsion. In addition the delay of roll-tilt perception and sensory conflict due to visual input for normal subjects was studied. The effects of off-center rotation on nystagmus were studied for normal subjects. The preliminary findings were: (1) linear acceleration changed the gain and postrotatory time constant of canal evoked lateral VOR nystagmus; (2) the nystagmus component on Z-axis tended to vector the resultant nystagmus onto gravito-inertial horizontal; and (3) a secondary nystagmus appeared after substantially suppressed VOR. A mathematical model was established to describe the reduced LVOR as a result of this interaction. These findings suggest that the otoliths are necessary for roll-tilt perception and for modifying canal evoked nystagmus, and that Ewald's second law is applicable to a single set of otoliths. Author

N90-22210# Midwest Research Inst., Kansas City, MO.
STUDIES OF 60-HZ EXPOSURE EFFECTS ON HUMAN FUNCTION Quarterly Report No. 3, 1 Jan. - 31 Mar. 1990
CHARLES GRAHAM and HARVEY D. COHEN 16 Apr. 1990 5 p
(Contract DE-FG01-89CE-34025; MRI PROJ. RA-111-C) (DE90-009473; DOE/CE-34025/T3) Avail: NTIS HC A01/MF A01

Public concern is expressed about possible health risks arising from exposure to the electric and magnetic fields generated by power distribution systems. This project is addressing this concern through a laboratory research program designed to evaluate the effects of brief exposure to known field conditions on multiple measures of human function. In previous research, it was found that such exposure had statistically significant effects on physiological measures of cardiac and brain activity, and on performance measures of reaction time and performance accuracy. These effects were seen more clearly under intermittent exposure conditions, and at certain levels of electric and magnetic field strength. In the current effort, a series of exploratory studies, followed by a confirmatory experiment, are planned to determine if the above physiological effects differ as a function of exposure to the electric and magnetic fields separately and combined, time of day, and rate of intermittent exposure. Further studies will explore the mechanisms underlying these effects. The information developed will be of value in risk assessment, and in basic research programs aimed at identifying specific factors involved in the interaction of powerline fields with the human system. During the present reporting period, funding was awarded to continue this research effort at a reduced level until December 31, 1990. The goals for this reporting period were to: complete exploratory Study 1; participate in a project review meeting at MRI; and begin additional exploratory studies. DOE

N90-22211 Massachusetts Univ., Amherst.
THE PREDICTABILITY AND EFFICIENCY OF HUMAN WALKING: METABOLIC, MECHANICAL, AND BIOPHYSICAL CONSIDERATIONS Ph.D. Thesis
KENNETH GEORGE HOLT 1989 196 p
Avail: Univ. Microfilms Order No. DA9011741

The major purpose was to compare the stride frequency predicted by a model of human walking based on the resonant frequency for a force-driven harmonic oscillator (FDHO) with that chosen by subjects when asked to walk at a comfortable rate on a treadmill (Preferred Stride Frequency - PSF). A second purpose was to determine if differences existed between the metabolic and mechanical costs and efficiency of the two (FDHO and PSF), and frequencies above and below the preferred. Eight adult subjects were tested on three days. On the first day preferred walking frequency was obtained, and from anthropometric measures of a segment lengths a predicted frequency was obtained. On the second and third days subjects were required to walk on a treadmill to a metronome at the preferred and predicted frequencies and at frequencies +/- 5, +/- 10, and +/- 15 strides per minute around the PSF obtained on the first day. Oxygen consumption was used to represent the metabolic cost at steady state. From the kinematic data mechanical work done by each segment and the head, arms and trunk were calculated. To produce an efficiency

calculation the metabolic data were converted to a work equivalent and divided into the mechanical work. Results indicated that the preferred stride frequency was extremely consistent across days as were the metabolic and mechanical costs associated with it. The preferred and predicted stride frequencies were not significantly different indicating that the FDHO is a good predictive model of walking frequency. The metabolic and mechanical costs and efficiency were also not different between the two, suggesting that the resonant frequency of the limbs as biological oscillators produces minimal metabolic cost. This is supported by the finding that the curves resulted in a strongly quadratic trend with minimum for metabolic work and a maximum for efficiency at the PSF.
Dissert. Abstr.

N90-22885# Naval Submarine Medical Center, Groton, CT.
THE KINETICS OF DARK ADAPTATION IN HYPOXIC SUBJECTS Interim Report
DOUGLAS R. KNIGHT, KENDALL BRYANT, CURTIS W. OLLAYOS, and S. M. LURIA 26 Dec. 1989 12 p
(AD-A218641; NSMRL-1151) Avail: NTIS HC A03/MF A01 CSCL 06/10

A double blind study was made to determine the effect of hypoxia on the rate of dark adaptation. The visual thresholds of 10 subjects were measured as they breathed either 21 or 12 percent O2 for 10 minutes in daylight followed by 50 minutes in the dark. The subjects were exposed to the two gases in counterbalanced order on separate days. Reducing the oxygen level to 12 percent delayed the course of dark adaptation without changing the final scotopic threshold. GRA

N90-22886# Army Research Inst. of Environmental Medicine, Natick, MA. Exercise Physiology Div.
PHYSIOLOGICAL AND PERCEPTUAL RESPONSES TO PROLONGED TREADMILL LOAD CARRIAGE Final Report, May 1988 - Nov. 1989
JOHN F. PATTON, JOHN KASZUBA, ROBERT P. MELLO, and KATY L. REYNOLDS 22 Jan. 1990 46 p
(Contract DA PROJ. 3E1-62787-A-879)
(AD-A218910; USARIEM-TP-11-90) Avail: NTIS HC A03/MF A01 CSCL 15/5

The physiological and perceptual responses were determined: prolonged, level treadmill walking at speeds of 3.96, 4.86, and 5.76 kilometers per hour, unloaded and with external loads (load carriage equipment + backpack) of 31.5 and 49.4 kilograms; the ability of subjects to perform high intensity, anaerobic exercise (Wingate test) immediately after load carriage; and the energy cost and perceptual responses of carrying the standard external frame pack to that of the new internal frame system are compared. Fifteen male subjects performed nine load carriage trials with an external frame pack All-Purpose Lightweight Individual Carrying Equipment (ALICE) and two trials with an internal frame pack Integrated Individual Fighting System (IIFS) in random order over a 7 week period. At the end of each trial blood samples were taken for the measurement of lactate and subjects performed either an upper or lower body anaerobic power test. Oxygen Uptake (VO2), Minute Ventilation (VE), heart rate, and differentiated ratings of perceived exertion Ratings of Perceived Exertion (RPE) were determined at the end of the first 10 min and every 20 min thereafter for the duration of the trial. A 10 min rest period was allowed each hour. No changes occurred in VO2 over time in the unloaded condition at any speed. GRA

N90-22887# Johns Hopkins Univ., Laurel, MD. Applied Physics Lab.
A STUDY OF LOW LEVEL LASER RETINAL DAMAGE Final Progress Report, 1 Jan. 1978 - 31 Dec. 1989
B. F. HOCHHEIMER 1 Mar. 1990 29 p Sponsored by Army Medical Research and Development Command
(AD-A218919; JHU/APL/STR-90-01) Avail: NTIS HC A03/MF A01 CSCL 06/10

The general objective of this program is to document changes in the retina due to very low level laser irradiation. We had two primary aims. One was to develop and improve methods that can be used, in vivo, to objectively determine changes that occur in the retina from laser irradiation. The second was to determine the mechanisms that cause these retinal changes. GRA

N90-22888# Tel-Aviv Univ. (Israel). Sackler School of Medicine.
LASER RETINAL EFFECTS: ELECTROPHYSIOLOGICAL DETERMINATION IN VISUAL CORTICAL CELLS OF MONKEYS AND CATS Final Report, 1 Apr. 1987 - 31 Aug. 1988
URI YINON 25 Jun. 1989 28 p
(Contract DAMD17-87-C-7095)
(AD-A218937) Avail: NTIS HC A03/MF A01 CSCL 09/3

The effect of laser induced retinal lesions on the visual cortex of mammalian animal model was examined. The effect of threshold energy levels of laser radiation was studied acutely and chronically in cats using the visual evoked response (VER). In addition, electroretinographic (ERG) studies were added to the program to obtain direct physiological evidence on the condition of the retinal area affected by the laser radiation. This study was coordinated with LAIR personnel with regard to the type of laser technology to be used and its availability in the Goldschleger Eye Institute. A Neodymium YAG laser device (Nd:YAG) was used; energy levels applied were 0.1 to 1.0 millijoules (mJ) and 1 to 100 pulses were given to the various cats. The results showed that the ERG is affected; the lased eye was less excitable than the normal eye in most of the cats studied, whatever laser energy has been applied. The findings of the visual evoked response (VER) showed that in most cats the lased eye was inferior to the normal eye. An effect was found even in cases where energy level was as small as 0.1 mJ and whether the animals were exposed to the laser radiation 1 day or 6 weeks prior to the recording session. GRA

N90-22889# City Univ. of New York Research Foundation, NY.
EXPOSURE OF HUMAN CELLS TO ELECTROMAGNETIC FIELDS Final Report, 1 Jan. 1988 - 31 Dec. 1989
ANN S. HENDERSON 27 Feb. 1990 23 p
(Contract N00014-88-K-0105)
(AD-A219377) Avail: NTIS HC A03/MF A01 CSCL 06/1

This study addressed the following basic question: How does extremely low-level non-ionizing radiation affect human cells, and if there are cellular responses that can be directly related to signal parameters such as frequency, amplitude and time of exposure. The focus of these studies was to identify transcriptional changes in human cultured cells, HL60, which result from exposure of these cells to defined extremely low frequency electromagnetic fields (elf EMFS). Our experiments show a pronounced measurable response observed as transcript increase, with associated changes in protein synthesis. The major findings relative to transcriptional changes are fourfold: (1) transcript changes in human cells correlate with previous findings of transcriptional and translational changes in Drosophila salivary gland cells; (2) the frequency of the signal in the range from 15 to 150 Hz results in a window at 45 Hz, (3) changing the amplitude (with resulting changes in E- and B-fields) in log increments from 0.5 to 500 uV at 60 Hz gives both amplitude and time-dependent windows, and (4) genes not usually expressed in HL-60 are unaffected by exposure to elf EMFs. Changes in the overall protein synthetic pattern have also been observed following exposure of HL60 cells to 60 Hz signals. GRA

N90-22957*# Massachusetts Inst. of Tech., Cambridge. Man Vehicle Lab.
SENSORY CONFLICT IN MOTION SICKNESS: AN OBSERVER THEORY APPROACH
CHARLES M. OMAN *In* NASA, Ames Research Center, Spatial Displays and Spatial Instruments 15 p Jul. 1989
(Contract NAG9-244)
Avail: NTIS HC A99/MF A04 CSCL 06/19

Motion sickness is the general term describing a group of common nausea syndromes originally attributed to motion-induced cerebral ischemia, stimulation of abdominal organ afferent, or overstimulation of the vestibular organs of the inner ear. Sea-, car-, and airsicknesses are the most commonly experienced examples. However, the discovery of other variants such as

Cinerama-, flight simulator-, spectacle-, and space sickness in which the physical motion of the head and body is normal or absent has led to a succession of sensory conflict theories which offer a more comprehensive etiologic perspective. Implicit in the conflict theory is the hypothesis that neutral and/or humoral signals originate in regions of the brain subversing spatial orientation, and that these signals somehow traverse to other centers mediating sickness symptoms. Unfortunately, the present understanding of the neurophysiological basis of motion sickness is far from complete. No sensory conflict neuron or process has yet been physiologically identified. To what extent can the existing theory be reconciled with current knowledge of the physiology and pharmacology of nausea and vomiting. The stimuli which causes sickness, synthesizes a contemporary Observer Theory view of the Sensory Conflict hypothesis are reviewed, and a revised model for the dynamic coupling between the putative conflict signals and nausea magnitude estimates is presented. The use of quantitative models for sensory conflict offers a possible new approach to improving the design of visual and motion systems for flight simulators and other virtual environment display systems. Author

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BEHAVIORAL SCIENCES

Includes psychological factors; individual and group behavior; crew training and evaluation; and psychiatric research.

A90-35880
SOME TEMPERAMENTAL DETERMINANTS OF THE EFFICIENCY OF PILOT TRAINING [NIEKTORE TEMPERAMENTALNE DETERMINANTY EFEKTYWNOSCI UCZENIA SIE PILOTAZU]
ZDZISLAW KOBOS and JAN TERELAK (Wojskowy Instytut Medycyny Lotniczej, Warsaw, Poland) Postepy Astronautyki (ISSN 0373-5982), vol. 22, no. 3-4, 1989, p. 19-25. In Polish. refs
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The dependence of learning efficiency on several temperamental features is examined on the basis of previous literature and original experiments. A correlation is found between reactivity and an external criterion of pilot training (flying time before first solo flight). R.B.

A90-35881
THE CHANGE OF THE SEMANTIC SPACE OF HUMAN EMOTIONAL STATES UNDER TIME-PRESSURE CONDITIONS [ZMIANA PRZESTRZENI SEMANTYCZNEJ STANOW EMOCJONALNYCH CZLOWIEKA W WARUNKACH DEFICYTU CZASU]
NINA N. DANILOVA, ALEKSANDR V. VARTANOV (Moskovskii Gosudarstvennyi Universitet, Moscow, USSR), and WLODZIMIERZ ONISZCZENKO (Warszawa, Uniwersytet, Warsaw, Poland) Postepy Astronautyki (ISSN 0373-5982), vol. 22, no. 3-4, 1989, p. 27-40. In Polish. refs
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The effect of mental pressure on the semantic space of emotional states is studied by applying multidimensional scaling (according to Torgerson's algorithm) to the matrix of subjective differences between semantic stimuli. The semantic stimuli were words describing emotional states. The differences between these stimuli were tested during two problem solving sessions. In the second session the time allowed for solving the problem was reduced to produce mental pressure. It is found that the increase of mental pressure causes a change in the semantic space, expressed in the appearance of additional axes (defined on the basis of response time and the subjective sensation of the subjects). Also, the increased mental pressure led to a change from scales with general characteristics to scales with more specific characteristics for positive and negative emotions. R.B.

A90-36286
MEDICAL OR ADMINISTRATIVE? PERSONALITY DISORDERS AND MALADAPTIVE PERSONALITY TRAITS IN AEROSPACE MEDICAL PRACTICE
D. R. JONES and J. C. PATTERSON (Aeropsych Associates, San Antonio, TX) Aviation Medicine Quarterly (ISSN 0951-3949), vol. 2, 1989, p. 83-91.
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Personality traits are pervasive patterns of feeling, thinking and behaving which may be seen in a variety of life situations. Personality disorders may represent the same patterns, but are so unvarying and inflexible that they interface with normal social or occupational functioning: they may or may not cause distress to the individual. Aeromedical standards generally define such disorders as disqualifying for entry into flying training in the United States, but once trained, fliers in whom these diagnoses are made may fall under administrative sanctions. Treatment may be difficult in the best of circumstances, because the manifestations are such a basic part of the flier's personality, and impossible if the individual sees no reason to change. Cooperation between mental health consultants who understand aviation and flight surgeons who understand personality disorders offers the best opportunity for fair and intelligent decisions. Author

A90-36299* Texas Univ., Austin.
PRELIMINARY RESULTS FROM THE EVALUATION OF COCKPIT RESOURCE MANAGEMENT TRAINING - PERFORMANCE RATINGS OF FLIGHTCREWS
ROBERT L. HELMREICH, JOHN A. WILHELM, STEVEN E. GREGORICH (Texas, University, Austin), and THOMAS R. CHIDESTER (NASA, Ames Research Center, Moffett Field, CA) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 61, June 1990, p. 576-579. refs
(Contract NCC2-286)
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The first data from the NASA/University of Texas Crew Performance project on the behavior of flightcrews with and without formal training in Cockpit Resource Management (CRM) is reported. Expert observers made detailed ratings of 15 components of crew behavior in both line operations and in full mission simulations. The results indicate that such training in crew coordination concepts increases the percentage of crews rated as above average in performance and decreases the percentage rated as below average. The data also show high and unexpected degrees of variations in rated performance among crews flying different aircraft within the same organization. It was also found that the specific behaviors that triggered observer ratings of above or below average performance differed markedly between organizations. Characteristics of experts' ratings and future research needs are also discussed. Author

N90-22212*# Essex Corp., Orlando, FL.
ISSUES IN DEVELOPMENT, EVALUATION, AND USE OF THE NASA PREFLIGHT ADAPTATION TRAINER (PAT)
NORMAN E. LANE and ROBERT S. KENNEDY Jul. 1988 50 p Prepared for Miami Univ., Oxford, OH
(Contract NAS9-17413)
(NASA-CR-185608; NAS 1.26:185608; EOTR-88-9) Avail: NTIS HC A03/MF A01 CSCL 05I

The Preflight Adaptation Trainer (PAT) is intended to reduce or alleviate space adaptation syndrome by providing opportunities for portions of that adaptation to occur under normal gravity conditions prior to space flight. Since the adaptation aspects of the PAT objectives involve modification not only of the behavior of the trainee, but also of sensiomotor skills which underly the behavioral generation, the defining of training objectives of the PAT utilizes four mechanisms: familiarization, demonstration, training and adaptation. These mechanisms serve as structural reference points for evaluation, drive the content and organization of the training procedures, and help to define the roles of the PAT instructors and operators. It was determined that three psychomotor properties are most critical for PAT evaluation: reliability; sensitivity; and relevance. It is cause for concern that

the number of measures available to examine PAT effects exceed those that can be properly studied with the available sample sizes; special attention will be required in selection of the candidate measure set. The issues in PAT use and application within a training system context are addressed through linking the three training related mechanisms of familiarization, demonstration and training to the fourth mechanism, adaptation. B.H.A.

