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NASA SP-7011 (376)
June 1993

AEROSPACE MEDICINE AND BIOLOGY

A CONTINUING BIBLIOGRAPHY WITH INDEXES

(NASA-SP-7011(376)) AEROSPACE MEDICINE AND BIOLOGY: A CONTINUING BIBLIOGRAPHY WITH INDEXES (SUPPLEMENT 376) (NASA) 89 p

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NASA SP-7011 (376)
June 1993

AEROSPACE MEDICINE AND BIOLOGY

A CONTINUING BIBLIOGRAPHY WITH INDEXES

National Aeronautics and Space Administration
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INTRODUCTION

This issue of *Aerospace Medicine and Biology* (NASA SP-7011) lists 265 reports, articles and other documents recently announced in the NASA STI Database. The first issue of *Aerospace Medicine and Biology* was published in July 1964.

Accession numbers cited in this issue include:

Scientific and Technical Aerospace Reports (STAR) (N-10000 Series)	N93-20541 — N93-22535
International Aerospace Abstracts (A-10000 Series)	A93-25711 — A93-29780

In its subject coverage, *Aerospace Medicine and Biology* concentrates on the biological, physiological, psychological, and environmental effects to which humans are 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. Applied research receives the most emphasis, but references to fundamental studies and theoretical principles related to experimental development also qualify for inclusion.

Each entry in the publication consists of a standard 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 include the original accession numbers from the respective announcement journals.

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

A cumulative index for 1993 will be published in early 1994.

Information on availability of documents listed, addresses of organizations, and CASI price schedules are located at the back of this issue.

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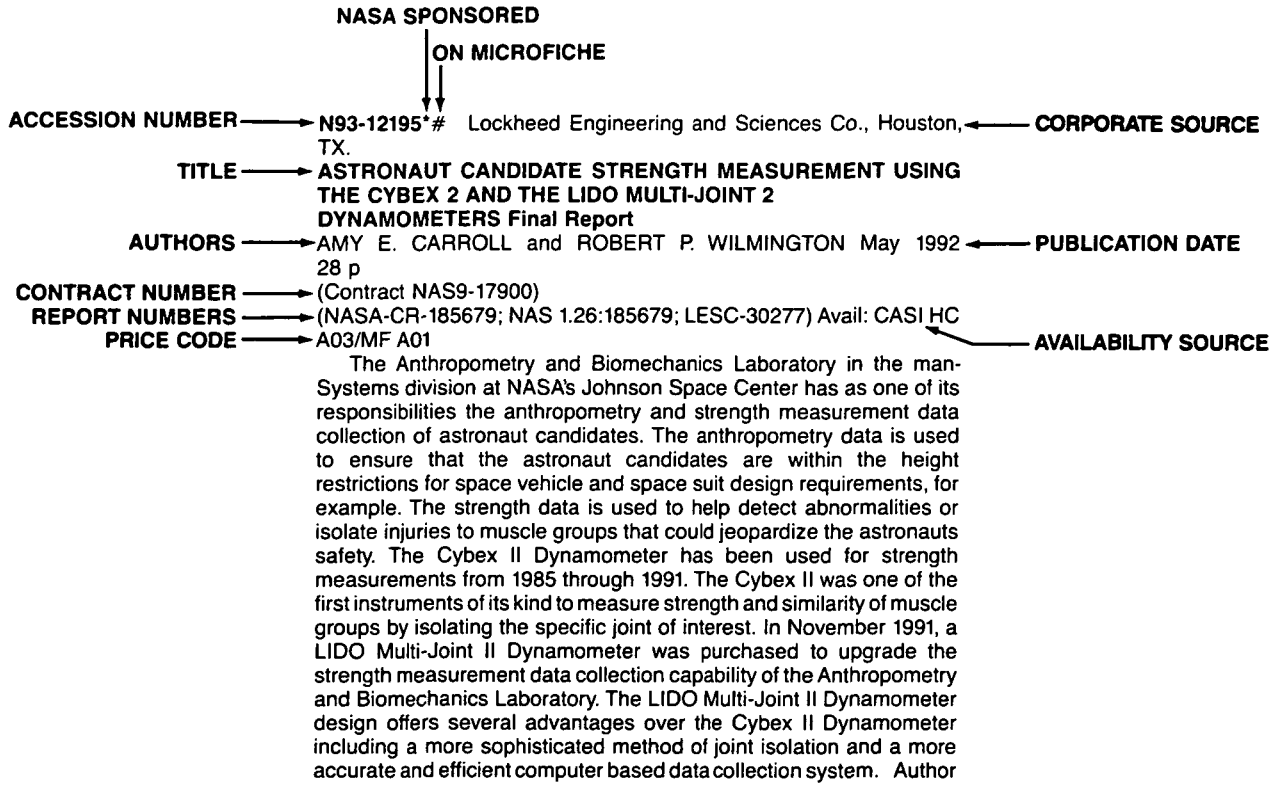
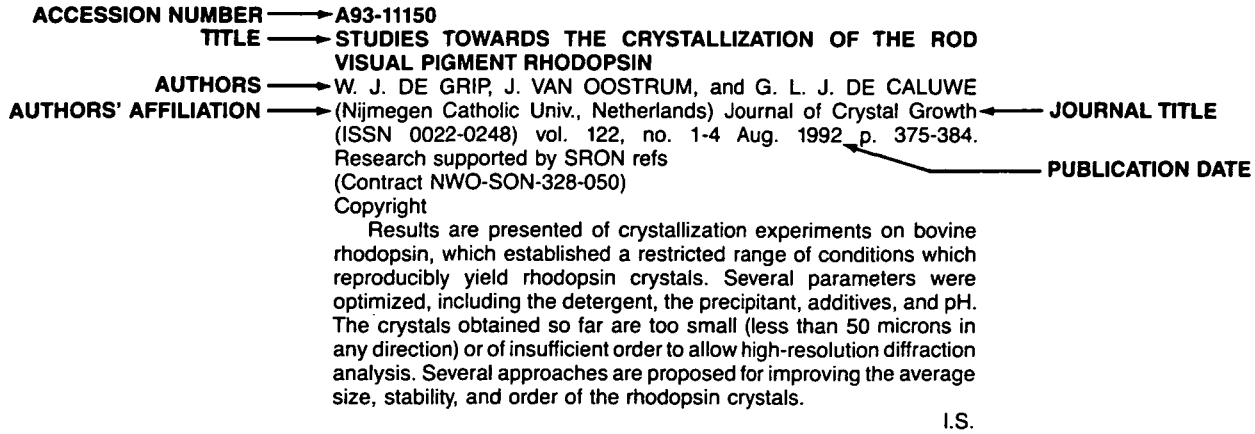


TYPICAL JOURNAL ARTICLE CITATION AND ABSTRACT



AEROSPACE MEDICINE AND BIOLOGY

A Continuing Bibliography (Suppl. 376)

June 1993

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LIFE SCIENCES (GENERAL)

A93-25821
STRUCTURE OF A MOLECULAR CHAPERONE FROM A THERMOPHILIC ARCHAEBACTERIUM
BARRY M. PHIPPS, DIETER TYPKE, REINER HEGERL, SUSANNE VOLKER (Max Planck Inst. for Biochemistry, Martinsried, Germany), ANGELIKA HOFFMANN, KARL O. STETTER (Regensburg Univ., Germany), and WOLFGANG BAUMEISTER (Max Planck Inst. for Biochemistry, Martinsried, Germany) Nature (ISSN 0028-0836) vol. 361, no. 6411 Feb. 4, 1993 p. 475-477. Research sponsored by Medical Research Council of Canada refs
Copyright

It was recently reported that a wide range of thermophilic archaebacteria have a novel ATPase complex, called a thermosome, which accumulates to high levels upon heat shock and may be a new type of molecular chaperone related to the chaperonins. The 3D structure of the thermosome from Pyrodictium occultum is determined here by random conical tilt reconstruction from electron micrographs. The reconstruction reveals a complex consisting of two rings of eight subunits each, stacked face-to-face. The subunits are kidney-shaped and composed of at least two domains. In the center of the thermosome is a large cavity of about 6.7 nm diameter; the opening of this cavity on each face of the complex is partially blocked by a mass which appears to be weakly connected to the eight-membered ring. C.D.