N90-22213*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
THE PSYCHOLOGY OF COMPUTER DISPLAYS IN THE MODERN MISSION CONTROL CENTER
MICHAEL M. GRANAAS (South Dakota Univ., Vermillion.) and DONALD C. RHEA Oct. 1988 6 p Previously announced in IAA as A88-37951
(NASA-TM-100451; H-1507; NAS 1.15:100451) Avail: NTIS HC A02/MF A01 CSCL 05I

Work at NASA's Western Aeronautical Test Range (WATR) has demonstrated the need for increased consideration of psychological factors in the design of computer displays for the WATR mission control center. These factors include color perception, memory load, and cognitive processing abilities. A review of relevant work in the human factors psychology area is provided to demonstrate the need for this awareness. The information provided should be relevant in control room settings where computerized displays are being used. Author

N90-22214# Idaho National Engineering Lab., Idaho Falls.
INSIGHTS INTO COMPLEX HUMAN PERFORMANCE
HEIDI ANN HAHN and HAROLD S. BLACKMAN 1990 7 p Presented at the American Nuclear Society Topical Meeting on Human Factors, Snowbird, 10-14 Jun. 1990
(Contract DE-AC07-76ID-01570)
(DE90-006957; EGG-M-89492; CONF-9006115-1) Avail: NTIS HC A02/MF A01

A research program was implemented to investigate the applicability of verbal protocol analysis to identify operator strategies for task performance and to assess how well strategies further define the performance of humans in complex systems. This research was conducted in two environments: control rooms of nuclear power plants and cockpits of civilian aircraft. Results are presented regarding the specific technique of applying verbal protocol methods as well as the importance of strategies in human performance in complex systems. DOE

N90-22890 Auburn Univ., AL.
RELATIONSHIP BETWEEN FLEXIBILITY OF CLOSURE AND SUCCESS IN PILOT NIGHT VISION SENSOR SYSTEM TRAINING Ph.D. Thesis
WILLIAM MITCHELL KNARR, JR. 1989 115 p
Avail: Univ. Microfilms Order No. DA8925630

The purpose was two-fold: specifically, to address a small part of evolving aviation technology - the pilot night vision sensor (PNVS) system - and its relationship to flexibility of closure (Cf); and generally, to determine what attributes/experiences are important to training aviators in the AH-64, Attack Helicopter. The subjects included 170 Army aviators entering the AH-64 Qualification Course. The course consisted of three flight training phases which provided the dependent variables for the study: aircraft transition (TRANS), PNVS, and gunnery (GUN). In order to analyze the relationships among the variables, several statistical designs were employed: ANOVA, regression, MANOVA, and LISREL. ANOVA indicated that Cf was a significant contributer (.05 level) to PNVS training, however, the proportion of variance accounted for was very small (.035). Other contributers to PNVS success included aviator's age, total flight time (FT), and instructor pilot (IP) qualifications. Those four variables (including Cf) accounted for almost 25 percent of the variance in PNVS scores. The regression analysis essentially reiterated the significance of the contributors highlighted by the ANOVA, but formatted those variables into a predictive algorithm to support selection and training. MANOVA indicated that flexibility of closure was a significant contributor, at the .05 level, to the AH-64 flight skills of transition, PNVS, and gunnery training. Other contributors, at the .05 level, to AH-64 flight skills included age and instructor pilot qualifications. LISREL capitalized on results of the MANOVA by incorporating its significant sources into causal models. Although achieving only limited success in validating the models, LISREL did highlight several relationships. The most intriguing were the interactions of age with other variables; however, none of the nodels adequately defined those relationships. Dissert. Abstr.

N90-22891# Royal Aerospace Establishment, Farnborough (England).
TRACKING IN UNCERTAIN ENVIRONMENTS
D. J. SALMOND 4 Sep. 1989 288 p
(RAE-TM-AW-121; BR112043; ETN-90-96443) Copyright Avail: NTIS HC A13/MF A02

The problem of tracking a target when the origin of the sensor measurements is uncertain is addressed. The full Bayesian solution to this type of problem gives rise to Gaussian mixture distributions. To implement such a tracking filter, the growth of components must be controlled by approximating the mixture distribution. Two algorithms are developed for approximating Gaussian mixture distributions. The performance of the algorithms is assessed by simulation for the problem of tracking a single target in the presence of uniformly distributed false measurements. The tracking example is extended to show how the Bayesian approach may be applied to more complex uncertain tracking problems, including that of fusing data from several independent sources. ESA

N90-22892# University of Northern Arizona, Flagstaff. Dept. of Health, Physical Education, and Recreation.
HUMAN COGNITIVE AND MOTOR PERFORMANCE MEASURES UNDER TYPICAL COOL WHITE FLUORESCENT ILLUMINATION VS RELATIVELY HIGH COOL WHITE ILLUMINANCE/IRRADIANCE LIGHTING Final Technical Report, 1 Dec. 1988 - 30 Dec. 1989
PATRICK ROY HANNON 31 Jan. 1990 9 p
(Contract AF-AFOSR-0164-89; AF PROJ. 3842)
(AD-A218445; AFOSR-90-0260TR) Avail: NTIS HC A02/MF A01 CSCL 05/8

Possible practice effects and diurnal fluctuations in human motor and cognitive performances under baseline illumination conditions (400 lux) were investigated. Six subjects were tested individually in order to partial out peer social interaction effects. The testing took place over a wide range of testing time epochs. Specifically, subjects were tested from 0800 to 1200 hours, 1400 to 1800 hours and 2000 to 0000 hours in a counter-balanced repeated measures design. GRA

N90-22893# Air Force Human Resources Lab., Williams AFB, AZ.
VISUAL BEHAVIOR IN THE F-15 SIMULATOR FOR AIR-TO-AIR COMBAT Interim Technical Report, Apr. 1988 - Nov. 1989
KEVIN W. DIXON, GRETCHEN M. KRUEGER, VICTORIA A. ROJAS, and ELIZABETH L. MARTIN Feb. 1990 21 p Prepared in cooperation with Air Force Human Resources Lab., Brooks AFB, TX Submitted for publication
(AD-A218648; AFHRL-TP-89-75) Avail: NTIS HC A03/MF A01 CSCL 01/2

This research effort was conducted to determine visual strategies of F-15 pilots during air-to-air combat through the use of an eye tracking system. This type of work helps simulator designers define field-of-view requirements for simulators. While an increase in field of view size produces a more realistic scenario for the pilots, it results in a decrease in brightness and resolution levels, and increases the cost. Six F-15 pilots flew offensive, defensive, neutral, and mutual support set-ups in the Simulator for Air-to-Air Combat (SAAC) at three different altitudes. Analyses show that the visual strategies and window usage vary greatly among the four set-ups. Before final conclusions are made concerning field-of-view requirements during air-to-air tasks, this experiment should be partially replicated using electronic masking. GRA

N90-22894# Carnegie-Mellon Univ., Pittsburgh, PA. Artificial Intelligence and Psychology Project.
EFFICIENT SPECIALIZATION OF RELATIONAL CONCEPTS Technical Report, 15 Sep. 1986 - 14 Sep. 1991
KURT VANLEHN 10 Mar. 1989 14 p Prepared in cooperation with Pittsburgh Univ., PA
(Contract N00014-86-K-0678)
(AD-A218889; AIP-71) Avail: NTIS HC A03/MF A01 CSCL 12/9

An algorithm is presented for a common induction problem, the specialization of overly general concepts. A concept is too general when it matches a negative example. The particular case addressed assumes that concepts are represented as conjunctions of positive literals, that specialization is performed by conjoining literals to the overly general concept, and that the resulting specializations are to be as general as possible. Although the problem is NP-hard, there exists an algorithm, based on manipulation of bit vectors, that has provided good performance in practice. GRA

N90-22895# Syracuse Univ., NY.
INTELLIGENT SIGNAL PROCESSING TECHNIQUES FOR MULTI-SENSOR SURVEILLANCE SYSTEMS Final Report, Apr. 1988 - Apr. 1989
HARVEY RHODY, DAVID SHER, and JAMES MODESTINO (Rensselaer Polytechnic Inst., Troy, NY.) Dec. 1989 58 p
(Contract F30602-88-D-0027; AF PROJ. 4506)
(AD-A218890; RADC-TR-89-292) Avail: NTIS HC A04/MF A01 CSCL 17/9

The purpose of this project is to develop an analytical frame work to represent the modern multi-target, multi-sensor surveillance environment and to investigate the adaptation of intelligent signal processing algorithms to that application. The outcome is to be a road map for the development of the system elements and a plan for integrating them into a functional body. GRA

N90-22896# Carnegie-Mellon Univ., Pittsburgh, PA. Artificial Intelligence and Psychology Project.
A PRELIMINARY ANALYSIS OF THE SOAR ARCHITECTURE AS A BASIS FOR GENERAL INTELLIGENCE Technical Report, 15 Sep. 1986 - 14 Sep. 1991
PAUL S. ROSENBLOOM, JOHN E. LAIRD, ALLEN NEWELL, and ROBERT MCCARL (Michigan Univ., Ann Arbor.) 8 May 1989 49 p Prepared in cooperation with Pittsburgh Univ., PA Submitted for publication
(Contract N00014-86-K-0678; N00014-86-C-0133)
(AD-A218913; AIP-64) Avail: NTIS HC A03/MF A01 CSCL 05/8

The central scientific problem of artificial intelligence is to understand what constitutes intelligent action and what processing organizations are capable of such action. Human intelligence shows, to first observation, what can only be termed general intelligence. The SOAR project has been attempting to understand the functionality required to support general intelligence. A step is taken towards providing an analysis of the SOAR architecture as a basis for general intelligence. Included are discussions of the basic assumptions underlying the development of SOAR, a description of SOAR cast in terms of the theoretical idea of multiple levels of description, an example of SOAR performing multi-column subtraction, and three analyses of SOAR: its natural tasks, the sources of its power, and its scope and limits. GRA

N90-22897*# Carnegie-Mellon Univ., Pittsburgh, PA. Dept. of Psychology.
TOWARDS THE KNOWLEDGE LEVEL IN SOAR: THE ROLE OF THE ARCHITECTURE IN THE USE OF KNOWLEDGE Technical Report, 15 Sep. 1986 - 14 Sep. 1991
PAUL S. ROSENBLOOM, ALLEN NEWELL, and JOHN E. LAIRD (Michigan Univ., Ann Arbor.) 7 Aug. 1989 77 p Prepared in cooperation with Pittsburgh Univ., PA Submitted for publication
(Contract NCC2-538; NCC2-517; N00039-86-C-0033; F33615-87-C-1499; N00014-86-K-0678; N00014-88-K-0554; N00014-88-K-0086; ARPA ORDER 4976)
(NASA-CR-186615; NAS 1.26:186615; AD-A218926; AIP-65)
Avail: NTIS HC A05/MF A01 CSCL 05/9

SOAR has been described as an architecture for a system that is to be capable of general intelligence. One way to specify what this might mean is to define general intelligence as the ability to approximate an ideal knowledge level system across a sufficiently broad set of goals and knowledge. In this chapter, this definition is used as the basis for evaluating the degree to which SOAR achieves general intelligence. A complete evaluation is beyond the scope of this chapter, however, it is focused on how the SOAR architecture supports and constrains the representation, storage, retrieval, use and acquisition of three pervasive forms of knowledge: procedural, episodic, and declarative knowledge. The analysis reveals that SOAR adequately supports procedural knowledge - to some extent it was designed for this - but that there are still significant questions about episodic and declarative knowledge. These questions arise primarily because of consequences of the principle source of constraint in SOAR, the fact that all learning occurs via chunking. New results are also presented on the acquisition of declarative knowledge. GRA

N90-22898# Carnegie-Mellon Univ., Pittsburgh, PA. Dept. of Psychology.
STOCHASTIC INTERACTIVE ACTIVATION AND THE EFFECT OF CONTEXT ON PERCEPTION Technical Report, 15 Sep. 1986 - 14 Sep. 1991
JAMES L. MCCLELLAND 14 Jul. 1989 45 p Prepared in cooperation with Pittsburgh Univ., PA
(Contract N00014-86-K-0678; N00014-86-G-0146; N00014-86-K-0349; NSF BNS-86-09729; NSF BNS-88-12048)
(AD-A218929; AIP-68) Avail: NTIS HC A03/MF A01 CSCL 05/8

Classically, context exerts a biasing effect on perceptual identification responses given without time pressure. Such effects are well described by classical models formulated in terms of signal detection theory or Luce's theory of choice. The classical models do not describe the actual time course of processing, however; they simply produce characterizations of asymptotic response probabilities. Mathematical analysis and computer simulation methods are used to show that interactive activation models exhibit the classical effect of context when they are allowed to run to equilibrium, if there is variability in the input to the network or if there is intrinsic randomness in the processing activity of the network itself. The findings suggest that interactive activation models should not be viewed as alternatives to classical accounts, but as hypotheses about the dynamics of information processing that lead to the asymptotic behavior that the classical models describe. GRA

N90-22899# Carnegie-Mellon Univ., Pittsburgh, PA. Artificial Intelligence and Psychology Project.
COGNITIVE EFFICIENCY CONSIDERATIONS FOR GOOD GRAPHIC DESIGN Technical Report, 15 Sep. 1986 - 14 Sep. 1991
STEPHEN CASNER (Pittsburgh Univ., PA.) and JILL H. LARKIN 1989 12 p
(Contract N00014-86-K-0678; N00014-88-K-0086)
(AD-A218976; AIP-81) Avail: NTIS HC A03/MF A01 CSCL 05/8

Larkin and Simon's (1987) analysis of how graphical representations support task performance is applied to designing graphical displays that streamline information-processing tasks. Theoretically this streamlining is done by designing external data structures that: (1) allow users to substitute less effortful visual operators for more effortful logical operators, and (2) reduce search for needed information. A design program called BOZ is used to produce four alternative displays of airline schedule information to support an airline reservation task. Several procedures that use a set of visual operators to perform the task using the different graphics are postulated. The number of times each operator is executed provides one measure of task difficulty (for a procedure and graphic). A second measure is the difficulty of executing each

operator. Seven subjects performed the airline reservation task using each of the four graphics. Response times for the different graphics differ by a factor of two, and this difference is statistically highly significant. Detailed data analyses suggest that these differences arise through substitution of visual operators for logical ones and through the use of visual cues that help reduce search. The analyses provide quantitative estimates of the time saved through operator substitutions. GRA

N90-22900# Carnegie-Mellon Univ., Pittsburgh, PA. Artificial Intelligence and Psychology Project.
DESIGNING GOOD EXPERIMENTS TO TEST BAD HYPOTHESES Technical Report, 15 Sep. 1986 - 14 Sep. 1991
DAVID KLAHR, KEVIN DUNBAR (McGill Univ., Montreal, Quebec), and ANNE L. FAY 15 Aug. 1989 41 p Prepared in cooperation with Pittsburgh Univ., PA Submitted for publication
(Contract N00014-86-K-0349; N00014-86-K-0678)
(AD-A218977; AIP-83) Avail: NTIS HC A03/MF A01 CSCL 05/8

What does it take to design a good experiment. Given an hypothesis to be evaluated (either in isolation or in competition with alternatives) what formal rules, heuristics, and pragmatic constraints combine to yield a potentially informative experiment. How do subjects' expectations about the plausibility of an hypothesis effect the kind of experiments that they design, their ability to accurately observe and encode experimental outcomes and their responses to information that is consistent or inconsistent with the hypothesis. These questions are addressed by creating a simulated discovery context and examining how subjects go about designing experiments to test hypotheses that are always, at the outset, incorrect. Thirty-six adult subjects were trained on the basic functions of a programmable robot. Then they were presented with a new function key (a repeat key) and asked to find out how it worked. The results show that subjects are remarkably adept at designing and interpreting experiments in a novel domain. When subjects are given a plausible hypothesis, they tend to design an experiment that demonstrates the effect that is to be expected. When given inplausible hypothesis, they write programs that are good discriminators. GRA

N90-22901# Carnegie-Mellon Univ., Pittsburgh, PA. Artificial Intelligence and Psychology Project.
WHAT MAKES SOME PROBLEMS HARD: EXPLORATIONS IN THE PROBLEM SPACE OF DIFFICULTY Technical Report, 15 Sep. 1986 - 14 Sep. 1991
KENNETH KOTOVSKY and HERBERT A. SIMON 14 Jul. 1989 54 p Prepared in cooperation with Pittsburgh Univ., PA
(Contract N00014-86-K-0678; N00014-85-K-0696)
(AD-A219002; AIP-97) Avail: NTIS HC A04/MF A01 CSCL 05/8

Two sources are identified, one larger, one smaller, of the great difficulty encountered by subjects solving the Chinese Ring Puzzle. Almost none of the subjects were able to solve the puzzle within two hours unless they were given a demonstration of how to move, and even with that help only half of the subjects obtained solutions. Discovering how to make moves, rather than other features of the problem search space, was the source of its inordinate difficulty. Evidence for this comes from isomorphs that were designed to digitize the moves, which in the original version have analog qualities. These digital isomorphs were solvable by almost all subjects, with average solution times of 10 to 25 minutes, depending on isomorph type. The digitized problems still required considerable effort for their solution. The difficulty of these problems in digital form is particularly surprising, given that the problem search space is linear: there is no branching. Hence, size of search space (exponential explosion) was not the source of difficulty here. The linearity of the search space did not prevent the subjects from making a large number of moves in reaching a solution. The average number of moves ranged from 150 to 450 for different isomorphs. In addition, the subjects' move behavior was often dichotomous, consisting of a very large number of non-progressive, often error-prone moves, followed by a very rapid, often error-free movement to the goal. GRA

N90-22902# Carnegie-Mellon Univ., Pittsburgh, PA. Artificial Intelligence and Psychology Project.
DISCOVERING PROBLEM SOLVING STRATEGIES: WHAT HUMANS DO AND MACHINES DON'T (YET) Technical Report, 15 Sep. 1986 - 14 Sep. 1991
KURT VANLEHN 21 Jul. 1989 18 p Presented at the 6th International Workshop on Machine Learning Prepared in cooperation with Pittsburgh Univ., PA
(Contract N00014-86-K-0678)
(AD-A219008; AIP-74) Avail: NTIS HC A03/MF A01 CSCL 12/9

People can discover new problem solving strategies on their own, without help from a teacher, text or other source. Many machine learning programs exist that discover strategies under similar conditions. Are there a sufficient set of computational models for understanding human strategy discoveries. A detailed analysis is presented of a human problem solving protocol that uncovers 10 cases of strategies being discovered. It is argued that most cases are adequately modeled by existing machine learning techniques, and several are not, which suggests some interesting research problems for machine learning. After a brief discussion of the methods of the analysis and the protocol, the protocol analysis is presented in enough detail to allow evaluation of the accuracy of the empirical claims. A subsequent section that classifies the cases of strategy discovery found in the data are classified according to standard machine learning concepts. The last section indicates which types of learning exhibited by the subject have not yet been exhibited by machine learning systems. This leads to the view that strategy acquisition by a component human is like scientific theory formation, with the attendant tasks hypothesis generation. Although current machine learning models of strategy acquisition seem pale by comparison, there seems to be nothing stopping us from building machine learning systems with human-level capabilities for strategy discovery. GRA

N90-22903# Carnegie-Mellon Univ., Pittsburgh, PA. Artificial Intelligence and Psychology Project.
RULES AND MAPS IN CONNECTIONIST SYMBOL PROCESSING Technical Report, 15 Sep. 1986 - 14 Sep. 1991
DAVID S. TOURETZKY Jun. 1989 20 p Presented at the 11th Annual Conference of the Cognitive Science Society, Ann Arbor, MI, Aug. 1989 Prepared in cooperation with Pittsburgh Univ., PA Submitted for publication
(Contract N00014-86-K-0678; NSF EET-87-16324)
(AD-A219028; AIP-79) Avail: NTIS HC A03/MF A01 CSCL 25/4

Two papers to be presented at the Eleventh Annual Conference of the Cognitive Science Society are presented. The first describes a simulation of chunking in a connectionist network. The network applies context sensitive rewrite rules to strings of symbols as they flow through its input buffer. Chunking is implemented as a form of self-supervised learning using back-propagation. Over time, the network improves its efficiency by replacing simple rule sequences with more complex chunks. The second paper describes the first implementation of Lakoff's new theory of cognitive phology. Lakoff's approach is based on a multilevel representation of utterances to which all rules apply in parallel. Cognitive phonology is free of the rule ordering constraints that make classical generative theories computationally awkward. The connectionist implementation utilizes a novel many maps architecture that may explain certain constraints on phonological rules not adequately accounted for by more abstract models. GRA

N90-22904# Carnegie-Mellon Univ., Pittsburgh, PA. Artificial Intelligence and Psychology Project.
CONNECTIONISM AND COMPOSITIONAL SEMANTICS Technical Report, 15 Sep. 1986 - 14 Sep. 1991
DAVID S. TOURETZKY May 1989 18 p Prepared in cooperation with Pittsburgh Univ., PA Submitted for publication
(Contract N00014-86-K-0678; NSF EET-87-16324)
(AD-A219029; AIP-78) Avail: NTIS HC A03/MF A01 CSCL 12/9

Quite a few interesting experiments have been done applying neural networks to natural language tasks. Without detracting from the value of these early investigations, it is argued that current neural network architectures are too weak to solve anything but toy language problems. Their downfall is the need for dynamic inference, in which several pieces of information not previously seen together are dynamically combined to derive the meaning of a novel input. A hierarchy of classes of connectionist models is defined, from categorizers and associative memories to pattern transformers are dynamic inferencers. Some well-known connectionist models that deal with natural language are shown to be either categorizers or pattern transformers. The second half examines in detail a particular natural language problem: prepositional phase attachment. Attaching a PP to an NP changes its meaning, thereby influencing other attachments. So PP attachment requires compositional semantics; and compositionality in non-toy domains requires dynamic inference. Mere pattern transformers cannot learn the PP attachment task without an exponential training set. Connectionist-style computation still has many valuable ideas to offer, so this is not an indictment of connectionisms's potential. GRA

N90-22905# Carnegie-Mellon Univ., Pittsburgh, PA. Artificial Intelligence and Psychology Project.