A93-26500* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
INCREASED RELEASE OF BRAIN SEROTONIN REDUCES VULNERABILITY TO VENTRICULAR FIBRILLATION IN THE CAT
HENDRIK LEHNERT (Medizinische Universitaetsklinik, Mainz, Germany), FEDERICO LOMBARDI (Cardiovascular Research Inst., Milan, Italy), ERNST A. RAEDER (Harvard Univ., Boston, MA), ANTONIO V. LORENZO (Children's Hospital Medical Center; MIT, Boston, MA), RICHARD L. VERRIER, BERNARD LOWN (Harvard Univ., Boston, MA), and RICHARD J. WURTMAN Journal of Cardiovascular Pharmacology (ISSN 0160-2446) vol. 10, no. 4 1987 p. 389-397. Research supported by Rappaport International Program in Cardiology, DFG, and Vittorio de Nora/Diamond Shamrock Foundation refs
(Contract NIH-HL-07776; NIH-HL-33567; NAG2-210)
Copyright

The effect of administering the serotonin precursor 5-l-hydroxytryptophan, in conjunction with a monamine oxidase inhibitor phenelzine and a l-amino acid decarboxylase inhibitor carbidopa, on neurochemical changes in the concentrations of serotonin and 5-hydroxyindoleacetic acid (5-HIAA) in the cerebrospinal fluid of the cat were investigated. Results showed that this drug regimen led to increases of serotonin and 5-hydroxyindoleacetic acid (5-HIAA) concentrations in the cerebrospinal fluid by 330 and 830 percent, respectively. Concomitantly, the threshold of ventricular fibrillation was found to be elevated by 42 percent and the effective refractory period was prolonged by 7 percent; the efferent sympathetic neural activity was suppressed in the normal heart. The results indicate that the enhancement of central serotoninergic neurotransmission can reduce the susceptibility of the heart to ventricular fibrillation mediated through a decline in sympathetic neural traffic to the heart. I.S.

A93-26548
GRAVIPERCEPTION IN UNICELLULAR ORGANISMS - A COMPARATIVE BEHAVIOURAL STUDY UNDER SHORT-TERM MICROGRAVITY
HANS MACHEMER, RICHARD BRAEUCKER (Bochum, Ruhr-Univ., Germany), AKIRA MURAKAMI (Hamamatsu Univ., Japan), and KENJIRO YOSHIMURA (Tokyo Univ., Japan) Microgravity Science and Technology (ISSN 0938-0108) vol. 5, no. 4 Feb. 1993 p. 221-231. Research supported by DARA and Science and Technology Agency of Japan refs
Copyright

Three species of unicellular ciliated organisms, Paramecium, Didinium, and Loxodes, were adjusted to defined culturing state, experimental solution, O2-supply, and temperature and were subjected to step-type transition from terrestrial gravity to 4.5 seconds of microgravity (near 10 exp -4 g) in a drop tower. For a quantitative approach to cellular behavior under microgravity, four identical modules designed for videotape recording of cellular locomotion were incubated at one time in the drop capsule, and each module held an experimental chamber including 100 to 200 cells. Image analysis of the data shows that the normal orientation bias of vertically swimming cells of Paramecium and Didinium (negative gravitaxis) was missing under microgravity; so were gravity-induced changes in velocity of these cells (gravikinesis), which tend to compensate passive sedimentation rates at 1 g. The rates of microgravity locomotion in Paramecium and Loxodes correspond to horizonal locomotion at 1 g. In Didinium, swimming at microgravity exceeds horizontal swimming at 1 g. Author

A93-26549
SWIMMING BEHAVIOR OF THE UNICELLULAR FLAGELLATE, EUGLENA GRACILIS, IN SIMULATED AND REAL MICROGRAVITY
KURT VOGEL (Erlangen-Nuernberg, Univ., Erlangen, Germany), RUTH HEMMERSBACH-KRAUSE (DLR, Inst. fuer Flugmedizin, Cologne, Germany), CHRISTIAN KUEHNEL, and DONAT-P. HAEDER (Erlangen-Nuernberg, Univ., Erlangen, Germany) Microgravity Science and Technology (ISSN 0938-0108) vol. 5, no. 4 Feb. 1993 p. 232-237. Research supported by DARA and BMFT refs
Copyright

The effects of real and simulated microgravity (on a fast rotating horizontal clinostat) on graviorientation and swimming velocity were studied in the photosynthetic unicellular flagellate Euglena gracilis. When an accurate orientation was achieved under 1 g-conditions, random orientation was observed under both simulated and real microgravity within a few minutes, indicating that the threshold for gravitaxis is higher than the residual acceleration in the range of 10 exp -3 to 10 exp -4 g. After the onset of microgravity, the cells persisted in their original direction until they were reoriented by collision with other cells or endogenous course corrections. The swimming velocities under the different conditions followed

Gaussian distributions. The mean velocity is higher under microgravity than at 1 g; this effect at 1 g is due to the sedimentation of the cells. The experiments prove that the fast rotating clinostat is a suitable research tool to produce simulated microgravity.
Author

A93-27000* National Aeronautics and Space Administration, Washington, DC.
TRYPTOPHAN AVAILABILITY MODULATES SEROTONIN RELEASE FROM RAT HYPOTHALAMIC SLICES
JUDITH D. SCHAECHTER and RICHARD J. WURTMAN (MIT, Cambridge, MA) Journal of Neurochemistry (ISSN 0022-3042) vol. 53, no. 6 1989 p. 1925-1933. Research supported by NASA, USAF, Center for Brain Sciences and Metabolism Charitable Trust, et al refs
Copyright
The relationship between the tryptophan availability and serononin release from rat hypothalamus was investigated using a new in vitro technique for estimating rates at which endogenous serotonin is released spontaneously or upon electrical depolarization from hypothalamic slices superfused with a solution containing various amounts of tryptophan. It was found that the spontaneous, as well as electrically induced, release of serotonin from the brain slices exhibited a dose-dependent relationship with the tryptophan concentration of the superfusion medium. I.S.

A93-27049* National Aeronautics and Space Administration, Washington, DC.
EFFECT OF CHRONIC D-FENFLURAMINE ADMINISTRATION ON RAT HYPOTHALAMIC SEROTONIN LEVELS AND RELEASE
JUDITH D. SCHAECHTER and RICHARD J. WURTMAN (MIT, Cambridge, MA) Life Sciences (ISSN 0024-3205) vol. 44, no. 4 1989 p. 265-271. Research supported by NASA, USAF, and Center for Brain Sciences and Metabolism Charitable Trust refs
Copyright
The effect of administering to rats (in doses of 1.25, 2.5, 5, or 10 mg/kg/day for 10 days) of an anorectic agent, D-fenfluramine, on the serotonin levels in hypothalamic tissue and on the in vitro release of serotonin by hypothalamic slices was investigated in rats which were sacrificed six days after the end of treatment. It was found that D-fenfuramine had no effect on tissue serotonin in doses from 1.25 to 5 mg/kg. However, given at 10 mg/kg level, serotonin led to a 22 percent decrease. The release of serotonin was found to be not affected by D-fenfluramine. I.S.

A93-27050* National Aeronautics and Space Administration, Washington, DC.
DOPAMINE RELEASE IN RAT STRIATUM - PHYSIOLOGICAL COUPLING TO TYROSINE SUPPLY
MATTHEW J. DURING, IAN N. ACWORTH, and RICHARD J. WURTMAN (MIT, Cambridge, MA) Journal of Neurochemistry (ISSN 0022-3042) vol. 52, no. 5 1989 p. 1449-1454. Research supported by USAF, Center for Brain Sciences and Metabolism Charitable Trust, and NASA refs
Copyright
Intracerebral microdialysis was used to monitor dopamine release in rat striatal extracellular fluid following the intraperitoneal administration of dopamine's precursor amino acid, L-tyrosine. Dopamine concentrations in dialysates increased transiently after tyrosine (50-100 mg/kg) administration. Pretreatment with haloperidol or the partial lesioning of nigrostriatal neurons enhanced the effect of tyrosine on dopamine release, and haloperidol also prolonged this effect. These data suggest that nigrostriatal dopaminergic neurons are responsive to changes in precursor availability under basal conditions, but that receptor-mediated feedback mechanisms limit the magnitude and duration of this effect.
Author

A93-27224
DIFFERENTIAL EFFECTS OF INSULIN RESISTANCE ON LEUCINE AND GLUCOSE KINETICS IN OBESITY
BENJAMIN CABALLERO (MIT, Cambridge, MA; Johns Hopkins Univ., Baltimore, MD) and RICHARD J. WURTMAN (MIT, Cambridge, MA) Metabolism (ISSN 0026-0495) vol. 40, no. 1 Jan. 1991 p. 51-58. Research supported by Center for Brain Sciences and Metabolism Charitable Trust refs
(Contract NIH-M01-RR-00088)
Copyright
The effect of insulin resistance on glucose and amino acid metabolism was investigated by measuring the glucose disposal rate, hepatic glucose production, and leucine carbon flux and oxidation, during the postabsorptive state and during euglycemic hyperinsulinemia in obese nondiabetic women and in lean controls. It was found that the insulin-mediated glucose disposal rate was significantly lower in the obese group than in controls. The insulin-induced decrease in plasma levels of branched chain amino acids was also significantly lowered in the obese group. However, the baseline leucine flux was similar in obese and in lean subjects, and its decline in response to insulin infusion was also comparable, as was also basal leucine carbon oxidation. The results indicate that the elevation in plasma branched chain amino acid levels commonly observed in obesity is not necessarily associated with an impaired insulin-mediated amino acid flux. I.S.

A93-27460
DYNAMICS OF THE CONTROLLED ENVIRONMENT CONDITIONS IN 'SVET' GREENHOUSE IN FLIGHT
T. N. IVANOVA and I. DANDOLOV (Bulgarian Academy of Sciences, Space Research Inst., Sofia, Bulgaria) B'lgarska Akademiia na Naukite, Dokladi (ISSN 0861-1459) vol. 45, no. 3 1992 p. 33-35. refs
Copyright
The dynamics of the controlled environment conditions in the SVET-4 space greenhouse model were investigated, using computerized equipment to continuously measure and collect the values of the inside environment parameters, which were then sent to earth. The on-ground analysis of telemetric data for the first 29 days indicated that radishes and the Chinese cabbage plants planted in SVET-4 grew under normal temperature conditions, but in insufficient substrate moisture. After supplying the necessary quantity of water, the analysis of the first 54 days of experiment is continuing. I.S.

A93-27775* National Aeronautics and Space Administration, Washington, DC.
THE EARLIEST FOSSIL EVIDENCE FOR SEXUAL DIMORPHISM IN PRIMATES
LEONARD KRISHTALKA (Carnegie Museum of Natural History, Pittsburgh, PA), RICHARD K. STUCKY (Denver Museum of Natural History, CO), and K. C. BEARD (Carnegie Museum of Natural History, Pittsburgh, PA) National Academy of Sciences, Proceedings (ISSN 0027-8424) vol. 87 July 1990 p. 5223-5226. Research supported by Carnegie Museum of Natural History refs
(Contract NSF BSR-84-02051; NSF BSR-87-09242; NAGW-949)
Copyright
Recently obtained material of the early Eocene primate Notharctus venticolus, including two partial skulls from a single stratigraphic horizon, provides the geologically earliest evidence of sexual dimorphism in canine size and shape in primates and the only unequivocal evidence for such dimorphism in strepsirhines. By analogy with living platyrrhines, these data suggest that Notharctus venticolus may have lived in polygynous social groups characterized by a relatively high level of intermale competition for mates and other limited resources. The anatomy of the upper incisors and related evidence imply that Notharctus is not as closely related to extant lemuriform primates as has been recently proposed. The early Eocene evidence for canine sexual dimorphism reported here, and its occurrence in a nonanthropoid, indicates that in the order Primates such a condition is either primitive or evolved independently more than once.
Author

A93-27799
MULTIPLE EVOLUTIONARY ORIGINS OF MAGNETOTAXIS IN BACTERIA
EDWARD F. DELONG (California Univ., Santa Barbara), RICHARD B. FRANKEL (California Polytechnic State Univ., San Luis Obispo), and DENNIS A. BAZYLINSKI (Virginia Polytechnic Inst. and State Univ., Blacksburg; Stevens Inst. of Technology, Hoboken, NJ)
Science (ISSN 0036-8075) vol. 259, no. 5096 Feb. 5, 1993 p. 803-806. refs
(Contract N00014-91-J-1290; N00014-90-J-1917; NSF MCB-91-17694)
Copyright
Magnetosomes are intracellular, iron-rich, membrane-enclosed magnetic particles that allow magnetotactic bacteria to orient in the earth's geomagnetic field as they swim. Uncultured magnetotactic bacteria of the iron sulfide type are specifically related to the dissimilatory sulfate-reducing bacteria within the delta subdivision of the Proteobacteria. These findings indicate a polyphyletic origin for magnetotactic bacteria and suggest that magnetotaxis based on iron oxides and iron sulfides evolved independently. Author

A93-27800
ALGAE AND OXYGEN IN EARTH'S ANCIENT ATMOSPHERE
JAMES F. KASTING (Pennsylvania State Univ., University Park)
Science (ISSN 0036-8075) vol. 259, no. 5096 Feb. 5, 1993 p. 835; Author's Reply, p. 835. refs
Copyright
Han and Runnegar's (1992) suggestion that O2 was a significant component of the atmosphere 2.0-2.5 billion years ago, on the basis of the metabolic requirements of eukaryotic microfossils, ignored the possibility that ocean surface waters might have been locally enriched in photosynthetically derived O2 while the atmosphere remained free of O2. Runnegar replies on the basis of Kasting's (1992) model of a diffusion-limited rate of escape for O2 from the ocean surface. O.C.