LEARNING EVENTS IN THE ACQUISITION OF THREE SKILLS Technical Report, 15 Sep. 1986 - 14 Sep. 1991

KURT VANLEHN 21 Jul. 1989 11 p Prepared in cooperation with Pittsburgh Univ., PA

(Contract N00014-86-K-0678)

(AD-A219038; AIP-73) Avail: NTIS HC A03/MF A01 CSCL 12/9

Current theories of cognitive skill acquisition, new problem solving rules are constructed by proceduralization, production compounding, chunking, syntactic generalization, and a variety of other mechanisms. All these mechanisms are assumed to run rather quickly, so a rule's acquisition should be a matter of a few seconds at most. Such learning events might be visible in protocol data. A method for locating the initial use of a rule in protocol data is discussed. The method is applied to protocols of subjects learning three tasks: a river crossing puzzle, the Tower of Hanoi, and a topic in college physics. Rules were discovered at the rate of about one every half hour. Most rules required several learning events before they were used consistently, which is not consistent with the one-trial learning predicted by explanation-based learning methods. Some observed patterns of learning events were consistent with a learning mechanism based on syntactic generalization rules. Although most rules seem to have been acquired at impasses (occasions when the subject does not know what to do next) there were clear cases of rules being learned without visible signs of an impasse, which does not support the popular hypothesis that all learning occurs at impasses. GRA

N90-22906# Carnegie-Mellon Univ., Pittsburgh, PA. Artificial Intelligence and Psychology Project.

A CONNECTIONIST IMPLEMENTATION OF COGNITIVE PHONOLOGY Technical Report, 15 Sep. 1986 - 14 Sep. 1991

DEIRDRE W. WHEELER (Pittsburgh Univ., PA.) and DAVID S. TOURETZKY 26 May 1989 12 p Presented at the Berkeley Workshop on Cognitive Phonology, 26 May 1989

(Contract N00014-86-K-0678)

(AD-A219095; AIP-75) Avail: NTIS HC A03/MF A01 CSCL 05/8

Initial results of an effort to actually implement Lakoff's theory of cognitive phonology in a connectionist framework are described. For all sorts of reasons, standard generative phonological theories cannot be implemented in connectionist frameworks. Lakoff's theory of cognitive phonology offers solutions to some of these problems in that it offers an alternative way to think about derivations and ordered rules, as well as eliminating the need for right-to-left iterative rule application. Many maps model are described and how Lakoff's cross-level phonological constructions may be implemented is shown. As will become clear, the basic assumption is that all phonological constructions should express correlations between levels and be satisfied in parallel, simultaneously, across the entire input domain. After describing the general properties of the model and how mappings between levels are actually implemented, a number of specific cases are considered. In particular, those apparently involving iterative application of rules are focused on, such as: Slovak shortening, Gidabal shortening, and vowel harmony in Yawelmani. The challenge is obviously to provide alternative accounts of those cases involving intra-level rules in Lakoff's theory. It is believed that the clustering mechanism allows this. Finally, the complex rule interactions in Icelandic is addressed, and it is shown that the theory, though very tightly constrained, can handle this case as well. GRA

N90-22907# Carnegie-Mellon Univ., Pittsburgh, PA. Dept. of Psychology.

COGNITIVE ARCHITECTURES AND RATIONAL ANALYSIS: COMMENT Technical Report, 15 Sep. 1986 - 14 Sep. 1991

HERBERT A. SIMON 17 Mar. 1989 25 p Submitted for publication

(Contract N00014-86-K-0678; F33615-81-K-1539; ARPA ORDER 3597)

(AD-A219199; AIP-58) Avail: NTIS HC A03/MF A01 CSCL 05/8

John Anderson has written a provocative chapter whose thesis may be oversimplified to read: To understand the behavior of an adaptive organism, don't study the organism; study its environment. To claim that architecture is more notation than substance is to make the same claim for the brain -- the fact that it supports adaptive behavior makes unnecessary any curiosity about how it operates. The exact way in which neurons accomplish their functions is not important -- not only their functional capabilities and the organization of these. Nothing else will show through to behavior. But what does show through is precisely called architecture. And for that reason architecture is by no means all notation; it has real substance in its effects on behavior. In the view of the author, Anderson assigns too little weight to architecture (and by implication to strategies) as determinants of adaptive behavior. GRA

N90-22908# Carnegie-Mellon Univ., Pittsburgh, PA. Dept. of Psychology.

INFORMATION PROCESSING APPROACHES TO COGNITIVE DEVELOPMENT Technical Report, 15 Sep. 1986 - 14 Sep. 1991

DAVID KLAHR 4 Aug. 1989 13 p Presented at the Theories of Child Development: Updates and Reformulations Symposium, Kansas City, MO, 27-30 Apr. 1989 Prepared in cooperation with Pittsburgh Univ., PA

(Contract N00014-86-K-0678)

(AD-A219200; AIP-59) Avail: NTIS HC A03/MF A01 CSCL 05/8

The history and current status of information processing approaches to cognitive development is reviewed. Because the approach is so pervasive, it is useful to characterize research in terms of distinctive features, and to organize the features according to whether they are soft-core or hard-core aspects of the information processing approach. Each of these features is illustrated by example, and the hard-core approach is expanded into a detailed analysis of self-modifying production systems and their potential for formulating theories of cognitive development. GRA

N90-22909# Carnegie-Mellon Univ., Pittsburgh, PA. School of Computer Science.

TOWARD A SOAR THEORY OF TAKING INSTRUCTIONS FOR IMMEDIATE REASONING TASKS Technical Report, 15 Sep. 1986 - 14 Sep. 1991

RICHARD L. LEWIS, ALLEN NEWELL, and THAD A. POLK Jun. 1989 12 p Submitted for publication Sponsored in part by NSF and Eastman Kodak Co., Rochester, NY Prepared in cooperation with Pittsburgh Univ., PA

(Contract N00014-86-K-0678)
(AD-A219201; AIP-60) Avail: NTIS HC A03/MF A01 CSCL 05/8

SOAR is a theory of the human cognitive architecture. The SOAR theory of taking instructions for immediate reasoning tasks, which involve extracting implicit information from simple situations in a few tens of seconds is presented. This theory is realized in a computer system that comprehends simple English instructions and organizes itself to perform a required task. Comprehending instructions produces a model of future behavior that is interpretively executed to yield task behavior. SOAR thereby acquires task-specific problem spaces that, together with basic reasoning capabilities, model human performance in multiple immediate reasoning tasks. By providing an account of taking instructions, the degrees of freedom available to the theory of immediate reasoning is reduced, and also more support for SOAR as a unified theory of cognition is given. GRA

N90-22910# Delaware Univ., Newark. Dept. of Psychology.
VISUAL SELECTIVE ATTENTION Final Report, 1 Jun. 1986 - 31 Dec. 1989
JAMES E. HOFFMAN 1 Feb. 1990 7 p
(Contract DAAL03-86-K-0080)
(AD-A219204; ARO-23871.5-LS) Avail: NTIS HC A02/MF A01 CSCL 06/4

Eye movements and attention is studied. Spatial attention can be allocated to different areas of the visual field within a single eye-fixation, showing that there is some degree of independence between the systems controlling attention and the eyes. Previous investigators have explored the degree of independence by requiring subjects to simultaneously attend to different points in the field and move their eyes to the same or different locations. For example, Klein (1979) reasoned that if the two systems are independent, then subjects should be able to move their eyes to one location and attend to another without any mutual interference. Although he reports results consistent with this hypothesis, there are methodological problems with his study that make any conclusions suspect. GRA

N90-22911# Carnegie-Mellon Univ., Pittsburgh, PA. Dept. of Psychology.
LEARNING ARTIFICIAL GRAMMARS WITH COMPETITIVE CHUNKING Technical Report, 15 Sep. 1986 - 14 Sep. 1991
EMILE SERVAN-SCHREIBER and JOHN R. ANDERSON 6 Aug. 1989 38 p Submitted for publication Prepared in cooperation with Pittsburgh Univ., PA
(Contract N00014-86-K-0678)
(AD-A219270; AIP-80) Avail: NTIS HC A03/MF A01 CSCL 12/9

When exposed to a regular stimulus field, for instance generated by an artificial grammar, subjects unintentionally learn to respond efficiently to the underlying structure: Miller (1958) reports that subjects memorize letter strings generated by an artificial grammar faster than randomly generated strings. Reber (1967) reports that, following rote memorization of exemplar sentences, subjects efficiently discriminate grammatical from non-grammatical strings. The hypothesis that the learning process is chunking and that grammatical knowledge is implicitly encoded in a hierarchical network of chunks was explored. Grammatical judgments are then based on the degree to which integrated representations of strings can be built using those chunks. Subjects were trained on exemplar sentences while inducing them to form specific chunks. Their grammatical knowledge was then tested with a discrimination task. It was found that subjects were less sensitive to grammatical violations that preserved their chunks than to violations that did not. The theory of competitive chunking (CC) was derived and found that it successfully reproduces, via computer simulations, both Miller's experimental results and our own. GRA

N90-22912# Carnegie-Mellon Univ., Pittsburgh, PA. Learning Research and Development Center.
A TASK-ANALYTIC APPROACH TO THE AUTOMATED DESIGN OF INFORMATION GRAPHICS Technical Report, 15 Sep. 1986 - 14 Sep. 1991
STEPHEN CASNER 1989 53 p Submitted for publication Prepared in cooperation with Pittsburgh Univ., PA
(Contract N00014-86-K-0678)
(AD-A219271; AIP-82) Avail: NTIS HC A04/MF A01 CSCL 14/5

Graphical representations popularly thought to be useful for communicating and processing information yield mixed results when tested with real users. Cognitive research suggests that graphic design methodologies that focus primarily on the information to be presented in a graphic fail to exploit the potentials of graphics for expediting human performance of information processing tasks: (1) allowing users to substitute efficient visual operators in place of more demanding logical operators; and (2) streamlining users' search for needed information. BOZ is a graphic design and presentation tool that constructively applies task-analytic principles of the user tasks. BOZ analyses a procedural description of a user task and derives a provably equivalent visual task by substituting visual operators in place of logical operators. BOZ automatically designs and renders an accompanying graphic, encoding data in the graphic such that performance of each visual operator is supported and visual search is minimized. Graphics produced by BOZ are static 2D images that support interactive manipulations of the graphical objects in a display to allow direct modification of the internally stored information that the graphic depicts. BOZ is used to design a graphical alternative to a standard tabular display of airline schedule information to support an airline reservation task. GRA

N90-22913# Carnegie-Mellon Univ., Pittsburgh, PA. Dept. of Psychology.
LABORATORY REPLICATION OF SCIENTIFIC DISCOVERY PROCESSES Technical Report, 15 Sep. 1986 - 14 Sep. 1991
YULIN QIN and HERBERT A. SIMON 30 Apr. 1989 49 p Submitted for publication Prepared in cooperation with Pittsburgh Univ., PA
(Contract N00014-86-K-0678; F33615-81-K-1539; ARPA ORDER 3597)
(AD-A219273; AIP-94) Avail: NTIS HC A03/MF A01 CSCL 05/8

Fourteen subjects were tape recorded while they undertook to find a law to summarize numerical data they were given. The source of the data was not identified, nor were the variables labeled semantically. Unknown to the subjects, the data were measurements of the distances of the planets from the Sun and the periods of their revolutions about it (equivalent to the data used by Johannes Kepler to discover his Third Law of planetary motion). Four of the 14 subjects discovered the same law as Kepler did (the period varies as the 3/2 power of the distance), and a fifth came very close to the answer. The subjects' protocols provide a detailed picture of the problem solving search they engaged in, mainly, but not exclusively, in the space of possible functions for fitting the data, and provide explanations as to why some succeeded and the others failed. The search heuristics used by the subjects are similar to those embodied in the BACON program, a computer simulation of certain scientific discovery processes. GRA

N90-22914# Carnegie-Mellon Univ., Pittsburgh, PA. Artificial Intelligence and Psychology Project.
AN INSTRUCTABLE CONNECTIONIST/CONTROL ARCHITECTURE: USING RULE-BASED INSTRUCTIONS TO ACCOMPLISH CONNECTIONIST LEARNING IN A HUMAN TIME SCALE
WALTER SCHNEIDER and WILLIAM L. OLIVER 1989 54 p Submitted for publication
(Contract N00014-86-K-0678)
(AD-A219274; AIP-95) Avail: NTIS HC A04/MF A01 CSCL 05/8

A hybrid cognitive architecture that combines connectionist and controlled processing is described. The connectionist/control architecture (CAP2) uses instructions to decompose cognitive tasks into subtasks that can be learned in a human time scale. A CAP2 simulation model that uses the same task decomposition used by human subjects learns a logic task ten times faster than a standard connectionist model that does not use task decomposition. Rules for carrying out tasks are stored in a sequential network (Elman, 1988; Jordan, 1986) that controls the flow of information through a modular connectionist network. It is argued that the CAP2 architecture better matches the human cognitive architectures than purely symbolic or purely connectionist architecture. GRA

N90-22915# Carnegie-Mellon Univ., Pittsburgh, PA. Artificial Intelligence and Psychology Project.
HATCHING A THEORY OF INCUBATION EFFECTS
CRAIG A. KAPLAN and JANET DAVIDSON 1989 49 p
(Contract N00014-86-K-0678)
(AD-A219275; AIP-98) Avail: NTIS HC A03/MF A01 CSCL 05/8

Does putting a problem aside to incubate really help, this question is addressed through a review of the literature on incubation that includes discussion of the four stage theory of creative thought (Wallas, 1926), the distinction between conscious and unconscious work, and an in depth look at the cognitive mechanisms that might underlie incubation effects. A critical examination of the experimental studies on incubation reveals a wide range of findings -- some in apparent contradiction. It is argued that this apparent confusion results mostly from a failure to consider the interaction of factors affecting incubation. These factors include the nature of the primary and interpolated tasks, the length and timing of the interruption (incubation period), and individual differences in the knowledge and abilities of subjects. Progress, towards understanding incubation may depend upon developing a unified theory (one that will take into account the interactions of the different factors in a consistent and principled way). One such unified theory is offered as an example, illustrating how a unified approach might account for the existing empirical literature on incubation including several previously puzzling results. GRA

N90-22916# Carnegie-Mellon Univ., Pittsburgh, PA. Artificial Intelligence and Psychology Project.
NON-LIFO (LAST-IN-FIRST-OUT) EXECUTION OF COGNITIVE PROCEDURES
KURT VANLEHN, WILLIAM BALL, and BERNADETTE KOWALSKI 13 Apr. 1989 58 p
(Contract N00014-86-K-0678; N00014-88-C-0688)
(AD-A219277; AIP-72) Avail: NTIS HC A04/MF A01 CSCL 05/8

Many current theories of human problem solving and skill acquisition assume that people work only on the unsatisfied goal that was created most recently. That is, the architecture obeys a last-in-first-out (LIFO) constraint on the selection of goals. This restriction seems necessary for the proper functioning of automatic learning mechanisms, such as production compilation and chunking. It is argued that this restriction is violated by some subjects on some tasks, and in particular, that 8 subjects from a sample of 26 execute subtraction procedures in a way that violates the LIFO constraint. Although there is a great deal of between- and within-subject strategy variation in the 8 subjects' behavior, it can be simply explained by hypothesizing that: (1) the goal selection is not necessarily LIFO, (2) goal selection knowledge is represented by explicit preferences, and (3) the 8 subjects have preferences that are mostly correct with just a few preferences that are overgeneralized, overspecialized or missing. On the other hand, LIFO-based models seem unable to explain the strategy variations in any simple way. Thus, it seems that part of the flexibility in human problem solving comes from having a choice of which goal to work on next. Fortunately, it is simple to amend automatic learning mechanisms so that they will function correctly in a non-LIFO architecture. GRA

N90-22917# York Univ. (Ontario).
VISUAL SENSITIVITIES AND DISCRIMINATIONS AND THEIR ROLE IN AVIATION Interim Report, 1 Nov. 1988 - 30 Oct. 1989
DAVID REGAN 30 Oct. 1989 67 p
(Contract F49620-88-C-0002)
(AD-A219319; AFOSR-90-0235TR) Avail: NTIS HC A04/MF A01 CSCL 06/4

Selective blindness to approaching or receding motion in depth exists and seems to be not uncommon in normally sighted individuals. A perfectly camouflaged bar within a random dot pattern was rendered visible by moving dots within the bar and outside the bar with equal and opposite velocities. Shape discrimination was compared for motion defined and contrast defined dotted rectangles. At high dot speeds and contrasts aspect ratio discrimination equal for the two kinds of rectangle and, at 2 to 3 percent, corresponded to a change of side length of only 24 arc sec. Orientation discrimination and shape discrimination degrade more rapidly at short presentation durations for a motion defined than for a contrast defined target. The findings suggest that helicopter pilots may be at risk of making visual judgement errors in nap of the earth flight where some objects and ground features are seen by motion alone when contrast or speed is low or when inspection duration is brief. A simple portable test was developed for assessing visual ability to see and discriminate motion defined form. The motion defined letter test was used on 25 patients with multiple sclerosis and 50 controls; 34/50 eyes of patients were abnormal even though visual acuity was normal. Nonlinear systems analysis: A new mathematical approach was developed for testing multi-neuron models in which individuals neurons are modelled as rectifiers. GRA

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MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

Includes human engineering; biotechnology; and space suits and protective clothing.

A90-35686
ROLE OF HUMAN FACTORS WIDENING IN NEW AIRCRAFT DESIGN
L. M. BERESTOV, S. IU. BORIS, V. V. GORIN, and V. V. ROGOZIN (Flight Research Institute, USSR) ICAO Bulletin (ISSN 0018-8778), vol. 44, Dec. 1989, p. 21-24.
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The use of an airborne laboratory to study the relationship between flight crews and flight equipment is discussed. The laboratory is based on a medium size, trunk-route aircraft, the TU-154 M, and is used in the USSR. The laboratory's instrumentation, data processing system, and simulation equipment are described. Results are presented from a study on various types of side-stick controllers (SSCs), focusing on the influence of the type and location of the SSC on the control process, the optimum force-displacement characteristics of the SSC, the optimum aircraft controllability characteristics using the SSC, pilot load, and the degree of adaptation by pilots to the SSC. Consideration is given to the importance of taking human factors into account during the process of aircraft design. R.B.

A90-36288
TERMINAL INSTRUMENT PROCEDURE CHART PRINT SIZE AND STYLE - HUMAN FACTORS IMPLICATIONS
C. E. MELTON Aviation Medicine Quarterly (ISSN 0951-3949), vol. 2, 1989, p. 99-104. refs
Copyright

Print size and style used on Terminal Instrument Procedure Charts are obviously adequate for the majority of users. All compensatory strategies employed by pilots to enhance chart

readability under adverse viewing conditions are, of course, not known but it is assumed that most use supplemental light and/or move the chart closer to their eyes. Also, most pilots' vision probably exceeds minimum aeromedical requirements. However, the presbyopic pilot who minimally meets the Federal Aviation Administration Class III medical near visual acuity policy of 20/60 (FAA Guide for Aviation Medical Examiners) will not be able to read alphanumeric data on charts in dim light (luminance levels below 1.0 foot-Lambert). If the airspace is designed to accommodate the user who just meets these minimum visual requirements, then print size on instrument approach and departure charts is clearly inadequate. Author

A90-37973#
SIMULATION OF CYCLIC ADSORPTION PROCESS FOR EXTENDED MISSIONS
FRANK F. JENG, STEVEN L. CHRISTIAN, WEN-CHING LEE, and RICHARD R. CHU (Lockheed Engineering and Sciences Co., Houston, TX) AIChE, Spring National Meeting, Houston, TX, Apr. 5, 1989, Paper. 24 p.

A solid amine CO2 control process for the Space Shuttle cabin is considered. A model which simulates the heat and mass transfer of the solid amine flight prototype system (FPS) is presented. The existing program, SAM, was modified so that test runs of the FPS can be simulated. Mass transfer coefficients of CO2 and H2O from cabin air to FPS, obtained by comparing the simulation results with test data, seem reasonable. Instantaneous rates of adsorption and desorption, accumulated adsorption and the driving forces are discussed. A plan for a breadboard test unit designed to support the modeling of the cyclic adsorption systems is included in the presentation. The operation and ranges of operating parameters are discussed. N.B.

A90-38058
COMPUTER SIMULATION OF POWER SYSTEMS FOR OPERATOR TRAINING
ANJAN BOSE (Arizona State University, Tempe) IN: IECEC-89; Proceedings of the Twenty-fourth Intersociety Energy Conversion Engineering Conference, Washington, DC, Aug. 6-11, 1989. Volume 1. New York, Institute of Electrical and Electronics Engineers, 1989, p. 165-169. refs
Copyright

The development of operator training simulators which depends on the availability of economical computational hardware is discussed. In addition, models and algorithms to simulate large power systems in real time require significant innovation. Although better models and algorithms continue to be developed, the research emphasis is not on still higher fidelity but on features that enhance training. The state of the art of operator training simulators for terrestrial power systems is reviewed. The training environment, control center functions, power system behavior, and instructional tools are discussed. I.E.

A90-38499
THE INTRODUCTION OF THE INNER IMMERSION COVERALL FOR BRITISH MILITARY AIRCREW
PETER WILLETT (Ministry of Defence Procurement Executive, London, England) SAFE Journal, vol. 20, Summer 1990, p. 27-32. refs
Copyright

British Military aircrew are starting to wear the Coverall Aircrew Inner Immersion Mk 1 garment. This is the first change in immersion garment design for 22 years and represents the biggest single change in standard UK aircrew equipment assemblies in that period. This redesign provided an opportunity to review the level of protection given, invoke the data made available by the 1971 survey (An Anthropometric Survey of 2000 RAF Aircrew) and investigate the use of different garment designs and material. The background to this change and the development involved in providing this new assembly are described. R.E.P.

N90-22087*# Toshiba Corp., Kawasaki (Japan). Mechanical Engineering Lab.
DEVELOPMENT OF A MULTIPURPOSE HAND CONTROLLER FOR JEMRMS
NOBUTO MATSUHIRA, SHOICHI IIKURA, MAKOTO ASAKURA, and YASUO SHINOMIYA *In* NASA, John F. Kennedy Space Center, The 24th Aerospace Mechanisms Symposium p 105-120 Apr. 1990
Avail: NTIS HC A16/MF A03 CSCL 05H

A prototype multipurpose hand controller for the JEMRMS (Japanese Experiment Module Remote Manipulator System) was developed. The hand controller (H/C) is an orthogonal type, with 6 degrees of freedom (DOF) and small size. The orthogonal type H/C is very simple for coordinate transformations and can easily control any type of manipulators. In fact, the JEMRMS is planned to have two manipulators controlled by a common H/C at this stage. The H/C was able to be used as a rate control joystick and a force reflection master arm, using an experimental 6 DOF manipulator. Good maneuverability was confirmed in the verification test. The orthogonal type H/C is suitable for use as a common H/C for the two manipulators of the JEMRMS. Author

N90-22101*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
AX-5 SPACE SUIT BEARING TORQUE INVESTIGATION
STUART LOEWENTHAL, VIC VYKUKAL, ROBERT MACKENDRICK, and PHILIP CULBERTSON, JR. (Sterling Federal Systems, Inc., Palo Alto, CA.) *In* NASA, John F. Kennedy Space Center, The 24th Aerospace Mechanisms Symposium p 301-312 Apr. 1990
Avail: NTIS HC A16/MF A03 CSCL 05H

The symptoms and eventual resolution of a torque increase problem occurring with ball bearings in the joints of the AX-5 space suit are described. Starting torques that rose 5 to 10 times initial levels were observed in crew evaluation tests of the suit in a zero-g water tank. This bearing problem was identified as a blocking torque anomaly, observed previously in oscillatory gimbal bearings. A large matrix of lubricants, ball separator designs and materials were evaluated. None of these combinations showed sufficient tolerance to lubricant washout when repeatedly cycled in water. The problem was resolved by retrofitting a pressure compensated, water exclusion seal to the outboard side of the bearing cavity. The symptoms and possible remedies to blocking are discussed. Author

N90-22102*# National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.
DESIGN OF A TELESCOPING TUBE SYSTEM FOR ACCESS AND HANDLING EQUIPMENT
ALAN C. LITTLEFIELD *In its* The 24th Aerospace Mechanisms Symposium p 313-327 Apr. 1990
Avail: NTIS HC A16/MF A03 CSCL 05H

Spacecraft processing presents unique problems for the design of ground support equipment. A telescoping tube system consists of a number of nested structural tubes that can be extended and retracted (telescoped) while supporting a load. A typical telescoping tube system provides lateral, torsional, and vertical support for an access platform. Several concepts for improved telescoping tubes were developed with emphasis placed on reliability, ease of maintenance, and cost effectiveness. The most promising prototype design utilizes adjustable rollers running on tracks bolted to the tube sections. A wire rope deployment system ensures that all tube sections are controlled during extension and retraction. Track shimming and roller adjustment allow for fabrication of a high precision tube assembly that does not require extensive machining or unusually large shop equipment. The use of rolling contact eliminates the contamination problems encountered with sliding tubes in previous designs. The prototype design is suitable for indoor or outdoor use. A prototype tube assembly was fabricated and tested for strength, stiffness, maintainability, and endurance. Author

N90-22215*# Old Dominion Coll., Norfolk, VA. Dept. of Mechanical Engineering and Mechanics.
EXPERT SYSTEMS FOR AUTOMATED MAINTENANCE OF A MARS OXYGEN PRODUCTION SYSTEM Final Report, period ending 30 Nov. 1989
ROBERT L. ASH, JEN-KUANG HUANG, and MING-TSANG HO Oct. 1989 169 p
(Contract NAG9-308)
(NASA-CR-186209; NAS 1.26:186209) Avail: NTIS HC A08/MF A01 CSCL 06K

A prototype expert system was developed for maintaining autonomous operation of a Mars oxygen production system. Normal operation conditions and failure modes according to certain desired criteria are tested and identified. Several schemes for failure detection and isolation using forward chaining, backward chaining, knowledge-based and rule-based are devised to perform several housekeeping functions. These functions include self-health checkout, an emergency shut down program, fault detection and conventional control activities. An effort was made to derive the dynamic model of the system using Bond-Graph technique in order to develop the model-based failure detection and isolation scheme by estimation method. Finally, computer simulations and experimental results demonstrated the feasibility of the expert system and a preliminary reliability analysis for the oxygen production system is also provided. Author

N90-22216*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
VISION SCIENCE AND TECHNOLOGY AT NASA: RESULTS OF A WORKSHOP
ANDREW B. WATSON, ed. and JEFFREY B. MULLIGAN, ed. Feb. 1990 68 p Workshop held at Moffett Field, CA, 30 Nov. - 2 Dec. 1988 Revised
(NASA-TM-102214-REV-1; A-89211-REV-1; NAS 1.15:102214-REV-1) Avail: NTIS HC A04/MF A01 CSCL 05H

A broad review is given of vision science and technology within NASA. The subject is defined and its applications in both NASA and the nation at large are noted. A survey of current NASA efforts is given, noting strengths and weaknesses of the NASA program.

N90-22217*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
SAMPLING AND NOISE IN VISION NETWORKS Abstract Only
ALBERT J. AHUMADA, JR. *In its* Vision Science and Technology at NASA: Results of a Workshop p 19-20 Feb. 1990
Avail: NTIS HC A04/MF A01 CSCL 05H

This research is part of the Human Interface Research Branch-Vision Group's program to develop computable models of biological solutions to general vision system problems. Two problem areas are addressed: effects of discrete sampling by receptors, and effects of visual system noise. Author

N90-22218*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
NETWORKS FOR IMAGE ACQUISITION, PROCESSING AND DISPLAY Abstract Only
ALBERT J. AHUMADA, JR. *In its* Vision Science and Technology at NASA: Results of a Workshop p 21 Feb. 1990
Avail: NTIS HC A04/MF A01 CSCL 05H

The human visual system comprises layers of networks which sample, process, and code images. Understanding these networks is a valuable means of understanding human vision and of designing autonomous vision systems based on network processing. Ames Research Center has an ongoing program to develop computational models of such networks. The models predict human performance in detection of targets and in discrimination of displayed information. In addition, the models are artificial vision systems sharing properties with biological vision that has been tuned by evolution for high performance. Properties include variable density sampling, noise immunity, multi-resolution coding, and fault-tolerance. The research stresses analysis of noise in visual networks, including sampling, photon, and processing unit noises. Specific accomplishments include: models of sampling array growth with variable density and irregularity comparable to that of the retinal cone mosaic; noise models of networks with signal-dependent and independent noise; models of network connection development for preserving spatial registration and interpolation; multi-resolution encoding models based on hexagonal arrays (HOP transform); and mathematical procedures for simplifying analysis of large networks. Author

N90-22220*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
VISIONS OF VISUALIZATION AIDS: DESIGN PHILOSOPHY AND EXPERIMENTAL RESULTS Abstract Only
STEPHEN R. ELLIS *In its* Vision Science and Technology at NASA: Results of a Workshop p 23 Feb. 1990
Avail: NTIS HC A04/MF A01 CSCL 05H

Aids for the visualization of high-dimensional scientific or other data must be designed. Simply casting multidimensional data into a two- or three-dimensional spatial metaphor does not guarantee that the presentation will provide insight or parsimonious description of the phenomena underlying the data. Indeed, the communication of the essential meaning of some multidimensional data may be obscured by presentation in a spatially distributed format. Useful visualization is generally based on pre-existing theoretical beliefs concerning the underlying phenomena which guide selection and formatting of the plotted variables. Two examples from chaotic dynamics are used to illustrate how a visulaization may be an aid to insight. Two examples of displays to aid spatial maneuvering are described. The first, a perspective format for a commercial air traffic display, illustrates how geometric distortion may be introduced to insure that an operator can understand a depicted three-dimensional situation. The second, a display for planning small spacecraft maneuvers, illustrates how the complex counterintuitive character of orbital maneuvering may be made more tractable by removing higher-order nonlinear control dynamics, and allowing independent satisfaction of velocity and plume impingement constraints on orbital changes. Author

N90-22223*# Odetics, Inc., Anaheim, CA.
INTENSITY DEPENDENT SPREAD THEORY Abstract Only
RICHARD HOLBEN *In* NASA, Ames Research Center, Vision Science and Technology at NASA: Results of a Workshop p 27 Feb. 1990
Avail: NTIS HC A04/MF A01 CSCL 05H

The Intensity Dependent Spread (IDS) procedure is an image-processing technique based on a model of the processing which occurs in the human visual system. IDS processing is relevant to many aspects of machine vision and image processing. For quantum limited images, it produces an ideal trade-off between spatial resolution and noise averaging, performs edge enhancement thus requiring only mean-crossing detection for the subsequent extraction of scene edges, and yields edge responses whose amplitudes are independent of scene illumination, depending only upon the ratio of the reflectance on the two sides of the edge. These properties suggest that the IDS process may provide significant bandwidth reduction while losing only minimal scene information when used as a preprocessor at or near the image plane. Author

N90-22224*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
IMAGE GATHERING, CODING, AND PROCESSING: END-TO-END OPTIMIZATION FOR EFFICIENT AND ROBUST ACQUISITION OF VISUAL INFORMATION Abstract Only
FRIEDRICH O. HUCK and CARL L. FALES *In* NASA, Ames Research Center, Vision Science and Technology at NASA: Results of a Workshop p 28-29 Feb. 1990
Avail: NTIS HC A04/MF A01 CSCL 05H

Researchers are concerned with the end-to-end performance of image gathering, coding, and processing. The applications range from high-resolution television to vision-based robotics, wherever the resolution, efficiency and robustness of visual information acquisition and processing are critical. For the presentation at this

workshop, it is convenient to divide research activities into the following two overlapping areas: The first is the development of focal-plane processing techniques and technology to effectively combine image gathering with coding, with an emphasis on low-level vision processing akin to the retinal processing in human vision. The approach includes the familiar Laplacian pyramid, the new intensity-dependent spatial summation, and parallel sensing/processing networks. Three-dimensional image gathering is attained by combining laser ranging with sensor-array imaging. The second is the rigorous extension of information theory and optimal filtering to visual information acquisition and processing. The goal is to provide a comprehensive methodology for quantitatively assessing the end-to-end performance of image gathering, coding, and processing. Author

N90-22225*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
HYBRID VISION ACTIVITIES AT NASA JOHNSON SPACE CENTER Abstract Only
RICHARD D. JUDAY *In* NASA, Ames Research Center, Vision Science and Technology at NASA: Results of a Workshop p 30 Feb. 1990
Avail: NTIS HC A04/MF A01 CSCL 05H

NASA's Johnson Space Center in Houston, Texas, is active in several aspects of hybrid image processing. (The term hybrid image processing refers to a system that combines digital and photonic processing). The major thrusts are autonomous space operations such as planetary landing, servicing, and rendezvous and docking. By processing images in non-Cartesian geometries to achieve shift invariance to canonical distortions, researchers use certain aspects of the human visual system for machine vision. That technology flow is bidirectional; researchers are investigating the possible utility of video-rate coordinate transformations for human low-vision patients. Man-in-the-loop teleoperations are also supported by the use of video-rate image-coordinate transformations, as researchers plan to use bandwidth compression tailored to the varying spatial acuity of the human operator. Technological elements being developed in the program include upgraded spatial light modulators, real-time coordinate transformations in video imagery, synthetic filters that robustly allow estimation of object pose parameters, convolutionally blurred filters that have continuously selectable invariance to such image changes as magnification and rotation, and optimization of optical correlation done with spatial light modulators that have limited range and couple both phase and amplitude in their response. Author

N90-22226*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
HUMAN MOTION PERCEPTION: HIGHER-ORDER ORGANIZATION Abstract Only
MARY K. KAISER and DENNIS R. PROFFITT (Virginia Univ., Charlottesville.) *In its* Vision Science and Technology at NASA: Results of a Workshop p 31-32 Feb. 1990
Avail: NTIS HC A04/MF A01 CSCL 05H

An overview is given of higher-order motion perception and organization. It is argued that motion is sufficient to fully specify a number of environmental properties, including: depth order, three-dimensional form, object displacement, and dynamics. A grammar of motion perception is proposed; applications of this work for display design are discussed. Author

N90-22227*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
TWO-DIMENSIONAL SHAPE RECOGNITION USING SPARSE DISTRIBUTED MEMORY Abstract Only
PENTTI KANERVA and BRUNO OLSHAUSEN *In its* Vision Science and Technology at NASA: Results of a Workshop p 33 Feb. 1990
Avail: NTIS HC A04/MF A01 CSCL 05H

Researchers propose a method for recognizing two-dimensional shapes (hand-drawn characters, for example) with an associative memory. The method consists of two stages: first, the image is preprocessed to extract tangents to the contour of the shape; second, the set of tangents is converted to a long bit string for recognition with sparse distributed memory (SDM). SDM provides a simple, massively parallel architecture for an associative memory. Long bit vectors (256 to 1000 bits, for example) serve as both data and addresses to the memory, and patterns are grouped or classified according to similarity in Hamming distance. At the moment, tangents are extracted in a simple manner by progressively blurring the image and then using a Canny-type edge detector (Canny, 1986) to find edges at each stage of blurring. This results in a grid of tangents. While the technique used for obtaining the tangents is at present rather ad hoc, researchers plan to adopt an existing framework for extracting edge orientation information over a variety of resolutions, such as suggested by Watson (1987, 1983), Marr and Hildreth (1980), or Canny (1986). Author

N90-22228*# Odetics, Inc., Anaheim, CA.
THE INTENSITY DEPENDENT SPREAD MODEL AND COLOR CONSTANCY Abstract Only
ELLIE KURRASCH *In* NASA, Ames Research Center, Vision Science and Technology at NASA: Results of a Workshop p 34 Feb. 1990
Avail: NTIS HC A04/MF A01 CSCL 05H