A93-27918
A BALANCED CARBOHYDRATE:PROTEIN DIET IN THE MANAGEMENT OF PARKINSON'S DISEASE
E. M. BERRY, J. H. GROWDON, J. J. WURTMAN, B. CABALLERO, and R. J. WURTMAN (MIT, Clinical Research Center, Cambridge; Massachusetts General Hospital, Boston)
Neurology (ISSN 0028-3878) vol. 41, no. 8 Aug. 1991 p. 1295-1297. Research supported by American Parkinson's Disease Foundation refs
Copyright
Although restricting dietary protein is a proposed adjunct to treating Parkinson's disease (PD), the effect of carbohydrate consumption is unknown. We measured plasma levodopa and large neutral amino acid (LNAA) levels in nine PD patients treated with carbidopa/levodopa and different isocaloric meals containing high protein-low carbohydrate, low protein-high carbohydrate, and balanced 5:1 carbohydrate:protein mixtures. We found that levodopa levels increased significantly regardless of the type of diet, but that plasma LNAA levels varied less and motor performance was superior after the balanced diet than after the other two meals. We conclude that PD patients can consume nutritionally adequate meals and still maintain a stable plasma levodopa:LNAA ratio. Author

A93-28691* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
THE EFFECTS OF GROWTH TEMPERATURE ON THE METHYL STEROL AND PHOSPHOLIPID FATTY ACID COMPOSITION OF METHYLOCOCCUS CAPSULATUS (BATH)
L. L. JAHNKE (NASA, Ames Research Center, Moffett Field, CA)
FEMS Microbiology Letters (ISSN 0378-1097) vol. 72, no. 3 June 15, 1992 p. 209-212.
Copyright
Growth of Methylococcus capsulatus (Bath) at temperatures ranging from 30 to 50 degrees C resulted in changes to the whole cell lipid constituents. As temperature was lowered, the overall proportion of hexadecenoic acid (C16:1) increased, and the relative proportions of the delta 9, delta 10 and delta 11 C16:1 double bond positional isomers changed. Methyl sterol content also increased as the growth temperature was lowered. The highest amounts of methyl sterol were found in 30 degrees C cells and the lowest in 50 degrees C cells (sterol-phospholipid ratios of 0.077 and 0.013, respectively). The data are consistent with a membrane modulating role for the sterol produced by this prokaryotic organism. A.U.T.

A93-28693
EFFECTS OF ANTIORTHOSTATIC SUSPENSION AND CORTICOSTERONE ON MACROPHAGE AND SPLEEN CELL FUNCTION
K. M. KOPYDLOWSKI, D. S. MCVEY, K. M. WOODS, J. J. IANDOLO, and S. K. CHAPES (Kansas State Univ., Manhattan)
Journal of Leukocyte Biology (ISSN 0741-5400) vol. 52, no. 2 Aug. 1992 p. 202-208.
Copyright
The purpose of this study was to determine whether antiorthostatic suspension of C3HeB/FeJ mice for a period of 11 days affected macrophage and spleen cell function. We found that antiorthostatic suspension did not alter macrophage secretion of prostaglandin E2, tumor necrosis factor alpha, and interleukin-1. Antiorthostatic suspension also did not affect macrophage-mediated contact-dependent cytotoxicity, TNF-mediated cytotoxicity, expression of class II histocompatibility molecules, or concanavalin A and Bandeiraea simplicifolia lectin binding sites. The proliferative response of splenic T cells in response to mitogens and staphylococcal exotoxins was significantly enhanced in antiorthostatically suspended mice. We detected significantly higher concentrations of corticosterone in the plasma of antiorthostatically suspended mice. Therefore, there did not appear to be any direct immunosuppressive effects of corticosterone on the parameters tested. A.U.T.

A93-28694
CYTOKINE SECRETION BY IMMUNE CELLS IN SPACE
S. K. CHAPES, D. R. MORRISON, J. A. GUIKEMA, M. L. LEWIS, and B. S. SPOONER (Kansas State Univ., Manhattan)
Journal of Leukocyte Biology (ISSN 0741-5400) vol. 52, no. 1 July 1992 p. 104-110.
Copyright
Cultured, bone marrow-derived macrophages, murine spleen and lymph node cells, and human lymphocytes were tested for their ability to secrete cytokines in space. Lipopolysaccharide-activated bone marrow macrophages were found to secrete significantly more interleukin-1 and tumor necrosis factor when stimulated in space than when stimulated on earth. Murine spleen cells stimulated with poly I:C in space released significantly more interferon-alpha at 1 and 14 hours after stimulation than cells stimulated on earth. Similarly, murine lymph node T cells and human peripheral blood lymphocytes, stimulated with concanavalin A in space, secreted significantly more interferon-gamma than ground controls. These data suggest that space flight has a significant enhancing effect on immune cell release of cytokines in vitro. A.U.T.

A93-28698* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
STRUCTURE OF A HUMAN MONOCLONAL ANTIBODY FAB FRAGMENT AGAINST GP41 OF HUMAN IMMUNODEFICIENCY VIRUS TYPE
X. M. HE, F. RUKER, E. CASALE, and D. C. CARTER (NASA, Marshall Space Flight Center, Huntsville, AL)
National Academy of Sciences of the United States of America, Proceedings (ISSN 0027-8424) vol. 89, no. 15 Aug. 1, 1992 p. 7154-7158.
Copyright
The three-dimensional structure of a human monoclonal antibody (Fab), which binds specifically to a major epitope of the transmembrane protein gp41 of the human immunodeficiency virus type 1, has been determined by crystallographic methods to a resolution of 2.7 A. It has been previously determined that this antibody recognizes the epitope SGKLICTTAVPWNAS, belongs to

the subclass IgG1 (kappa), and exhibits antibody-dependent cellular cytotoxicity. The quaternary structure of the Fab is in an extended conformation with an elbow bend angle between the constant and variable domains of 175 degrees. Structurally, four of the hypervariable loops can be classified according to previously recognized canonical structures. The third hypervariable loops of the heavy (H3) and light chain (L3) are structurally distinct. Hypervariable loop H3, residues 102H-109H, is unusually extended from the surface. The complementarity-determining region forms a hydrophobic binding pocket that is created primarily from hypervariable loops L3, H3, and H2. A.U.T.

A93-28700* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
NORMALIZATION OF CELL RESPONSES IN CAT STRIATE CORTEX
D. J. HEEGER (NASA, Ames Research Center, Moffett Field, CA) Visual Neuroscience (ISSN 0952-5238) vol. 9, no. 2 Aug. 1992 p. 181-197.
Copyright

Simple cells in the striate cortex have been depicted as half-wave-rectified linear operators. Complex cells have been depicted as energy mechanisms, constructed from the squared sum of the outputs of quadrature pairs of linear operators. However, the linear/energy model falls short of a complete explanation of striate cell responses. In this paper, a modified version of the linear/energy model is presented in which striate cells mutually inhibit one another, effectively normalizing their responses with respect to stimulus contrast. This paper reviews experimental measurements of striate cell responses, and shows that the new model explains a significantly larger body of physiological data. A.U.T.

A93-28704
VARIABLE LYMPHOCYTE RESPONSES IN RATS AFTER SPACE FLIGHT
P. V. NASH and A. M. MASTRO (Pennsylvania State Univ., University Park) Experimental Cell Research (ISSN 0014-4827) vol. 202, no. 1 Sept. 1992 p. 125-131.
Copyright

Most studies of human blood lymphocyte function following space flight have indicated that microgravity suppresses T cell proliferation. However, several other postflight experiments with animals have shown no decrease in proliferation of lymphocytes from peripheral lymphatic tissues, suggesting that different tissues may be variably affected by microgravity. Therefore, we examined the proliferation of lymphocytes from both spleen and lymph nodes of rats following a 4-day flight aboard the Space Shuttle. The experiments were designed to investigate tissue variability as well as potential mechanisms involved in suppressing proliferation. We found that proliferation of lymph node lymphocytes (LNL) from flight (FLT) animals stimulated with the antigen receptor-dependent T cell mitogen concanavalin A was depressed and could not be restored by supplementing cultures with interleukin 1 or interleukin 2 (IL-2). Response to another receptor-dependent mitogen, phytohemagglutinin, was not decreased. However, proliferation of FLT LNL following stimulation with the receptor-independent, mitogenic combination of phorbol ester and ionomycin was depressed. LNL IL-2 activity, cell surface marker expression, and B cell responses to mitogen were normal. Thus, deficits in antigen receptor/ligand interactions, cell surface marker expression, or IL-2 did not account for the suppressed lymphocyte proliferation observed postflight. In contrast to LNL, FLT splenocyte proliferation was not depressed. Assayable IL-2, IL-2 receptor expression, and cell surface marker expression likewise were unaffected by space flight. The differences between lymph nodeand splenic responses demonstrate the tissue-specific nature of microgravity effects on individual lymphatic tissues. A.U.T.

A93-28706* National Aeronautics and Space Administration, Washington, DC.
THERMOREGULATORY RESPONSES OF RHESUS MONKEYS DURING SPACEFLIGHT
F. M. SULZMAN, J. S. FERRARO, C. A. FULLER, M. C. MOORE-EDE, V. KLIMOVITSKY, V. MAGEDOV, and A. M. ALPATOV (NASA, Div. of Life Sciences, Washington) Physiology and Behavior (ISSN 0031-9384) vol. 51, no. 3 March 1992 p. 585-591.
Copyright

This study examines the activity, axillary temperature (T(ax)), and ankle skin temperature (Tsk) of two male Rhesus monkeys exposed to microgravity in space. The animals were flown on a Soviet biosatellite mission (COSMOS 1514). Measurements on the flight animals, as well as synchronous flight controls, were performed in the Soviet Union. Additional control studies were performed in the United States to examine the possible role of metabolic heat production in the T(ax) response observed during the spaceflight. All monkeys were exposed to a 24-h light-dark cycle (LD 16:8) throughout these studies. During weightlessness, T(ax) in both flight animals was lower than on earth. The largest difference (0.75 degree C) occurred during the night. There was a reduction in mean heart rate and Tsk during flight. This suggests a reduction in both heat loss and metabolic rate during spaceflight. Although the circadian rhythms in all variables were present during flight, some differences were noted. For example, the amplitude of the rhythms in Tsk and activity were attenuated. Furthermore, the T(ax) and activity rhythms did not have precise 24.0 hour periods and may have been externally desynchronized from the 24-h LD cycle. These data suggest a weakening of the coupling between the internal circadian pacemaker and the external LD synchronizer. A.U.T.

A93-28711* National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.
HEALTH SERVICES AT THE KENNEDY SPACE CENTER
E. B. FERGUSON, P. HUMBERT, I. D. LONG, and D. A. TIPTON (NASA, Kennedy Space Center, Cocoa Beach, FL) Florida Medical Association, Journal (ISSN 0015-4148) vol. 79, no. 8 Aug. 1992 p. 562-564.
Copyright

Comprehensive occupational health services are provided to approximately 17,000 workers at the Kennedy Space Center and an additional 6000 on Cape Canaveral Air Force Station. These areas cover about 120,000 acres encompassing part of the Merritt Island Wild Life Refuge and wetlands which are the habitat of numerous endangered and protected species of wildlife. The services provided at the Kennedy Space Center optimally assure a safe and healthy working environment for the employees engaged in the preparation and launching of this country's Space Shuttle and other important space exploration programs. A.U.T.

A93-28714* National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.
ENVIRONMENTAL MONITORING AND RESEARCH AT THE JOHN F. KENNEDY SPACE CENTER
C. R. HALL, C. R. HINKLE, W. M. KNOTT, and B. R. SUMMERFIELD (NASA, Kennedy Space Center, Cocoa Beach, FL) Florida Medical Association, Journal (ISSN 0015-4148) vol. 79, no. 8 Aug. 1992 p. 545-552.
Copyright

The Biomedical Operations and Research Office at the NASA John F. Kennedy Space Center has been supporting environmental monitoring and research since the mid-1970s. Program elements include monitoring of baseline conditions to document natural variability in the ecosystem, assessments of operations and construction of new facilities, and ecological research focusing on wildlife habitat associations. Information management is centered around development of a computerized geographic information system that incorporates remote sensing and digital image processing technologies along with traditional relational data base management capabilities. The proactive program is one in which the initiative is to anticipate potential environmental concerns before they occur and, by utilizing in-house expertise, develop impact minimization or mitigation strategies to reduce environmental risk. A.U.T.

A93-28716* National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.
CHALLENGES OF SPACE MEDICAL OPERATIONS AND LIFE SCIENCES MANAGEMENT
S. G. HADDAD (NASA, Kennedy Space Center, Cocoa Beach, FL) Florida Medical Association, Journal (ISSN 0015-4148) vol. 79, no. 8 Aug. 1992 p. 534-536.
Copyright

The Kennedy Space Center (KSC) has been the premier launch and landing site for America's space program since the early 1960s. Visitors are cognizant of space vehicles, processing facilities and launch pads which are treasured national resources. However, most are unaware of the unique organization which supports launch and landing activities and manages the center's occupational medicine, environmental health, ecological and environmental monitoring functions, as well as human and plant research programs. Management of this multifaceted organization can be complex because funding its different functions comes from a number of sources. Additionally the diverse disciplines of personnel present a special challenge in maintaining professional competencies while assuring efficiency in cyclical operations. This article explains the organization's structure and reviews some of its accomplishments. A.U.T.

A93-28722
THE OVERVIEW EFFECT - THE IMPACT OF SPACE EXPLORATION ON THE EVOLUTION OF NURSING SCIENCE
H. K. BUTCHER and C. FORCHUK Nursing Science Quarterly (ISSN 0894-3184) vol. 5, no. 3 Fall 1992 p. 118-123.
Copyright

The purpose of this article is to explore the overview effect, an experience evoked by space travel that has the capacity to transform all patterns of human existence and evolution toward greater potentials in human diversity and creativity. As nurses migrate with humanity into the solar system and beyond, they will experience the overview effect. The core components of the effect include changed perceptions of space, time, sound, and weight which have the potential to transform the evolution of nursing science. Nursing paradigms will encompass a view of humanity as integral with an infinite evolutionary universe. After generations of living in space in a diversity of new environments, the physical body will undergo radical changes, and the meaning of health will be transformed. The article concludes with a discussion on the parallels between Rogers' science of unitary human beings and the overview effect. A.U.T.