Odetics is investigating the use of the intensity dependent spread (IDS) model for determining color constancy. Object segmentation is performed effortlessly by the human visual systems, but creating computer vision that takes an image as input and performs object identification on the basis of color has some difficulties. The unknown aspects of the light illuminating a scene in space or anywhere can seriously interfere with the use of color for object identification. The color of an image depends not only on the physical characteristics of the object, but also on the wavelength composition of the incident illumination. IDS processing provides the extraction of edges and of reflectance changes across edges, independent of variations in scene illumination. IDS depends solely on the ratio of the reflectances on the two sides of the edge. Researchers are in the process of using IDS to recover the reflectance image. Author

N90-22229*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
FILLING IN THE RETINAL IMAGE Abstract Only
JAMES LARIMER and THOMAS PIANTANIDA (SRI International Corp., Menlo Park, CA.) *In its* Vision Science and Technology at NASA: Results of a Workshop p 35 Feb. 1990
Avail: NTIS HC A04/MF A01 CSCL 05H

The optics of the eye form an image on a surface at the back of the eyeball called the retina. The retina contains the photoreceptors that sample the image and convert it into a neural signal. The spacing of the photoreceptors in the retina is not uniform and varies with retinal locus. The central retinal field, called the macula, is densely packed with photoreceptors. The packing density falls off rapidly as a function of retinal eccentricity with respect to the macular region and there are regions in which there are no photoreceptors at all. The retinal regions without photoreceptors are called blind spots or scotomas. The neural transformations which convert retinal image signals into percepts fills in the gaps and regularizes the inhomogeneities of the retinal photoreceptor sampling mosaic. The filling-in mechamism plays an important role in understanding visual performance. The filling-in mechanism is not well understood. A systematic collaborative research program at the Ames Research Center and SRI in Menlo Park, California, was designed to explore this mechanism. It was shown that the perceived fields which are in fact different from the image on the retina due to filling-in, control some aspects of performance and not others. Researchers have linked these mechanisms to putative mechanisms of color coding and color constancy. Author

N90-22230*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
A3I VISIBILITY MODELING PROJECT Abstract Only
JAMES LARIMER, ARIES ARDITI, JAMES BERGEN, and NORMAN

BADLER (Pennsylvania Univ., Philadelphia.) *In its* Vision Science and Technology at NASA: Results of a Workshop p 36 Feb. 1990
Avail: NTIS HC A04/MF A01 CSCL 05H

The Army-NASA Aircrew Aircraft Integration program is supporting a joint project to build a visibility computer-aided design (CAD) tool. CAD has become an essential tool in modern engineering applications. CAD tools are used to create engineering drawings and to evaluate potential designs before they are physically realized. The visibility CAD tool will provide the design engineer with a tool to aid in the location and specification of windows, displays, and control in crewstations. In an aircraft cockpit the location of instruments and the emissive and reflective characteristics of the surfaces must be determined to assure adequate aircrew performance. The visibility CAD tool will allow the designer to ask and answer many of these questions in the context of a three-dimensional graphical representation of the cockpit. The graphic representation of the cockpit is a geometrically valid model of the cockpit design. A graphic model of a pilot, called the pilot manikin, can be placed naturalistically in the cockpit model. The visibility tool has the capability of mapping the cockpit surfaces and other objects modeled in this graphic design space onto the simulated pilot's retinas for a given visual fixation. Author

N90-22231*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
MOTION DETECTION IN ASTRONOMICAL AND ICE FLOE IMAGES Abstract Only
M. MANOHAR, H. K. RAMAPRIYAN, and J. P. STRONG *In* NASA, Ames Research Center, Vision Science and Technology at NASA: Results of a Workshop p 37 Feb. 1990
Avail: NTIS HC A04/MF A01 CSCL 05H

Two approaches are presented for establishing correspondence between small areas in pairs of successive images for motion detection. The first one, based on local correlation, is used on a pair of successive Voyager images of the Jupiter which differ mainly in locally variable translations. This algorithm is implemented on a sequential machine (VAX 780) as well as the Massively Parallel Processor (MPP). In the case of the sequential algorithm, the pixel correspondence or match is computed on a sparse grid of points using nonoverlapping windows (typically 11 x 11) by local correlations over a predetermined search area. The displacement of the corresponding pixels in the two images is called the disparities to cubic surfaces. The disparities at points where the error between the computed values and the surface values exceeds a particular threshold are replaced by the surface values. A bilinear interpolation is then used to estimate disparities at all other pixels between the grid points. When this algorithm was applied at the red spot in the Jupiter image, the rotating velocity field of the storm was determined. The second method of motion detection is applicable to pairs of images in which corresponding areas can experience considerable translation as well as rotation. Author

N90-22233*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
FACTORS AFFECTING THE PERCEPTION OF TRANSPARENT MOTION Abstract Only
JEFFREY B. MULLIGAN *In its* Vision Science and Technology at NASA: Results of a Workshop p 38 Feb. 1990
Avail: NTIS HC A04/MF A01 CSCL 05H

It is possible to create a perception of transparency by combining patterns having different motions. Two particular combination rules, have specific interpretations in terms of physical phenomena: additive (specular reflection) and multiplicative (shadow illumination). Arbitrary combination rules applied to random patterns generate percepts in which the motions of the two patterns are visible, but have super-imposed noise. It is also possible to combine the patterns (using an exclusive-OR rule) so that only noise is visible. Within a one-dimensional family of combination rules which include addition and multiplication, there is a range where smooth motions are seen with no superimposed noise; this range is centered about the additive combination. This result suggests that the motion system deals with a linear representation of luminance, and is consistent with the analysis of motion by linear sensors. This research gives tentative validation the use in beam splitters (which combine images additively) in the construction of heads-up aviation displays. Further work is needed to determine if the superiority of additive combination generalizes to the case of full-color imagery (there are results in the literature suggesting that subtractive color mixture yields the best legibility of overlapping alphanumerics). Author

N90-22234*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
PHOTONIC PROCESSING AT NASA AMES RESEARCH CENTER Abstract Only
ELLEN OCHOA and MAX REID *In its* Vision Science and Technology at NASA: Results of a Workshop p 39 Feb. 1990
Avail: NTIS HC A04/MF A01 CSCL 05H

The Photonic Processing group is engaged in applied research on optical processors in support of the Ames vision to lead the development of autonomous intelligent systems. Optical processors, in conjunction with numeric and symbolic processors, are needed to provide the powerful processing capability that is required for many future agency missions. The research program emphasizes application of analog optical processing, where free-space propagation between components allows natural implementations of algorithms requiring a large degree of parallel computation. Special consideration is given in the Ames program to the integration of optical processors into larger, heterogeneous computational systems. Demonstration of the effective integration of optical processors within a broader knowledge-based system is essential to evaluate their potential for dependable operation in an autonomous environment such as space. The Ames Photonics program is currently addressing several areas of interest. One of the efforts is to develop an optical correlator system with two programmable spatial light modulators (SLMs) to perform distortion invariant pattern recognition. Another area of research is optical neural networks, also for use in distortion-invariant pattern recognition. Author

N90-22235*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
SPARSE DISTRIBUTED MEMORY OVERVIEW Abstract Only
MIKE RAUGH *In its* Vision Science and Technology at NASA: Results of a Workshop p 40-41 Feb. 1990
Avail: NTIS HC A04/MF A01 CSCL 05H

The Sparse Distributed Memory (SDM) project is investigating the theory and applications of massively parallel computing architecture, called sparse distributed memory, that will support the storage and retrieval of sensory and motor patterns characteristic of autonomous systems. The immediate objectives of the project are centered in studies of the memory itself and in the use of the memory to solve problems in speech, vision, and robotics. Investigation of methods for encoding sensory data is an important part of the research. Examples of NASA missions that may benefit from this work are Space Station, planetary rovers, and solar exploration. Sparse distributed memory offers promising technology for systems that must learn through experience and be capable of adapting to new circumstances, and for operating any large complex system requiring automatic monitoring and control. Sparse distributed memory is a massively parallel architecture motivated by efforts to understand how the human brain works. Sparse distributed memory is an associative memory, able to retrieve information from cues that only partially match patterns stored in the memory. It is able to store long temporal sequences derived from the behavior of a complex system, such as progressive records of the system's sensory data and correlated records of the system's motor controls. Author

N90-22237*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
COMPUTER VISION TECHNIQUES FOR ROTORCRAFT LOW ALTITUDE FLIGHT

BANAVAR SRIDHAR *In its* Vision Science and Technology at NASA: Results of a Workshop p 45-46 Feb. 1990
Avail: NTIS HC A04/MF A01 CSCL 05H

Rotorcraft operating in high-threat environments fly close to the earth's surface to utilize surrounding terrain, vegetation, or manmade objects to minimize the risk of being detected by an enemy. Increasing levels of concealment are achieved by adopting different tactics during low-altitude flight. Rotorcraft employ three tactics during low-altitude flight: low-level, contour, and nap-of-the-earth (NOE). The key feature distinguishing the NOE mode from the other two modes is that the whole rotorcraft, including the main rotor, is below tree-top whenever possible. This leads to the use of lateral maneuvers for avoiding obstacles, which in fact constitutes the means for concealment. The piloting of the rotorcraft is at best a very demanding task and the pilot will need help from onboard automation tools in order to devote more time to mission-related activities. The development of an automation tool which has the potential to detect obstacles in the rotorcraft flight path, warn the crew, and interact with the guidance system to avoid detected obstacles, presents challenging problems. Research is described which applies techniques from computer vision to automation of rotorcraft navigtion. The effort emphasizes the development of a methodology for detecting the ranges to obstacles in the region of interest based on the maximum utilization of passive sensors. The range map derived from the obstacle-detection approach can be used as obstacle data for the obstacle avoidance in an automatic guidance system and as advisory display to the pilot. The lack of suitable flight imagery data presents a problem in the verification of concepts for obstacle detection. This problem is being addressed by the development of an adequate flight database and by preprocessing of currently available flight imagery. The presentation concludes with some comments on future work and how research in this area relates to the guidance of other autonomous vehicles. Author

N90-22239*# California Univ., Berkeley. Telerobotics Unit.
INSTRUMENTATION AND ROBOTIC IMAGE PROCESSING USING TOP-DOWN MODEL CONTROL Abstract Only
LAWRENCE STARK, BARBARA MILLS, AN H. NGUYEN, and HUY X. NGO *In* NASA, Ames Research Center, Vision Science and Technology at NASA: Results of a Workshop p 49 Feb. 1990
Avail: NTIS HC A04/MF A01 CSCL 05H

A top-down image processing scheme is described. A three-dimensional model of a robotic working environment, with robot manipulators, workpieces, cameras, and on-the-scene visual enhancements is employed to control and direct the image processing, so that rapid, robust algorithms act in an efficient manner to continually update the model. Only the model parameters are communicated, so that savings in bandwidth are achieved. This image compression by modeling is especially important for control of space telerobotics. The background for this scheme lies in an hypothesis of human vision put forward by the senior author and colleagues almost 20 years ago - the Scanpath Theory. Evidence was obtained that repetitive sequences of saccadic eye movements, the scanpath, acted as the checking phase of visual pattern recognition. Further evidence was obtained that the scanpaths were apparently generated by a cognitive model and not directly by the visual image. This top-down theory of human vision was generalized in some sense to the frame in artificial intelligence. Another source of the concept arose from bioengineering instrumentation for measuring the pupil and eye movements with infrared video cameras and special-purpose hardware. Author

N90-22241*# Stanford Univ., CA.
STANFORD/NASA-AMES CENTER OF EXCELLENCE IN MODEL-BASED HUMAN PERFORMANCE Abstract Only
BRIAN A. WANDELL *In* NASA, Ames Research Center, Vision Science and Technology at NASA: Results of a Workshop p 51 Feb. 1990
Avail: NTIS HC A04/MF A01 CSCL 05H

The human operator plays a critical role in many aeronautic and astronautic missions. The Stanford/NASA-Ames Center of Excellence in Model-Based Human Performance (COE) was initiated in 1985 to further our understanding of the performance capabilities and performance limits of the human component of aeronautic and astronautic projects. Support from the COE is devoted to those areas of experimental and theoretical work designed to summarize and explain human performance by developing computable performance models. The ultimate goal is to make these computable models available to other scientists for use in design and evaluation of aeronautic and astronautic instrumentation. Within vision science, two topics have received particular attention. First, researchers did extensive work analyzing the human ability to recognize object color relatively independent of the spectral power distribution of the ambient lighting (color constancy). The COE has supported a number of research papers in this area, as well as the development of a substantial data base of surface reflectance functions, ambient illumination functions, and an associated software package for rendering and analyzing image data with respect to these spectral functions. Second, the COE supported new empirical studies on the problem of selecting colors for visual display equipment to enhance human performance in discrimination and recognition tasks. Author

N90-22242*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
AMES VISION GROUP RESEARCH OVERVIEW Abstract Only
ANDREW B. WATSON *In its* Vision Science and Technology at NASA: Results of a Workshop p 52 Feb. 1990
Avail: NTIS HC A04/MF A01 CSCL 05H

A major goal of the reseach group is to develop mathematical and computational models of early human vision. These models are valuable in the prediction of human performance, in the design of visual coding schemes and displays, and in robotic vision. To date researchers have models of retinal sampling, spatial processing in visual cortex, contrast sensitivity, and motion processing. Based on their models of early human vision, researchers developed several schemes for efficient coding and compression of monochrome and color images. These are pyramid schemes that decompose the image into features that vary in location, size, orientation, and phase. To determine the perceptual fidelity of these codes, researchers developed novel human testing methods that have received considerable attention in the research community. Researchers constructed models of human visual motion processing based on physiological and psychophysical data, and have tested these models through simulation and human experiments. They also explored the application of these biological algorithms to applications in automated guidance of rotorcraft and autonomous landing of spacecraft. Researchers developed networks for inhomogeneous image sampling, for pyramid coding of images, for automatic geometrical correction of disordered samples, and for removal of motion artifacts from unstable cameras. Author

N90-22243*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
PYRAMID IMAGE CODES Abstract Only
ANDREW B. WATSON *In its* Vision Science and Technology at NASA: Results of a Workshop p 53 Feb. 1990
Avail: NTIS HC A04/MF A01 CSCL 05H

All vision systems, both human and machine, transform the spatial image into a coded representation. Particular codes may be optimized for efficiency or to extract useful image features. Researchers explored image codes based on primary visual cortex in man and other primates. Understanding these codes will advance the art in image coding, autonomous vision, and computational human factors. In cortex, imagery is coded by features that vary in size, orientation, and position. Researchers have devised a mathematical model of this transformation, called the Hexagonal oriented Orthogonal quadrature Pyramid (HOP). In a pyramid code, features are segregated by size into layers, with fewer features in the layers devoted to large features. Pyramid schemes provide scale invariance, and are useful for coarse-to-fine searching and for progressive transmission of images. The HOP Pyramid is novel in three respects: (1) it uses a hexagonal pixel lattice, (2) it uses

oriented features, and (3) it accurately models most of the prominent aspects of primary visual cortex. The transform uses seven basic features (kernels), which may be regarded as three oriented edges, three oriented bars, and one non-oriented blob. Application of these kernels to non-overlapping seven-pixel neighborhoods yields six oriented, high-pass pyramid layers, and one low-pass (blob) layer. Author

N90-22918*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
SPATIAL DISPLAYS AND SPATIAL INSTRUMENTS
STEPHEN R. ELLIS, ed., MARY K. KAISER, ed., and ARTHUR J. GRUNWALD, ed. (Technion - Israel Inst. of Tech., Haifa.) Jul. 1989 623 p Conference held in Pacific Grove, CA, 31 Aug. - 3 Sep. 1987; sponsored by NASA, Ames Research Center, Moffett Field, CA and California Univ., Berkeley
(NASA-CP-10032; A-88090; NAS 1.55:10032) Avail: NTIS HC A99/MF A04 CSCL 05/8

The conference proceedings topics are divided into two main areas: (1) issues of spatial and picture perception raised by graphical electronic displays of spatial information; and (2) design questions raised by the practical experience of designers actually defining new spatial instruments for use in new aircraft and spacecraft. Each topic is considered from both a theoretical and an applied direction. Emphasis is placed on discussion of phenomena and determination of design principles.

N90-22919*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
PICTORIAL COMMUNICATION: PICTURES AND THE SYNTHETIC UNIVERSE
STEPHEN R. ELLIS (California Univ., Berkeley.) *In its* Spatial Displays and Spatial Instruments 23 p Jul. 1989
Avail: NTIS HC A99/MF A04 CSCL 05/8

Principles for the design of dynamic spatial instruments for communicating quantitative information to viewers are considered through a brief review of the history of pictorial communication. Pictorial communication is seen to have two directions: (1) from the picture to the viewer; and (2) from the viewer to the picture. Optimization of the design of interactive instruments using pictorial formats requires an understanding of the manipulative, perceptual, and cognitive limitations of human viewers. Author

N90-22920*# California Univ., Berkeley. School of Optometry.
SPATIAL CONSTRAINTS OF STEREOPSIS IN VIDEO DISPLAYS
CLIFTON SCHOR *In* NASA, Ames Research Center, Spatial Displays and Spatial Instruments 14 p Jul. 1989
Avail: NTIS HC A99/MF A04 CSCL 05/8

Recent development in video technology, such as the liquid crystal displays and shutters, have made it feasible to incorporate stereoscopic depth into the 3-D representations on 2-D displays. However, depth has already been vividly portrayed in video displays without stereopsis using the classical artists' depth cues described by Helmholtz (1866) and the dynamic depth cues described in detail by Ittleson (1952). Successful static depth cues include overlap, size, linear perspective, texture gradients, and shading. Effective dynamic cues include looming (Regan and Beverly, 1979) and motion parallax (Rogers and Graham, 1982). Stereoscopic depth is superior to the monocular distance cues under certain circumstances. It is most useful at portraying depth intervals as small as 5 to 10 arc secs. For this reason it is extremely useful in user-video interactions such as telepresence. Objects can be manipulated in 3-D space, for example, while a person who controls the operations views a virtual image of the manipulated object on a remote 2-D video display. Stereopsis also provides structure and form information in camouflaged surfaces such as tree foliage. Motion parallax also reveals form; however, without other monocular cues such as overlap, motion parallax can yield an ambiguous perception. For example, a turning sphere, portrayed as solid by parallax can appear to rotate either leftward or rightward. However, only one direction of rotation is perceived when stereo-depth is included. If the scene is static, then stereopsis is the principal cue for revealing the camouflaged surface structure. Finally, dynamic stereopsis provides information about the direction of motion in depth (Regan and Beverly, 1979). Clearly there are many spatial constraints, including spatial frequency content, retinal eccentricity, exposure duration, target spacing, and disparity gradient, which - when properly adjusted - can greatly enhance stereodepth in video displays. Author

N90-22921*# California Univ., Santa Barbara. Dept. of Psychology.
STEREOSCOPIC DISTANCE PERCEPTION
JOHN M. FOLEY *In* NASA, Ames Research Center, Spatial Displays and Spatial Instruments 9 p Jul. 1989
Avail: NTIS HC A99/MF A04 CSCL 05/8