A93-28725* National Aeronautics and Space Administration, Washington, DC.
LOCALIZATION OF EXTRACELLULAR MATRIX COMPONENTS IN DEVELOPING MOUSE SALIVARY GLANDS BY CONFOCAL MICROSCOPY
P. HARDMAN and B. S. SPOONER (NASA, Specialized Center of Research and Training in Gravitational Biology; Kansas State Univ., Manhattan) Anatomical Record (ISSN 0003-276X) vol. 234, no. 3 Nov. 1992 p. 452-459.
Copyright

The importance of the extracellular matrix (ECM) in epithelial-mesenchymal interactions in developing organisms is well established. Proteoglycans and interstitial collagens are required for the growth, morphogenesis, and differentiation of epithelial organs and the distribution of these molecules has been described. However, much less is known about other ECM macromolecules in developing epithelial organs. We used confocal microscopy to examine the distribution of laminin, heparan sulfate (BM-1) proteoglycan, fibronectin, and collagen types I, IV, and V, in mouse embryonic salivary glands. Organ rudiments were isolated from gestational day 13 mouse embryos and cultured for 24, 48, or 72 hours. Whole mounts were stained by indirect immunofluorescence and then examined using a Zeiss Laser Scan Microscope. We found that each ECM component examined had a distinct distribution and that the distribution of some molecules varied with culture time. Laminin was mainly restricted to the basement membrane. BM-1 proteoglycan was concentrated in the basement membrane and also formed a fine network throughout the mesenchyme. Type IV collagen was mainly located in the basement membrane of the epithelium, but it was also present throughout the mesenchyme. Type V collagen was distributed throughout the mesenchyme at 24 hours, but at 48 hours was principally located in the basement membrane. Type I collagen was distributed throughout the mesenchyme at all culture times, and accumulated in the clefts and particularly at the epithelial-mesenchymal interface as time in culture increased. Fibronectin was observed throughout the mesenchyme at all times. A.U.T.

A93-28726* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
ATRIAL NATRIURETIC PEPTIDE DEGRADATION BY CPA47 CELLS - EVIDENCE FOR A DIVALENT CATION-INDEPENDENT CELL-SURFACE PROTEOLYTIC ACTIVITY
S. J. FROST, Y. M. CHEN, and P. A. WHITSON (NASA, Johnson Space Center, Houston, TX) Biochimica et Biophysica Acta (ISSN 0006-3002) vol. 1112, no. 1 Nov. 23, 1992 p. 45-51.
Copyright

Atrial natriuretic peptide (ANP) is rapidly cleared and degraded in vivo. Nonguanylate-cyclase receptors (C-ANPR) and a metalloproteinase, neutral endopeptidase (EC 3.4.24.11) (NEP 24.11), are thought to be responsible for its metabolism. We investigated the mechanisms of ANP degradation by an endothelial-derived cell line, CPA47. CPA47 cells degraded 88 percent of 125I-ANP after 1 h at 37 degrees C as determined by HPLC. Medium preconditioned by these cells degraded 41 percent of the 125I-ANP, and this activity was inhibited by a divalent cation chelator, EDTA. Furthermore, a cell-surface proteolytic activity degraded 125I-ANP in the presence of EDTA when receptor-mediated endocytosis was inhibited either by low temperature (4 degrees C) or by hyperosmolarity at 37 degrees C. The metalloproteinase, NEP 24.11, is unlikely to be the cell-surface peptidase because 125I-ANP is degraded by CPA47 cells at 4 degrees C in the presence of 5 mM EDTA. These data indicate that CPA47 cells can degrade ANP by a novel divalent cation-independent cell-surface proteolytic activity. A.U.T.

A93-28727
A METHOD OF MULTIVARIATE ANALYSIS OF DATA IN THE STUDY OF THE EFFECTS OF SPACE FLIGHT FACTORS ON THE RAT BRAIN NEURON STRUCTURE
M. A. MAKHANOV and A. A. FEDOROV Biulleten' Eksperimental'noi Biologii i Meditsiny (ISSN 0365-9615) vol. 114, no. 7 July 1992 p. 91-93. In Russian.
Copyright

The usage of some methods of multivariate analysis for neuro-morphological studies is discussed. The alterations of dendritic trees of pyramidal neurons of layer III of visual cortex of the rat exposed to the influence of space flight aboard biosputnik 'Cosmos-1887' were studied and the results are described to illustrate the methods power. o-technique of factor analysis was shown to be suitable for processing of the data obtained from an experiment with complex environmental conditions. A.U.T.

A93-28728
EFFECT OF DEXAMETHASONE ON PROLIFERATING OSTEOBLASTS - INHIBITION OF PROSTAGLANDIN E2 SYNTHESIS, DNA SYNTHESIS, AND ALTERATIONS IN ACTIN CYTOSKELETON
M. HUGHES-FULFORD, R. APPEL, M. KUMEGAWA, and J. SCHMIDT (USVA, Medical Center, San Francisco, CA) Experimental Cell Research (ISSN 0014-4827) vol. 203, no. 1 Nov. 1992 p. 150-156.
Copyright

Elevated levels of glucocorticoids caused by disease (Cushing's syndrome) or therapeutic treatment of asthma are known to cause osteoporosis. Space flight, an environmental condition, is known to cause a rise in endogenous cortisols accompanied by a significant loss of bone and calcium. Long-term space inhabitants have lost up to 18 percent of weight bearing bone during long-term flight. This study demonstrates that elevated concentrations of

glucocorticoids lower the endogenous production of PGE2 and interfere with osteoblast proliferation. Osteoblasts grown with dexamethasone had significantly lower DNA synthesis and endogenous synthesis of PGE2. Addition of exogenous dmPGE2 to the dexamethasone growth-inhibited cells stimulated DNA synthesis over twofold. In synchronous control cultures, we found that endogenous prostaglandin synthesis increased in late G1, preceding S-phase DNA synthesis by several hours. The addition of exogenous dexamethasone to synchronous cultures resulted in a significant decrease in the prostaglandin synthesis followed by a significant decrease in DNA synthesis in parallel cultures. Further, dexamethasone caused the actin cytoskeleton to collapse and the cell morphology to become rounded and spindle shaped. Addition of exogenous PGE2 to the dexamethasone-treated osteoblasts caused recovery of the actin architecture and phenotype. These data support the hypothesis that the glucocorticoid-mediated decrease in prostaglandin synthesis may be a contributing factor in the reduced bone quality and trabecular bone formation seen in glucocorticoid-induced osteoporosis.

A.U.T.

A93-28730
SPERM MOTILITY UNDER CONDITIONS OF WEIGHTLESSNESS

U. ENGELMANN, F. KRASSNIGG, and W. B. SCHILL (Giessen Univ., Germany) Journal of Andrology (ISSN 0196-3635) vol. 13, no. 5 Sept.-Oct. 1992 p. 433-436.

Copyright

The aim of this study was to determine the differences in motility of frozen and thawed bull spermatozoa under conditions of weightlessness compared with ground conditions. The tests were performed within a series of scientific and technologic experiments under microgravity using sounding rockets in the Technologische Experimente unter Schwerelosigkeit (TEXUS) program launched in Kiruna, North Sweden. Using a computerized sperm motility analyzer, significant differences were found in sperm motility under microgravity compared with sperm under gravitational conditions on earth. Computer analysis showed alterations in straight line and curvilinear velocity, as well as in linearity values. The amount of progressively motile spermatozoa, including all spermatozoa with a velocity > 20 microns/second, increased significantly from 24 percent +/- 9.5 percent in the reference test to 49 percent +/- 7.6 percent in the microgravity test. In conclusion, there is strong evidence that gravity influences sperm motility.