Limited cue, open-loop tasks in which a human observer indicates distances or relations among distances are discussed. By open-loop tasks, it is meant tasks in which the observer gets no feedback as to the accuracy of the responses. What happens when cues are added and when the loop is closed are considered. The implications of this research for the effectiveness of visual displays is discussed. Errors in visual distance tasks do not necessarily mean that the percept is in error. The error could arise in transformations that intervene between the percept and the response. It is argued that the percept is in error. It is also argued that there exist post-perceptual transformations that may contribute to the error or be modified by feedback to correct for the error. Author

N90-22922*# Scripps Institution of Oceanography, La Jolla, CA.
PARADOXICAL MONOCULAR STEREOPSIS AND PERSPECTIVE VERGENCE
J. T. ENRIGHT *In* NASA, Ames Research Center, Spatial Displays and Spatial Instruments 9 p Jul. 1989
(Contract NSF BNS-85-19616)
Avail: NTIS HC A99/MF A04 CSCL 05/8

The question of how to most effectively convey depth in a picture is a multifaceted problem, both because of potential limitations of the chosen medium (stereopsis, image motion), and because effectiveness can be defined in various ways. Practical applications usually focus on information transfer, i.e., effective techniques for evoking recognition of implied depth relationships, but this issue depends on subjective judgements which are difficult to scale when stimuli are above threshold. Two new approaches to this question are proposed here which are based on alternative criteria for effectiveness. Paradoxical monocular stereopsis is a remarkably compelling impression of depth which is evoked during one-eyed viewing of only certain illustrations; it can be unequivocally recognized because the feeling of depth collapses when one shifts to binocular viewing. An exploration of the stimulus properties which are effective for this phenomenon may contribute useful answers for the more general perceptual problem. Positive vergence is an eye-movement response associated with changes of fixation point within a picture which implies depth; it also arises only during monocular viewing. The response is directionally appropriate (i.e., apparently nearer objects evoke convergence, and vice versa), but the magnitude of the response can be altered consistently by making relatively minor changes in the illustration. The cross-subject agreement in changes of response magnitude would permit systematic exploration to determine which stimulus configurations are most effective in evoking perspective vergence, with quantitative answers based upon this involuntary reflex. It may well be that most effective pictures in this context will embody features which would increase effectiveness of pictures in a more general sense. Author

N90-22923*# Bristol Univ. (England). Dept. of Psychology.
SEEING BY EXPLORING
RICHARD L. GREGORY *In* NASA, Ames Research Center, Spatial Displays and Spatial Instruments 9 p Jul. 1989
Avail: NTIS HC A99/MF A04 CSCL 05/8

The classical notion of how things are seen is that perception is passive, that the eyes are windows, and in floods reality. Physiological work of the 19th century cast doubt on this view

that perception is passive acceptance of reality. Perception is not at the present time a popular topic for philosophers. This must be partly because scientific accounts of perception have now gone a long way away from appearances. They depend on physiological and psycho-physical experiments which require technical investigation and do not fall within traditional concepts of philosophy. Theories of visual perception are examined, both from a physical and psycho-physical standpoint. Author

N90-22924*# Oregon Univ., Eugene. Dept. of Computer Science.
THE PERCEPTION OF THREE-DIMENSIONALITY ACROSS CONTINUOUS SURFACES
KENT A. STEVENS *In* NASA, Ames Research Center, Spatial Displays and Spatial Instruments 8 p Jul. 1989
(Contract N00014-87-K-0321)
Avail: NTIS HC A99/MF A04 CSCL 05/8

The apparent three-dimensionality of a viewed surface presumably corresponds to several internal preceptual quantities, such as surface curvature, local surface orientation, and depth. These quantities are mathematically related for points within the silhouette bounds of a smooth, continuous surface. For instance, surface curvature is related to the rate of change of local surface orientation, and surface orientation is related to the local gradient of distance. It is not clear to what extent these 3D quantities are determined directly from image information rather than indirectly from mathematically related forms, by differentiation or by integration within boundary constraints. An open empirical question, for example, is to what extent surface curvature is perceived directly, and to what extent it is quantitative rather than qualitative. In addition to surface orientation and curvature, one derives an impression of depth, i.e., variations in apparent egocentric distance. A static orthographic image is essentially devoid of depth information, and any quantitative depth impression must be inferred from surface orientation and other sources. Such conversion of orientation to depth does appear to occur, and even to prevail over stereoscopic depth information under some circumstances. Author

N90-22925*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
PERCEIVING ENVIRONMENTAL PROPERTIES FROM MOTION INFORMATION: MINIMAL CONDITIONS
DENNIS R. PROFFITT (Virginia Univ., Charlottesville.) and MARY K. KAISER *In its* Spatial Displays and Spatial Instruments 14 p Jul. 1989
Avail: NTIS HC A99/MF A04 CSCL 05/8

The status of motion as a minimal information source for perceiving the environmental properties of surface segregation, three-dimensional (3-D) form, displacement, and dynamics is discussed. The selection of these particular properties was motivated by a desire to present research on perceiving properties that span the range of dimensional complexity. Author

N90-22926*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
VISUAL SLANT UNDERESTIMATION
JOHN A. PERRONE and PETER WENDEROTH (Sydney Univ., Australia) *In its* Spatial Displays and Spatial Instruments 9 p Jul. 1989
Avail: NTIS HC A99/MF A04 CSCL 05/8

Observers frequently underestimate the in-depth slant of rectangles under reduction conditions. This also occurs for slanted rectangles depicted on a flat display medium. Perrone (1982) provides a model for judged slant based upon properties of the 2-D trapezoidal projection of the rectangle. Two important parameters of this model are the angle of convergence of the sides of the trapezoid and the projected length of the trapezoid. This model was tested using a range of stimulus rectangles and found that the model failed to predict some of the major trends in the data. However, when the projected width of the base of the trapezoid projection was used in the model, instead of the projected length, excellent agreement between the theoretical and obtained slant judgements resulted. The good fit between the experimental data and the new model predictions indicates that perceived slant estimates are highly correlated with specifiable features in the stimulus display. Author

N90-22927*# Forschungsinstitut fuer Anthropotechnik, Wachtberg (Germany, F.R.). Research Inst. for Human Engineering.
THE PHOTO-COLORIMETRIC SPACE AS A MEDIUM FOR THE REPRESENTATION OF SPATIAL DATA
K. FRIEDRICH KRAISS and HEINO WIDDEL *In* NASA, Ames Research Center, Spatial Displays and Spatial Instruments 13 p Jul. 1989
Avail: NTIS HC A99/MF A04 CSCL 05/8

Spatial displays and instruments are usually used in the context of vehicle guidance, but it is hard to find applicable spatial formats in information retrieval and interaction systems. Human interaction with spatial data structures and the applicability of the CIE color space to improve dialogue transparency is discussed. A proposal is made to use the color space to code spatially represented data. The semantic distances of the categories of dialogue structures or, more general, of database structures, are determined empirically. Subsequently the distances are transformed and depicted into the color space. The concept is demonstrated for a car diagnosis system, where the category cooling system could, e.g., be coded in blue, the category ignition system in red. Hereby a correspondence between color and semantic distances is achieved. Subcategories can be coded as luminance differences within the color space. Author

N90-22928*# York Univ., Toronto (Ontario). Human Performance Lab.
SPATIAL VISION WITHIN EGOCENTRIC AND EXOCENTRIC FRAMES OF REFERENCE
IAN P. HOWARD *In* NASA, Ames Research Center, Spatial Displays and Spatial Instruments 17 p Jul. 1989
Avail: NTIS HC A99/MF A04 CSCL 05/8

The extent to which perceptual judgements within egocentric and exocentric frames of reference are subject to illusory disturbances and long term modifications is discussed. It is argued that well known spatial illusions, such as the oculogyral illusion and induced visual motion have usually been discussed without proper attention being paid to the frame of reference within which they occur, and that this has led to the construction of inadequate theories and inappropriate procedures for testing them. Author

N90-22929*# Stanford Univ., CA.
DISTORTIONS IN MEMORY FOR VISUAL DISPLAYS
BARBARA TVERSKY *In* NASA, Ames Research Center, Spatial Displays and Spatial Instruments 17 p Jul. 1989
Avail: NTIS HC A99/MF A04 CSCL 05/8

Systematic errors in perception and memory present a challenge to theories of perception and memory and to applied psychologists interested in overcoming them as well. A number of systematic errors in memory for maps and graphs are reviewed, and they are accounted for by an analysis of the perceptual processing presumed to occur in comprehension of maps and graphs. Visual stimuli, like verbal stimuli, are organized in comprehension and memory. For visual stimuli, the organization is a consequence of perceptual processing, which is bottom-up or data-driven in its earlier stages, but top-down and affected by conceptual knowledge later on. Segregation of figure from ground is an early process, and figure recognition later; for both, symmetry is a rapidly detected and ecologically valid cue. Once isolated, figures are organized relative to one another and relative to a frame of reference. Both perceptual (e.g., salience) and conceptual factors (e.g., significance) seem likely to affect selection of a reference frame. Consistent with the analysis, subjects perceived and remembered curves in graphs and rivers in maps as more symmetric than they actually were. Symmetry, useful for detecting and recognizing figures, distorts map and graph figures alike. Top-down processes also seem to operate in that calling attention to the symmetry vs. asymmetry of a slightly asymmetric curve yielded memory errors in the direction of the description.

Conceptual frame of reference effects were demonstrated in memory for lines embedded in graphs. In earlier work, the orientation of map figures was distorted in memory toward horizontal or vertical. In recent work, graph lines, but not map lines, were remembered as closer to an imaginary 45 deg line than they had been. Reference frames are determined by both perceptual and conceptual factors, leading to selection of the canonical axes as a reference frame in maps, but selection of the imaginary 45 deg as a reference frame in graphs. Author

N90-22930*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
HELMET-MOUNTED PILOT NIGHT VISION SYSTEMS: HUMAN FACTORS ISSUES
SANDRA G. HART and MICHAEL S. BRICKNER (National Academy of Sciences - National Research Council, Washington, DC.) *In its* Spatial Displays and Spatial Instruments 21 p Jul. 1989
Avail: NTIS HC A99/MF A04 CSCL 05/8

Helmet-mounted displays of infrared imagery (forward-looking infrared (FLIR)) allow helicopter pilots to perform low level missions at night and in low visibility. However, pilots experience high visual and cognitive workload during these missions, and their performance capabilities may be reduced. Human factors problems inherent in existing systems stem from three primary sources: the nature of thermal imagery; the characteristics of specific FLIR systems; and the difficulty of using FLIR system for flying and/or visually acquiring and tracking objects in the environment. The pilot night vision system (PNVS) in the Apache AH-64 provides a monochrome, 30 by 40 deg helmet-mounted display of infrared imagery. Thermal imagery is inferior to television imagery in both resolution and contrast ratio. Gray shades represent temperatures differences rather than brightness variability, and images undergo significant changes over time. The limited field of view, displacement of the sensor from the pilot's eye position, and monocular presentation of a bright FLIR image (while the other eye remains dark-adapted) are all potential sources of disorientation, limitations in depth and distance estimation, sensations of apparent motion, and difficulties in target and obstacle detection. Insufficient information about human perceptual and performance limitations restrains the ability of human factors specialists to provide significantly improved specifications, training programs, or alternative designs. Additional research is required to determine the most critical problem areas and to propose solutions that consider the human as well as the development of technology. Author

N90-22931*# California Univ., Santa Cruz. Dept. of Psychology.
SEPARATE VISUAL REPRESENTATIONS FOR PERCEPTION AND FOR VISUALLY GUIDED BEHAVIOR
BRUCE BRIDGEMAN *In* NASA, Ames Research Center, Spatial Displays and Spatial Instruments 15 p Jul. 1989
Avail: NTIS HC A99/MF A04 CSCL 05/8

Converging evidence from several sources indicates that two distinct representations of visual space mediate perception and visually guided behavior, respectively. The two maps of visual space follow different rules; spatial values in either one can be biased without affecting the other. Ordinarily the two maps give equivalent responses because both are veridically in register with the world; special techniques are required to pull them apart. One such technique is saccadic suppression: small target displacements during saccadic eye movements are not preceived, though the displacements can change eye movements or pointing to the target. A second way to separate cognitive and motor-oriented maps is with induced motion: a slowly moving frame will make a fixed target appear to drift in the opposite direction, while motor behavior toward the target is unchanged. The same result occurs with stroboscopic induced motion, where the frame jump abruptly and the target seems to jump in the opposite direction. A third method of separating cognitive and motor maps, requiring no motion of target, background or eye, is the Roelofs effect: a target surrounded by an off-center rectangular frame will appear to be off-center in the direction opposite the frame. Again the effect influences perception, but in half of the subjects it does not influence pointing to the target. This experience also reveals more characteristics of the maps and their interactions with one another, the motor map apparently has little or no memory, and must be fed from the biased cognitive map if an enforced delay occurs between stimulus presentation and motor response. In designing spatial displays, the results mean that what you see isn't necessarily what you get. Displays must be designed with either perception or visually guided behavior in mind. Author

N90-22932*# State Univ. of New York, Albany. Inst. for Vision Research.
THE EFFECTS OF VIEWPOINT ON THE VIRTUAL SPACE OF PICTURES
H. A. SEDGWICK *In* NASA, Ames Research Center, Spatial Displays and Spatial Instruments 24 p Jul. 1989
Avail: NTIS HC A99/MF A04 CSCL 05/8

Pictorial displays whose primary purpose is to convey accurate information about the 3-D spatial layout of an environment are discussed. How and how well, pictures can convey such information is discussed. It is suggested that picture perception is not best approached as a unitary, indivisible process. Rather, it is a complex process depending on multiple, partially redundant, interacting sources of visual information for both the real surface of the picture and the virtual space beyond. Each picture must be assessed for the particular information that it makes available. This will determine how accurately the virtual space represented by the picture is seen, as well as how it is distorted when seen from the wrong viewpoint. Author

N90-22933*# Pittsburgh Univ., PA. Dept. of Psychology.
PERCEIVED ORIENTATION, SPATIAL LAYOUT AND THE GEOMETRY OF PICTURES
E. BRUCE GOLDSTEIN *In* NASA, Ames Research Center, Spatial Displays and Spatial Instruments 7 p Jul. 1989
Avail: NTIS HC A99/MF A04 CSCL 05/8

The purpose is to discuss the role of geometry in determining the perception of spatial layout and perceived orientation in pictures viewed at an angle. This discussion derives from Cutting's (1988) suggestion, based on his analysis of some of the author's data (Goldstein, 1987), that the changes in perceived orientation that occur when pictures are viewed at an angle can be explained in terms of geometrically produced changes in the picture's virtual space. Author

N90-22934*# Cornell Univ., Ithaca, NY. Dept. of Psychology.
ON THE EFFICACY OF CINEMA, OR WHAT THE VISUAL SYSTEM DID NOT EVOLVE TO DO
JAMES E. CUTTING *In* NASA, Ames Research Center, Spatial Displays and Spatial Instruments 8 p Jul. 1989
Avail: NTIS HC A99/MF A04 CSCL 05/8

Spatial displays, and a constraint that they do not place on the use of spatial instruments are discussed. Much of the work done in visual perception by psychologists and by computer scientists has concerned displays that show the motion of rigid objects. Typically, if one assumes that objects are rigid, one can then proceed to understand how the constant shape of the object can be perceived (or computed) as it moves through space. The author maintains that photographs and cinema are visual displays that are also powerful forms of art. Their efficacy, in part, stems from the fact that, although viewpoint is constrained when composing them, it is not nearly so constrained when viewing them. It is obvious, according to the author, that human visual systems did not evolve to watch movies or look at photographs. Thus, what photographs and movies present must be allowed in the rule-governed system under which vision evolved. Machine-vision algorithms, to be applicable to human vision, should show the same types of tolerance. Author

N90-22935*# Vanderbilt Univ., Nashville, TN.
THE PERCEPTION OF GEOMETRICAL STRUCTURE FROM CONGRUENCE

JOSEPH S. LAPPIN and THOMAS D. WASON (Allotech, Inc., Raleigh, NC.) *In* NASA, Ames Research Center, Spatial Displays and Spatial Instruments 15 p Jul. 1989 Sponsored in part by AFOSR, Washington, DC
(Contract NIH-EY-05926)
Avail: NTIS HC A99/MF A04 CSCL 05/8

The principle function of vision is to measure the environment. As demonstrated by the coordination of motor actions with the positions and trajectories of moving objects in cluttered environments and by rapid recognition of solid objects in varying contexts from changing perspectives, vision provides real-time information about the geometrical structure and location of environmental objects and events. The geometric information provided by 2-D spatial displays is examined. It is proposed that the geometry of this information is best understood not within the traditional framework of perspective trigonometry, but in terms of the structure of qualitative relations defined by congruences among intrinsic geometric relations in images of surfaces. The basic concepts of this geometrical theory are outlined. Author

N90-22936*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
EXOCENTRIC DIRECTION JUDGEMENTS IN COMPUTER-GENERATED DISPLAYS AND ACTUAL SCENES
STEPHEN R. ELLIS, STEPHEN SMITH, MICHAEL W. MCGREEVY, and ARTHUR J. GRUNWALD *In its* Spatial Displays and Spatial Instruments 15 p Jul. 1989
Avail: NTIS HC A99/MF A04 CSCL 05/8

One of the most remarkable perceptual properties of common experience is that the perceived shapes of known objects are constant despite movements about them which transform their projections on the retina. This perceptual ability is one aspect of shape constancy (Thouless, 1931; Metzger, 1953; Borresen and Lichte, 1962). It requires that the viewer be able to sense and discount his or her relative position and orientation with respect to a viewed object. This discounting of relative position may be derived directly from the ranging information provided from stereopsis, from motion parallax, from vestibularly sensed rotation and translation, or from corollary information associated with voluntary movement. It is argued that: (1) errors in exocentric judgements of the azimuth of a target generated on an electronic perspective display are not viewpoint-independent, but are influenced by the specific geometry of their perspective projection; (2) elimination of binocular conflict by replacing electronic displays with actual scenes eliminates a previously reported equidistance tendency in azimuth error, but the viewpoint dependence remains; (3) the pattern of exocentrically judged azimuth error in real scenes viewed with a viewing direction depressed 22 deg and rotated + or - 22 deg with respect to a reference direction could not be explained by overestimation of the depression angle, i.e., a slant overestimation. Author

N90-22937*# Japan Broadcasting Corp., Tokyo. Science and Technical Research Labs.
HOW TO REINFORCE PERCEPTION OF DEPTH IN SINGLE TWO-DIMENSIONAL PICTURES
S. NAGATA *In* NASA, Ames Research Center, Spatial Displays and Spatial Instruments 18 p Jul. 1989
Avail: NTIS HC A99/MF A04 CSCL 05/8