A.U.T.

A93-28733
A MICROFERMENTATION TEST FOR THE RAPID IDENTIFICATION OF YEASTS

T. C. MOLINA, S. K. MISHRA, and D. L. PIERSON (Krug Life Sciences Microbiology Lab., Houston, TX) Journal of Medical & Veterinary Mycology (ISSN 0268-1218) vol. 30, no. 4 1992 p. 323-326.

Copyright

The accuracy and speed of a microfermentation test (MFT), developed as a supplementary aid to other yeast identification systems, were compared with the conventional fermentation method in identifying 15 yeast species. The MFT significantly reduced the incubation period required to obtain a definitive identification. The method is easy to perform and the media and space requirements are minimal.

A.U.T.

A93-28738
HEALTH IN SPACE - AND ON EARTH

A. I. GRIGOR'EV (Inst. of Biomedical Problems, Moscow, Russia) World Health Forum (ISSN 0251-2432) vol. 13, no. 2-3 1992 p. 144-150.

Copyright

Because astronauts confront unprecedented hazards, manned space exploration has to proceed gradually and cautiously, each new step being taken with the benefit of what has been learned during earlier stages about bodily requirements. As well as helping to protect the lives of astronauts, however, space medicine is proving to have valuable applications in global health care.

A.U.T.

A93-28743
QUANTITATIVE AUTORADIOGRAPHIC ANALYSIS OF MUSCARINIC CHOLINERGIC AND GABAA (BENZODIAZEPINE) RECEPTORS IN THE FOREBRAIN OF RATS FLOWN ON THE SOVIET BIOSATELLITE COSMOS 2044

T. M. HYDE, L. C. WU, I. B. KRASNOV, S. K. SIGWORTH, N. G. DAUNTON, and F. D'AMELIO (NIH, National Inst. of Mental Health, Washington) Brain Research (ISSN 0006-8993) vol. 593, no. 2 Oct. 16, 1992 p. 291-294. Research supported by PHS

Copyright

The quantitative autoradiographic analysis of muscarinic cholinergic and GABAA (benzodiazepine) receptors was performed on selected regions of the cerebral cortex and striatum of rats flown in the Soviet Biosatellite COSMOS 2044. An age- and strain-matched synchronous ground-based control group was employed for comparison. Muscarinic cholinergic receptor density was found to be significantly lower in the striatum of the flight animals as compared with that in the synchronous control group. No significant differences between flight and synchronous control groups were found in the other regions examined. GABAA (benzodiazepine) receptors showed no significant differences between the flight and control groups in any of the regions sampled. Although additional studies are needed to reach definitive conclusions, the decrease in muscarinic cholinergic receptors observed in the striatum suggests spaceflight-related alterations in motor activity.

A.U.T.

A93-28745
EARLY AMPHIBIAN (ANURAN) MORPHOGENESIS IS SENSITIVE TO NOVEL GRAVITATIONAL FIELDS

A. W. NEFF, H. YOKOTA, H. M. CHUNG, M. WAKAHARA, and G. M. MALACINSKI (Indiana Univ., Bloomington) Developmental Biology (ISSN 0012-1606) vol. 155, no. 1 Jan. 1993 p. 270-274.

Copyright

Anuran amphibian embryos (Xenopus laevis and Rana dybowskii) are sensitive to novel gravitational fields. Under simulated weightlessness, (i) the location of the first horizontal cleavage furrow was shifted toward the vegetal pole at the eight-cell stage; (ii) the position of the blastocoel was more centered, and the number of cell layers in the blastocoel roof was increased at the blastula stage; (iii) the dorsal lip appeared closer to the vegetal pole at the gastrula stage; and (iv) head and eye dimensions were enlarged at the hatching tadpole stage. Effects of simulated hypergravity were opposite to those of simulated weightlessness, except that hypergravity, unlike simulated weightlessness, reduced the number of primordial germ cells in feeding tadpoles. Despite those dramatic differences in the early embryogenesis, tadpoles at the feeding stage are largely indistinguishable from controls.

A.U.T.

A93-28746* National Aeronautics and Space Administration, Washington, DC.
ALTERATIONS IN BIOSYNTHETIC ACCUMULATION OF COLLAGEN TYPES I AND III DURING GROWTH AND MORPHOGENESIS OF EMBRYONIC MOUSE SALIVARY GLANDS

P. HARDMAN and B. S. SPOONER (NASA, Specialized Center of Research and Training in Gravitational Biology; Kansas State Univ., Manhattan) International Journal of Developmental Biology (ISSN 0214-6282) vol. 36, no. 3 Sept. 1992 p. 423-427.

Copyright

We examined the biosynthetic patterns of interstitial collagens in mouse embryonic submandibular and sublingual glands cultured in vitro. Rudiments explanted on day 13 of gestation and cultured for 24, 48, and 72 h all synthesized collagen types I, III, and V. However, while the total incorporation of label into collagenous proteins did not change over the three-day culture period, the rate of accumulation of newly synthesized types I and III did change.

At 24 h, the ratio of newly synthesized collagen types I:III was approximately 2, whereas at 72 h, the ratio was approximately 5. These data suggest that collagen types I and III may be important in initiation of branching in this organ, but that type I may become dominant in the later stages of development and in maintenance of the adult organ. A.U.T.

A93-28748* National-Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
HALF-SQUARING IN RESPONSES OF CAT STRIATE CELLS
D. J. HEEGER (NASA, Ames Research Center, Moffett Field, CA) Visual Neuroscience (ISSN 0952-5238) vol. 9, no. 5 Nov. 1992 p. 427-443.
Copyright

Simple cells in striate cortex have been depicted as rectified linear operators, and complex cells have been depicted as energy mechanisms (constructed from the squared sums of linear operator outputs). This paper discusses two essential hypotheses of the linear/energy model: (1) that a cell's selectivity is due to an underlying (spatiotemporal and binocular) linear stage; and (2) that a cell's firing rate depends on the squared output of the underlying linear stage. This paper reviews physiological measurements of cat striate cell responses, and concludes that both of these hypotheses are supported by the data. A.U.T.

A93-28752
HISTOCHEMICAL AND CONTRACTILE RESPONSES OF RAT MEDIAL GASTROCNEMIUS TO 2 WEEKS OF COMPLETE DISUSE
P. F. GARDINER, M. FAVRON, and P. CORRIVEAU (Montreal Univ., Canada) Canadian Journal of Physiology and Pharmacology (ISSN 0008-4212) vol. 70, no. 8 Aug. 1992 p. 1075-1081.
Copyright

We studied the histochemical and in situ contractile changes in a rat ankle extensor, medial gastrocnemius, in which activation of muscle fibres by motoneurones was blocked for 14 days, using the sodium channel blocker tetrodotoxin applied to the sciatic nerve. Muscles were atrophied and showed slower twitch responses, greater fusion at subtetanic frequencies of stimulation, and higher twitch/tetanic ratios. Tetanic force/mm2 of fibre area and fatiguability were unchanged. Type II fibres were more atrophied and showed greater decreases in mitochondrial succinate dehydrogenase activity than type I fibres. The contractile changes resulting from complete disuse do not occur in models in which weight-bearing alone has been removed (space flight, hindlimb suspension), suggesting that the residual motoneurone activity reported in models of weightlessness is sufficient to prevent these responses. Similarly, the finding of a greater type II fibre susceptibility to complete disuse, which differs from the pattern seen in models of weightlessness, suggest that this residual motoneurone activity in the latter influences atrophic responses in a manner that is variable among motor unit types, to produce the reported preferential type I atrophy characteristic of removal of weight-bearing. A.U.T.