The physical conditions of the display of single 2-D pictures, which produce images realistically, were studied by using the characteristics of the intake of the information for visual depth perception. Depth sensitivity, which is defined as the ratio of viewing distance to depth discrimination threshold, was introduced in order to evaluate the availability of various cues for depth perception: binocular parallax, motion parallax, accommodation, convergence, size, texture, brightness, and air-perspective contrast. The effects of binocular parallax in different conditions, the depth sensitivity of which is greatest at a distance of up to about 10 m, were studied with the new versatile stereoscopic display. From these results, four conditions to reinforce the perception of depth in single pictures were proposed, and these conditions are met by the old viewing devices and the new high-definition and wide television displays. Author

N90-22938*# ILLIANA Aviation Sciences, Las Cruces, NM.
THE EYES PREFER REAL IMAGES
STANLEY N. ROSCOE *In* NASA, Ames Research Center, Spatial Displays and Spatial Instruments 9 p Jul. 1989
Avail: NTIS HC A99/MF A04 CSCL 05/8

For better or worse, virtual imaging displays are with us in the form of narrow-angle combining-glass presentations, head-up displays (HUD), and head-mounted projections of wide-angle sensor-generated or computer-animated imagery (HMD). All military and civil aviation services and a large number of aerospace companies are involved in one way or another in a frantic competition to develop the best virtual imaging display system. The success or failure of major weapon systems hangs in the balance, and billions of dollars in potential business are at stake. Because of the degree to which national defense is committed to the perfection of virtual imaging displays, a brief consideration of their status, an investigation and analysis of their problems, and a search for realistic alternatives are long overdue. Author

N90-22939*# Marcus (Aaron) and Associates, Berkeley, CA.
SPATIAL ISSUES IN USER INTERFACE DESIGN FROM A GRAPHIC DESIGN PERSPECTIVE
AARON MARCUS *In* NASA, Ames Research Center, Spatial Displays and Spatial Instruments 7 p Jul. 1989
Avail: NTIS HC A99/MF A04 CSCL 05/8

The user interface of a computer system is a visual display that provides information about the status of operations on data within the computer and control options to the user that enable adjustments to these operations. From the very beginning of computer technology the user interface was a spatial display, although its spatial features were not necessarily complex or explicitly recognized by the users. All text and nonverbal signs appeared in a virtual space generally thought of as a single flat plane of symbols. Current technology of high performance workstations permits any element of the display to appear as dynamic, multicolor, 3-D signs in a virtual 3-D space. The complexity of appearance and the user's interaction with the display provide significant challenges to the graphic designer of current and future user interfaces. In particular, spatial depiction provides many opportunities for effective communication of objects, structures, processes, navigation, selection, and manipulation. Issues are presented that are relevant to the graphic designer seeking to optimize the user interface's spatial attributes for effective visual communication. Author

N90-22940*# Illinois Univ., Chicago. Dept. of Biomedical Visualization.
INTERACTIVE DISPLAYS IN MEDICAL ART
DEIRDRE ALLA MCCONATHY and MICHAEL DOYLE *In* NASA, Ames Research Center, Spatial Displays and Spatial Instruments 10 p Jul. 1989
Avail: NTIS HC A99/MF A04 CSCL 05/8

Medical illustration is a field of visual communication with a long history. Traditional medical illustrations are static, 2-D, printed images; highly realistic depictions of the gross morphology of anatomical structures. Today medicine requires the visualization of structures and processes that have never before been seen. Complex 3-D spatial relationships require interpretation from 2-D diagnostic imagery. Pictures that move in real time have become clinical and research tools for physicians. Medical illustrators are involved with the development of interactive visual displays for three different, but not discrete, functions: as educational materials, as clinical and research tools, and as data bases of standard imagery used to produce visuals. The production of interactive displays in the medical arts is examined. Author

N90-22941*# Illinois Univ., Urbana. Coll. of Medicine.
THE INTERACTIVE DIGITAL VIDEO INTERFACE
MICHAEL D. DOYLE *In* NASA, Ames Research Center, Spatial

Displays and Spatial Instruments 4 p Jul. 1989
Avail: NTIS HC A99/MF A04 CSCL 05/8

A frequent complaint in the computer oriented trade journals is that current hardware technology is progressing so quickly that software developers cannot keep up. An example of this phenomenon can be seen in the field of microcomputer graphics. To exploit the advantages of new mechanisms of information storage and retrieval, new approaches must be made towards incorporating existing programs as well as developing entirely new applications. A particular area of need is the correlation of discrete image elements to textural information. The interactive digital video (IDV) interface embodies a new concept in software design which addresses these needs. The IDV interface is a patented device and language independent process for identifying image features on a digital video display and which allows a number of different processes to be keyed to that identification. Its capabilities include the correlation of discrete image elements to relevant text information and the correlation of these image features to other images as well as to program control mechanisms. Sophisticated interrelationships can be set up between images, text, and program control mechanisms. Author

N90-22942*# Kansas Univ., Lawrence. Dept. of Geography.
DISPLAYS, INSTRUMENTS, AND THE MULTI-DIMENSIONAL WORLD OF CARTOGRAPHY
GEORGE F. MCCLEARY, JR. *In* NASA, Ames Research Center, Spatial Displays and Spatial Instruments 19 p Jul. 1989
Avail: NTIS HC A99/MF A04 CSCL 05/8

Cartographers are creators and purveyors of maps. Maps are representations of space, geographical images of the environment. Maps organize spatial information for convenience, particularly for use in performing tasks which involve the environment. There are many different kinds of maps, and there are as many different uses of maps as there are spatial problems to be solved. Maps and the display instrument dichotomy are examined. Also examined are the categories of map use along with the characteristics of maps. Author

N90-22943*# CAE Electronics Ltd., Montreal (Quebec).
MULTI-AXIS CONTROL OF TELEMANIPULATORS
G. M. MCKINNON and RON KRUK *In* NASA, Ames Research Center, Spatial Displays and Spatial Instruments 11 p Jul. 1989
Avail: NTIS HC A99/MF A04 CSCL 05/8

The development of multi-axis hand controllers for use in telemanipulator systems is described. Experience in the control of the SRMS (shuttle remote manipulator system) arm is reviewed together with subsequent tests involving a number of simulators and configurations, including use as a side-arm flight control for helicopters. The factors affecting operator acceptability are reviewed. Author

N90-22944*# Massachusetts Inst. of Tech., Cambridge.
TELEPRESENCE, TIME DELAY, AND ADAPTATION
RICHARD HELD and NATHANIEL DURLACH (Boston Univ., MA.) *In* NASA, Ames Research Center, Spatial Displays and Spatial Instruments 16 p Jul. 1989
Avail: NTIS HC A99/MF A04 CSCL 05/8

Displays are now being used extensively throughout the society. More and more time is spent watching television, movies, computer screens, etc. Furthermore, in an increasing number of cases, the observer interacts with the display and plays the role of operator as well as observer. To a large extent, the normal behavior in the normal environment can also be thought of in these same terms. Taking liberties with Shakespeare, it might be said, all the world's a display and all the individuals in it are operators in and on the display. Within this general context of interactive display systems, a discussion is began with a conceptual overview of a particular class of such systems, namely, teleoperator systems. The notion is considered of telepresence and the factors that limit telepresence, including decorrelation between the: (1) motor output of the teleoperator as sensed directly via the kinesthetic/tactual system, and (2) the motor output of the teleoperator as sensed indirectly via feedback from the slave robot, i.e., via a visual display of the motor actions of the slave robot. Finally, the deleterious effect of time delay (a particular decorrelation) on sensory-motor adaptation (an important phenomenon related to telepresence) is examined. Author

N90-22945*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
ADAPTING TO VARIABLE PRISMATIC DISPLACEMENT
ROBERT B. WELCH and MALCOLM M. COHEN *In its* Spatial Displays and Spatial Instruments 10 p Jul. 1989
Avail: NTIS HC A99/MF A04 CSCL 05/8

In each of two studies, subjects were exposed to a continuously changing prismatic displacement with a mean value of 19 prism diopters (variable displacement) and to a fixed 19-diopter displacement (fixed displacement). In Experiment 1, significant adaptation (post-pre shifts in hand-eye coordination) was found for fixed, but not for variable, displacement. Experiment 2 demonstrated that adaptation was obtained for variable displacement, but it was very fragile and is lost if the measures of adaptation are preceded by even a very brief exposure of the hand to normal or near-normal vision. Contrary to the results of some previous studies, an increase in within-S dispersion was not found of target pointing responses as a result of exposure to variable displacement. Author

N90-22946*# California Univ., Berkeley.
VISUAL ENHANCEMENTS IN PICK-AND-PLACE TASKS: HUMAN OPERATORS CONTROLLING A SIMULATED CYLINDRICAL MANIPULATOR
WON S. KIM, FRANK TENDICK, and LAWRENCE STARK *In* NASA, Ames Research Center, Spatial Displays and Spatial Instruments 25 p Jul. 1989 Previously announced in IAA as A88-23669
(Contract NCC2-86; JPL-956873)
Avail: NTIS HC A99/MF A04 CSCL 05/8

A teleoperation simulator was constructed with vector display system, joysticks, and a simulated cylindrical manipulator, in order to quantitatively evaluate various display conditions. The first of two experiments conducted investigated the effects of perspective parameter variations on human operators' pick-and-place performance, using a monoscopic perspective display. The second experiment involved visual enhancements of the monoscopic perspective display, by adding a grid and reference lines, by comparison with visual enhancements of a stereoscopic display; results indicate that stereoscopy generally permits superior pick-and-place performance, but that monoscopy nevertheless allows equivalent performance when defined with appropriate perspective parameter values and adequate visual enhancements. Author

N90-22947*# Stanford Univ., CA.
DIRECTION OF MOVEMENT EFFECTS UNDER TRANSFORMED VISUAL/MOTOR MAPPINGS
H. A. CUNNINGHAM and M. PAVEL *In* NASA, Ames Research Center, Spatial Displays and Spatial Instruments 8 p Jul. 1989
Avail: NTIS HC A99/MF A04 CSCL 05/8

Performance in a discrete aiming task was compared under several transformed visual/motor mappings: rotations by 45, 90, 135, and 180 deg and reflections about the horizontal and the vertical midlines. Eight aiming targets were used, corresponding to eight directions of movement: up, down, right, left, up-right, down-left, up-left, and down-right. Direction of movements were characterized in terms of separable visual and motor components, and two kinds of direction of movement effects were considered. First, a direction of movement effect paralleling that seen in rapid aiming under the usual nontransformed mapping. Second, because rotations, but not reflections, are physically realizable 2-D transformations, a visual/motor control system which is sensitive to physical constraints should perform reflections, but not rotations, in a piecemeal fashion. Results supported the hypothesis that a motor factor having to do with complexity of limb movement accounts for differences in movement accuracy between right and left oblique directions. Direction of movement effects were more

evident in reflections than in rotations, and were consistent with the hypothesis that the visual/motor-control system seeks a physically realizable 2-D rotation solution to reflections. Results also suggested that reversal of two orthogonal basis dimensions is far less difficult than reversing only one and leaving the other intact. Author

N90-22948*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
DISPLAYS FOR TELEMANIPULATION
BLAKE HANNAFORD, MARCOS SALGANICOFF, and ANTAL K. BEJCZY *In* NASA, Ames Research Center, Spatial Displays and Spatial Instruments 17 p Jul. 1989
Avail: NTIS HC A99/MF A04 CSCL 05/8

Visual displays drive the human operator's highest bandwidth sensory input channel. Thus, no telemanipulation system is adequate which does not make extensive use of visual displays. Although an important use of visual displays is the presentation of a televised image of the work scene, visual displays are examined for presentation of nonvisual information (forces and torques) for simulation and planning, and for management and control of the large numbers of subsystems which make up a modern telemanipulation system. Author

N90-22949*# Texas A&M Univ., College Station. Dept. of Psychology.
PERCEPTION-ACTION RELATIONSHIPS RECONSIDERED IN LIGHT OF SPATIAL DISPLAY INSTRUMENTS
WAYNE L. SHEBILSKE *In* NASA, Ames Research Center, Spatial Displays and Spatial Instruments 8 p Jul. 1989
Avail: NTIS HC A99/MF A04 CSCL 05/8

Spatial display instruments convey information about both the identity and the location of objects in order to assist surgeons, astronauts, pilots, blind individuals, and others in identification, remote manipulations, navigation, and obstacle avoidance. Scientists believe that these instruments have not reached their full potential and that progress toward new applications, including the possibility of restoring sight to the blind, will be accelerated by advancing the understanding of perceptual processes. This stimulating challenge to basic researchers was advanced by Paul Bach-Y-Rita (1972) and by the National Academy of Science (1986) report on Electronic Aids for the Blind. Although progress has been made, new applications of spatial display instruments in medicine, space, aviation, and rehabilitation await improved theoretical and empirical foundations. Author

N90-22950*# Texas A&M Univ., College Station. Dept. of Psychology.
A COMMENTARY ON PERCEPTION-ACTION RELATIONSHIPS IN SPATIAL DISPLAY INSTRUMENTS
WAYNE L. SHEBILSKE *In* NASA, Ames Research Center, Spatial Displays and Spatial Instruments 7 p Jul. 1989
Avail: NTIS HC A99/MF A04 CSCL 05/8

Transfer of information across disciplines is promoted, while basic and applied researchers are cautioned about the danger of assuming simple relationships between stimulus information, perceptual impressions, and performance including pattern recognition and sensorimotor skills. A theoretical and empirical foundation was developed predicting those relationships. Author

N90-22951*# Boeing Commercial Airplane Co., Seattle, WA.
SPATIAL DISPLAYS AS A MEANS TO INCREASE PILOT SITUATIONAL AWARENESS
DELMAR M. FADDEN, ROLF BRAUNE, and JOHN WIEDEMANN *In* NASA, Ames Research Center, Spatial Displays and Spatial Instruments 12 p Jul. 1989
Avail: NTIS HC A99/MF A04 CSCL 05/8

Experiences raise a number of concerns for future spatial-display developers. While the promise of spatial displays is great, the cost of their development will be correspondingly large. The knowledge and skills which must be coordinated to ensure successful results is unprecedent. From the viewpoint of the designer, basic knowledge of how human beings perceive and process complex displays appears fragmented and largely unquantified. Methodologies for display development require prototyping and testing with subject pilots for even small changes. Useful characterizations of the range of differences between individual users is nonexistent or at best poorly understood. The nature, significance, and frequency of interpretation errors associated with complex integrated displays is unexplored and undocumented territory. Graphic displays have intuitive appeal and can achieve face validity much more readily than earlier symbolic displays. The risk of misleading the pilot is correspondingly greater. Thus while some in the research community are developing the tools and techniques necessary for effective spatial-display development, potential users must be educated about the issues so that informed choices can be made. The scope of the task facing all is great. The task is challenging and the potential for meaningful contributions at all levels is high indeed. Author

N90-22954*# Sandia National Labs., Albuquerque, NM. Advanced Technology Div.
EXPERIENCES IN TELEOPERATION OF LAND VEHICLES
DOUGLAS E. MCGOVERN *In* NASA, Ames Research Center, Spatial Displays and Spatial Instruments 11 p Jul. 1989
(Contract DE-AC04-76DP-00789)
Avail: NTIS HC A99/MF A04 CSCL 05/8

Teleoperation of land vehicles allows the removal of the operator from the vehicle to a remote location. This can greatly increase operator safety and comfort in applications such as security patrol or military combat. The cost includes system complexity and reduced system performance. All feedback on vehicle performance and on environmental conditions must pass through sensors, a communications channel, and displays. In particular, this requires vision to be transmitted by close-circuit television with a consequent degradation of information content. Vehicular teleoperation, as a result, places severe demands on the operator. Teleoperated land vehicles have been built and tested by many organizations, including Sandia National Laboratories (SNL). The SNL fleet presently includes eight vehicles of varying capability. These vehicles have been operated using different types of controls, displays, and visual systems. Experimentation studying the effects of vision system characteristics on off-road, remote driving was performed for conditions of fixed camera versus steering-coupled camera and of color versus black and white video display. Additionally, much experience was gained through system demonstrations and hardware development trials. The preliminary experimental findings and the results of the accumulated operational experience are discussed. Author

N90-22955*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
DEVELOPMENT OF A STEREO 3-D PICTORIAL PRIMARY FLIGHT DISPLAY
MARK NATAUPSKY, TIMOTHY L. TURNER, HAROLD LANE, and LUCILLE CRITTENDEN (Research Triangle Inst., Research Triangle Park, NC.) *In* NASA, Ames Research Center, Spatial Displays and Spatial Instruments 8 p Jul. 1989
Avail: NTIS HC A99/MF A04 CSCL 05/8

Computer-generated displays are becoming increasingly popular in aerospace applications. The use of stereo 3-D technology provides an opportunity to present depth perceptions which otherwise might be lacking. In addition, the third dimension could also be used as an additional dimension along which information can be encoded. Historically, the stereo 3-D displays have been used in entertainment, in experimental facilities, and in the handling of hazardous waste. In the last example, the source of the stereo images generally has been remotely controlled television camera pairs. The development of a stereo 3-D pictorial primary flight display used in a flight simulation environment is described. The applicability of stereo 3-D displays for aerospace crew stations to meet the anticipated needs for 2000 to 2020 time frame is investigated. Although, the actual equipment that could be used in an aerospace vehicle is not currently available, the lab research is necessary to determine where stereo 3-D enhances the display of information and how the displays should be formatted. Author

N90-22956*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
SYNTHETIC PERSPECTIVE OPTICAL FLOW: INFLUENCE ON PILOT CONTROL TASKS
C. THOMAS BENNETT, WALTER W. JOHNSON, JOHN A. PERRONE, and ANIL V. PHATAK (Analytical Mechanics Associates, Inc., Palo Alto, CA.) *In its* Spatial Displays and Spatial Instruments 9 p Jul. 1989
Avail: NTIS HC A99/MF A04 CSCL 05/8

One approach used to better understand the impact of visual flow on control tasks has been to use synthetic perspective flow patterns. Such patterns are the result of apparent motion across a grid or random dot display. Unfortunately, the optical flow so generated is based on a subset of the flow information that exists in the real world. The danger is that the resulting optical motions may not generate the visual flow patterns useful for actual flight control. Researchers conducted a series of studies directed at understanding the characteristics of synthetic perspective flow that support various pilot tasks. In the first of these, they examined the control of altitude over various perspective grid textures (Johnson et al., 1987). Another set of studies was directed at studying the head tracking of targets moving in a 3-D coordinate system. These studies, parametric in nature, utilized both impoverished and complex virtual worlds represented by simple perspective grids at one extreme, and computer-generated terrain at the other. These studies are part of an applied visual research program directed at understanding the design principles required for the development of instruments displaying spatial orientation information. The experiments also highlight the need for modeling the impact of spatial displays on pilot control tasks. Author

N90-22958*# Max-Planck-Inst. fuer Verhaltensphysiologie, Seewiesen uber Starnberg (Germany, F.R.).
INTERACTIONS OF FORM AND ORIENTATION
HORST MITTELSTAEDT *In* NASA, Ames Research Center, Spatial Displays and Spatial Instruments 14 p Jul. 1989
Avail: NTIS HC A99/MF A04 CSCL 05/8

It is well known that the orientation of an optical pattern relative to egocentric or extraneous references affects its figural quality, that is, alters its perceived form and concomitantly delays or quickens its identification (Rock 1973). A square presented in the frontal plane to an upright person (S), for instance, changes from a box to a diamond when it is rotated with respect to the S's median plane by 45 deg. This angle, that is, the angle between the orientations of the pattern in which the two apparent figures (Gestalten) attain a summit of purity and distinctness, will be called the figural disparity of the pattern. If, as in this case, the S is upright, the retinal meridian and the subjective vertical (SV) are both in the viewer's median plane. The question arises with respect to which of these orientation references the two figures are identified. The answer may be found when the pattern and the S are oriented in such a way that the projections of the retinal meridian and the SV into the plane of the pattern diverge by the pattern's figural disparity or its periodic multiples: that is, in this case of a square by 45 or 135 deg, respectively. Similarly, which reference determines whether an equilateral triangle is seen as a pyramid or a traffic warning sign may be revealed at a divergence of SV and retinal meridian of 60 or 180 deg, respectively. It is generally found that for head roll tilts (Rho) and figural disparities of up to 90 deg, the figure whose axis coincides with the SV is seen. At head tilts of Rho = 180 deg, however, the retinal reference dominates, as a rule independently of the figural disparity.
Author

N90-22959*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
OPTICAL, GRAVITATIONAL, AND KINESTHETIC DETERMINANTS OF JUDGED EYE LEVEL
ARNOLD E. STOPER and MALCOLM M. COHEN *In its* Spatial Displays and Spatial Instruments 18 p Jul. 1989
Avail: NTIS HC A99/MF A04 CSCL 05/8

Subjects judged eye level, defined in three distinct ways relative to three distinct reference planes: a gravitational horizontal, giving the gravitationally referenced eye level (GREL); a visible surface, giving the surface-referenced eye level (SREL); and a plane fixed with respect to the head, giving the head-referenced eye level (HREL). The information available for these judgements was varied by having the subjects view an illuminated target that could be placed in a box which: (1) was pitched at various angles, (2) was illuminated or kept in darkness, (3) was moved to different positions along the subject's head-to-foot body axis, and (4) was viewed with the subjects upright or reclining. The results showed: (1) judgements of GREL made in the dark were 2.5 deg lower than in the light, with a significantly greater variability; (2) judged GREL was shifted approximately half of the way toward SREL when these two eye levels did not coincide; (3) judged SREL was shifted about 12 percent of the way toward HREL when these two eye levels did not coincide, (4) judged HREL was shifted about half way toward SREL when these two eye level did not coincide and when the subject was upright (when the subject was reclining, HREL was shifted approx. 90 percent toward SREL); (5) the variability of the judged HREL in the dark was nearly twice as great with the subject reclining than with the subject upright. These results indicate that gravity is an important source of information for judgement of eye level. In the absence of information concerning the direction of gravity, the ability to judge HREL is extremely poor. A visible environment does not seem to afford precise information as to judgements of direction, but it probably does afford significant information as to the stability of these judgements.
Author

N90-22960*# Hamburg Univ. (Germany, F.R.). Neurological Clinic.
VOLUNTARY PRESETTING OF THE VESTIBULAR OCULAR REFLEX PERMITS GAZE STABILIZATION DESPITE PERTURBATION OF FAST HEAD MOVEMENTS
WOLFGANG H. ZANGEMEISTER *In* NASA, Ames Research Center, Spatial Displays and Spatial Instruments 11 p Jul. 1989
Avail: NTIS HC A99/MF A04 CSCL 05/8

Normal subjects are able to change voluntarily and continuously their head-eye latency together with their compensatory eye movement gain. A continuous spectrum of intent-latency modes of the subject's coordinated gaze through verbal feedback could be demonstrated. It was also demonstrated that the intent to counteract any perturbation of head-eye movement, i.e., the mental set, permitted the subjects to manipulate consciously their vestibular ocular reflex (VOR) gain. From the data, it is inferred that the VOR is always on. It may be, however, variably suppressed by higher cortical control. With appropriate training, head-mounted displays should permit an easy VOR presetting that leads to image stabilization, perhaps together with a decrease of possible misjudgements.
Author

N90-22961*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
THE MAKING OF THE MECHANICAL UNIVERSE
JAMES BLINN *In* NASA, Ames Research Center, Spatial Displays and Spatial Instruments 18 p Jul. 1989
Avail: NTIS HC A99/MF A04 CSCL 05/8

The Mechanical Universe project required the production of over 550 different animated scenes, totaling about 7 and 1/2 hours of screen time. The project required the use of a wide range of techniques and motivated the development of several different software packages. A documentation is presented of many aspects of the project, encompassing artistic design issues, scientific simulations, software engineering, and video engineering.
Author

N90-22962*# Massachusetts Univ., Amherst. Center for Art and Technology.
SYNESTHETIC ART THROUGH 3-D PROJECTION: THE REQUIREMENTS OF A COMPUTER-BASED SUPERMEDIUM
ROBERT MALLARY *In* NASA, Ames Research Center, Spatial Displays and Spatial Instruments 13 p Jul. 1989
Avail: NTIS HC A99/MF A04 CSCL 05/8

A computer-based form of multimedia art is proposed that uses

the computer to fuse aspects of painting, sculpture, dance, music, film, and other media into a one-to-one synthesia of image and sound for spatially synchronous 3-D projection. Called synesthetic art, this conversion of many varied media into an aesthetically unitary experience determines the character and requirements of the system and its software. During the start-up phase, computer stereographic systems are unsuitable for software development. Eventually, a new type of illusory-projective supermedium will be required to achieve the needed combination of large-format projection and convincing real life presence, and to handle the vast amount of 3-D visual and acoustic information required. The influence of the concept on the author's research and creative work is illustrated through two examples. Author

N90-22964*# Princeton Univ., NJ. Dept. of Mechanical and Aerospace Engineering.

VOLUMETRIC VISUALIZATION OF 3D DATA

GREGORY RUSSELL and RICHARD MILES *In* NASA, Ames Research Center, Spatial Displays and Spatial Instruments 8 p Jul. 1989 Sponsored in part by Princeton Univ., NJ and ONR, Washington, DC

Avail: NTIS HC A99/MF A04 CSCL 09/2

In recent years, there has been a rapid growth in the ability to obtain detailed data on large complex structures in three dimensions. This development occurred first in the medical field, with CAT (computer aided tomography) scans and now magnetic resonance imaging, and in seismological exploration. With the advances in supercomputing and computational fluid dynamics, and in experimental techniques in fluid dynamics, there is now the ability to produce similar large data fields representing 3D structures and phenomena in these disciplines. These developments have produced a situation in which currently there is access to data which is too complex to be understood using the tools available for data reduction and presentation. Researchers in these areas are becoming limited by their ability to visualize and comprehend the 3D systems they are measuring and simulating. Author

N90-22965*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

DETERMINATION OF DEPTH-VIEWING VOLUMES FOR STEREO THREE-DIMENSIONAL GRAPHIC DISPLAYS

RUSSELL V. PARRISH and STEVEN P. WILLIAMS (Army Aviation Systems Command, Saint Louis, MO.) Washington Jun. 1990 21 p

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(NASA-TP-2999; L-16655; NAS 1.60:2999; AVSCOM-TM-90-B-016) Avail: NTIS HC A03/MF A01 CSCL 05/8

Real-world, 3-D, pictorial displays incorporating true depth cues via stereopsis techniques offer a potential means of displaying complex information in a natural way to prevent loss of situational awareness and provide increases in pilot/vehicle performance in advanced flight display concepts. Optimal use of stereopsis requires an understanding of the depth viewing volume available to the display designer. Suggested guidelines are presented for the depth viewing volume from an empirical determination of the effective region of stereopsis cueing (at several viewer-CRT screen distances) for a time multiplexed stereopsis display system. The results provide the display designer with information that will allow more effective placement of depth information to enable the full exploitation of stereopsis cueing. Increasing viewer-CRT screen distances provides increasing amounts of usable depth, but with decreasing fields-of-view. A stereopsis hardware system that permits an increased viewer-screen distance by incorporating larger screen sizes or collimation optics to maintain the field-of-view at required levels would provide a much larger stereo depth-viewing volume. Author

N90-22966*# Bionetics Corp., Cocoa Beach, FL.

THE PHYSIOLOGICAL COST OF WEARING THE PROPELLANT HANDLER'S ENSEMBLE AT THE KENNEDY SPACE CENTER

BRIAN R. SCHONFELD, DONALD F. DOERR, and CLARE MARIE TOMASELLI Jan. 1990 47 p Prepared in cooperation with NASA, Kennedy Space Center, Cocoa Beach, FL

(Contract NAS10-10285)

(NASA-TM-102786; NAS 1.15:102786) Avail: NTIS HC A03/MF A01 CSCL 05/8

The potential for exposure to toxins used in the propulsion systems of spacecraft dictates the use of a whole body protective suit, the Propellant Handler's Ensemble (PHE) during preflight preparation and launching. The weight, structure, and operating parameters of the PHE may be expected to have a significant impact upon the metabolic, cardiovascular, and thermal responses of the user, especially during ambient temperature extremes and high workload situations. Four male subjects participated in tests in -7, 23, and 43 C (20, 74, and 110 F) environments in two versions of the PHE, the autonomous backpack (BP) and the hoseline (HL) supplied configuration. Measurements included heart rate (HR) rectal temperature, four skin temperatures, oxygen (O2), and carbon dioxide (CO2) in the helmet area, interior suit temperature, and suit pressure. Exercise metabolism was estimated from HR, PHE weight, and treadmill speed and grade. The HR responses between each PHE configuration were not statistically different. As a percentage of HR maximum, the mean values were 79 percent (COLD), 84 percent (LAB), and 90 percent (HOT). Helmet O2 and CO2 levels were correlated with percent HR max (P less than 0.001). Rectal temperatures were similar for each PHE configuration, except in the HOT exposure where the BP version exceeded the HL configuration (P less than 0.05). In nearly every instance the HR was driven to moderately high levels, the supplied respiratory gases were not optimum, and thermal adversity was a primary stressor. Our findings suggest that medical and physical fitness standards, along with operational restrictions, should be imposed upon PHE users to avoid situations that could adversely affect the worker. Author

N90-22967# Southampton Univ. (England). Human Factors Research Unit.

THE APPLICATION OF A NON-LINEAR LEAST SQUARES METHOD TO PREDICTING SEAT TRANSMISSIBILITY

C. Y. CHEN and M. J. GRIFFIN Mar. 1989 29 p

(ISVR-TR-173; ETN-90-96446) Avail: NTIS HC A03/MF A01

A standard procedure for measuring seat transmissibility is investigated. The subject-seat system is divided into two subsystems: the human body and the seat. The application of the nonlinear least squares method to both subsystems is described. The predictions and measurements of the apparent mass, M (omega), (of the seated human body) and the dynamic stiffness, S (omega), (of the seat) are in good agreement. Using the Gauss-Newton method, dynamic parameters in both subsystems were obtained and the transmissibility of the seat was determined. The predicted and measured values of seat transmissibility, H (omega), are similar. ESA

N90-22968# Technische Univ., Berlin (Germany, F.R.). Inst. fuer. Luft- und Raumfahrt.

LUNAR BASE 2 (THE SECOND THOUSAND DAYS OF A BASE ON THE MOON)

A. ECKERT, A.-J. HENNING, A. MONOKROUSSOS, R. SCHMUDLACH, and C. STUURMAN 1989 61 p Presented at the Summer Semester Course on Spaceflight Planning, Berlin, Fed. Republic of Germany, 1989

(ILR-MITT-230(1989); ETN-90-96482) Avail: NTIS HC A04/MF A01

The growth of an initial lunar base is examined. Beginning with a crew of 48 persons, its capacity is expanded to 100 persons after a thousand days. The requirements and effects of this developing lunar outpost are considered. Special attention is payed to further evolution towards a full grown fabrication site for lunar oxygen and other raw materials. The following topics are included: central base configuration, power systems, lunar science, lunar farm, infrastructure and transportation, and operations time schedule. ESA

N90-22969# Naval Submarine Medical Center, Groton, CT.
MOTOR AND COGNITIVE PERFORMANCE DO NOT CHANGE DURING A TEN-WEEK SUBMARINE PATROL Interim Report, Oct. 1988 - Sep. 1989
CHRISTINE L. SCHLICHTING, DAVID J. STYER, and PATRICK GRAY 22 Dec. 1989 11 p
(AD-A218639; NSMRL-1150) Avail: NTIS HC A03/MF A01 CSCL 05/8

Submariners experience many stresses and changes in their normal lifestyles while on patrol. These stresses may affect performance, vitamin levels, mood, and blood chemistry. The effect of vitamin supplementation on performance in submariners before, during, and after a submarine patrol was investigated. While on patrol, half of the subjects were given a vitamin supplement while the other half received a placebo. There were no changes in performance on tests of motor performance, timed mental arithmetic, digit symbol substitution, or choice reaction time that could be attributed to either the vitamin supplement or to the patrol. GRA

N90-22970# Federal Aviation Administration, Washington, DC. Office of Aviation Medicine.
AIRLINER CABIN OZONE: AN UPDATED REVIEW Final Report
C. E. MELTON Dec. 1989 19 p
(AD-A219264; SOT/FAA/AM-89/13) Avail: NTIS HC A03/MF A01 CSCL 06/11

The recent literature pertaining to ozone contamination of airliner cabins is reviewed. Measurements in airliner cabins without filters showed that ozone levels were about 50 percent of atmospheric ozone. Filters were about 90 percent effective in destroying ozone. Ozone (0.12 to 0.14 ppmv) caused mild subjective respiratory irritation in exercising men, but 0.20 to 0.30 ppmv did not have adverse effects on patients with chronic heart or lung disease. Ozone (1.0 to 2.0 ppmv) decreased survival time of influenza infected rats and mice and suppressed the capacity of lung macrophages to destroy Listeria. Airway responses to ozone are divided into an early parasympathetically mediated bronchoconstrictive phase and a later histamine-mediated congestive phase. Evidence indicates that intracellular free radicals are responsible for ozone damage and that the damage may be spread to other cells by toxic intermediate products: Antioxidants provide some protection to cells in vitro from ozone but dietary intake of antioxidant vitamins by humans has only a weak effect, if any. This review indicates that earlier findings regarding ozone toxicity do not need to be corrected. Compliance with existing FAA ozone standards appears to provide adequate protection to aircrews and passengers. GRA

N90-22971# Florida Univ., Gainesville.
MULTIMEDIA SYSTEM CONTROL Final Technical Report, Jun. 1988 - May 1989
D. G. CHILDERS, J. C. PRINCIPE, and A. A. ARROYO Jan. 1990 25 p
(Contract F30602-88-D-0027)
(AD-A219392; RADC-TR-89-321) Avail: NTIS HC A03/MF A01 CSCL 23/2

The initial objective of this research program was to investigate new ways of interactive communication between the human and the computer. In highly specialized and demanding environments such as computer aided design, computer aided manufacturing, information processing or battle management, an integrated workstation using other than the conventional keyboard, mouse or touch displays may be necessary. Specifically we propose to investigate the use of brain waves (electroencephalogram- EEG) to control cursor movements, such that a desired command could be selected from a given menu. We call this interface, the EEG mouse. The computer user brain waves will have to be transmitted (we propose through radio telemetry) and processed by the workstation. However, the user will control the computer function by selecting functions from a menu by pure thought. No other computer input would have to be activated. With the advances in digital signal processing of the brain waves in real-time would be easily implemented in an I/O subsystem built around one of DSP chips. Our conclusion is that the neural network shows potential to discriminate between YES and NO answers using signal evoked responses. Further tuning of the signal processing is required to increase the reliability of the technique. GRA

N90-23063*# Iowa Univ., Iowa City. Dept. of Mechanical Engineering.
MAN-IN-THE-CONTROL-LOOP SIMULATION OF MANIPULATORS
J. L. CHANG, TSUNG-CHIEH LIN, and K. HAROLD YAE *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the 3rd Annual Conference on Aerospace Computational Control, Volume 2 p 688-798 15 Dec. 1989
Avail: NTIS HC A20/MF A03 CSCL 05/8

A method to achieve man-in-the-control-loop simulation is presented. Emerging real-time dynamics simulation suggests a potential for creating an interactive design workstation with a human operator in the control loop. The recursive formulation for multibody dynamics simulation is studied to determine requirements for man-in-the-control-loop simulation. High speed computer graphics techniques provides realistic visual cues for the simulator. Backhoe and robot arm simulations are implemented to demonstrate the capability of man-in-the-control-loop simulation. Author

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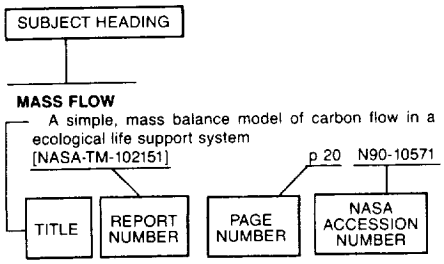

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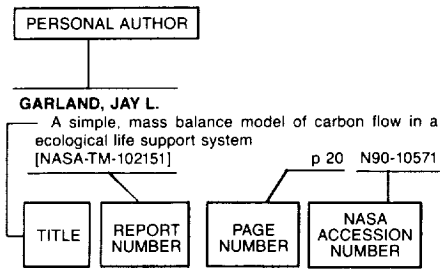

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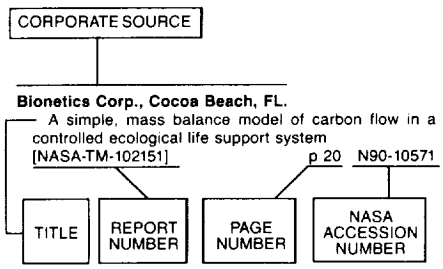

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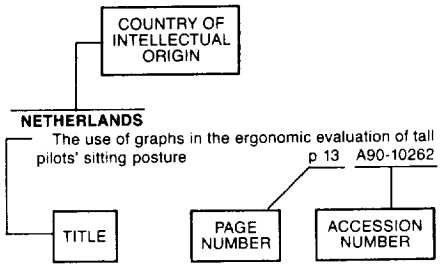

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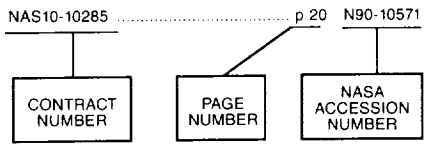

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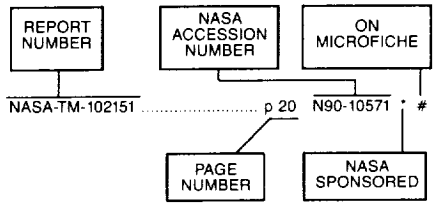

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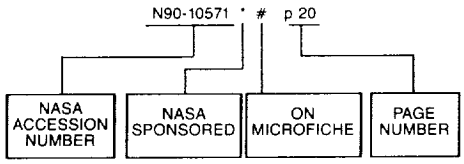

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