A93-28763
DISTINGUISHING UNLOADING- VERSUS RELOADING-INDUCED CHANGES IN RAT SOLEUS MUSCLE
B. B. KRIPPENDORF and D. A. RILEY (Wisconsin Medical College, Milwaukee) Muscle and Nerve (ISSN 0148-639X) vol. 16, no. 1 Jan. 1993 p. 99-108.
Copyright

Previously, solei from rats orbited 12.5 days aboard Cosmos 1887 biosatellite were biopsied 48-56 hours postflight. These atrophic muscles showed severe pathology. Designing a ground-based model of that space flight, we tested the hypothesis that 48 hours of postflight muscle reloading induced pathological changes. Rats were subjected to 12.5 days of hindlimb suspension unloading and biopsied immediately after suspension or after returning to normal weightbearing 12, 24, or 48 hours. Soleus morphological changes were quantitated on histochemically and immunohistochemically stained cross-sections. Solei from 0-hour reloaded rats showed significantly decreased wet weights, diminished myofiber cross-sectional area, angular myofibers, myofibril disruption, and more myofibers expressing fast myosin. Compared with suspension alone (0-hour reloading), reloading 12-48 hours induced slightly increased soleus wet weights, myofiber swelling, significant interstitial tissue edema, macrophage activation, and monocyte infiltration. These results suggest the degree and type of muscle degenerative changes observed postflight depend on the duration of gravity readaptation before biopsy and not solely on exposure to microgravity. A.U.T.

A93-28764
IDENTIFICATION OF A CRITICAL PERIOD FOR MOTOR DEVELOPMENT IN NEONATAL RATS
K. D. WALTON, D. LIEBERMAN, A. LLINAS, M. BEGIN, and R. R. LLINAS (New York Univ. Medical Center, NY) Neuroscience (ISSN 0306-4522) vol. 51, no. 4 Dec. 1992 p. 763-767.
Copyright

Manipulation of the developing nervous system has provided valuable insights into nervous system function. One important concept to arise from this type of study has been the identification of specific 'critical periods' for the development of various functions. A critical period has been most clearly shown for the visual system where monocular eye closure for a few weeks led to functionally significant changes in visually guided behaviors and the connectivity of the visual cortex. Critical periods have also been defined for other sensory systems. Although studies of the effect of manipulating sensory systems during development are sometimes difficult to interpret (e.g. Ref. 7), this difficulty is compounded in the case of the motor system. Problems arise because manipulations of the postnatal motor system are difficult to implement and usually require invasive procedures such as tenotomy, neurotomy, and nerve crush (for review, see Ref. 17). We have approached the problem of manipulating the motor environment by adapting a paradigm widely used to study the experimental effects of simulated weightlessness in adult rats: namely, tail suspension. This method has several advantages for manipulating the motor system: (i) because it is noninvasive, it is less discomforting than neurotomy, tenotomy or nerve crush; (ii) it does not immobilize the animals, they move about the cage and extend and flex their hindlimbs; and (iii) it specifically examines the importance of load-bearing on the development of antigravity muscles and their neuronal circuits.(ABSTRACT TRUNCATED AT 250 WORDS) A.U.T.

N93-20848# Utrecht State Univ. (Netherlands). Dept. of Computer Science.
TWO STRIKES AGAINST PERFECT PHYLOGENY
HANS L. BODLAENDER, MIKE R. FELLOWS (Victoria Univ., British Columbia), and TANDY J. WARNOW (University of Southern California, Los Angeles.) Feb. 1992 19 p
(Contract EEC-3075; NSF CCR-88-13632; NSF DMS-90-05833)
(ISSN 0924-3275)
(RUU-CS-92-08; ETN-93-92808) Avail: CASI HC A03/MF A01

A study on perfect phylogeny is presented. A major effort in molecular biology is the computation of phylogenies for species sets. A longstanding open problem in this area is called the perfect phylogeny problem. For almost two decades the complexity of this problem remained open, with progress limited to polynomial time algorithms for a few special cases and relaxations of the problem shown to be NP complete. From an applications point of view, the problem is of interest both in its general form, where the number of characters may vary, and in its fixed parameter form. The perfect phylogeny problem has been shown to be equivalent to the problem of triangulating colored graphs. It has also been shown recently that for a given fixed number of characters, the yes-instances have bounded treewidth, opening the possibility of applying methodologies for bounded tree width to the fixed parameter form of the problem. The Perfect Phylogeny problem is shown to be difficult in two different ways. The general problem is shown to be NP complete, and the various finite state approaches for bounded treewidth are shown not to be applicable to the fixed parameter forms of the problem. ESA

N93-20959# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany).
BIOCHEMICALLY ACTIVE LAYERS FOR SELECTIVE MATERIAL DETECTION SENSORS [BIOCHEMISCH ACTIVE SCHICHTEN FUER SENSOREN ZUR SELEKTIVEN STOFFDETEKTION]
REINHOLD HILPERT 1992 17 p In GERMAN Presented at the Seminar on Grunbauelemente zur Chemischen Sensorik, Munich, Germany, 19-20 May 1992y 1992
(MBB-Z-0440-92-PUB; ETN-93-92756) Avail: CASI HC A03/MF A01

The requirements for biological components of biosensors are reviewed. The examples of blood glucose and pesticides in drinking water are given. Properties of metabolizing components such as enzymes are examined. The posibility of using antibodies as biosensors is investigated. The methods for the immobilization of biological components on the transducer are studied: adsorption bonding at the transducer surface, embedding in matrices or behind semipermeable membranes, covalent coupling. The difficulties of obtaining numerical data on biochemical reactions to estimate response time or sensitivity area of sensor are pointed out. ESA

N93-21074# Canadian Space Agency, Ottawa (Ontario).
SPACE LIFE SCIENCES OVERVIEW
ALAN MORTIMER *In its* Spacebound 1991 p 16-17 1991
Avail: Canadian Space Agency, P.O. Box 7275, Ottawa, ON, Canada K1L 8E3 HC

The Canadian Space Agency's Space Life Sciences program is reviewed. Collaborative programs with NASA have led to participation in the SLS-1 mission (neurovestibular physiology, cardiology) and preparation of experiments for Spacehab-J (amphibian development), IML-2 (neurovestibular physiology, neuro-autonomic control), and middeck DSO's (height change, cerebral blood flow). The Aquatic Research Facility will be built and flown on an annual basis as part of the NASA Life Sciences Secondary Payload Program. Cooperative programs with the Soviet Union include formation of a Canada/USSR joint working group in space life sciences; research in radiation, metabolism, gravitational biology, and neurovestibular physiology with the Institute of Biomedical Problems in Moscow; and a significant radiation dosimetry technology program. Precursor experiments for a MIR spaceflight experiment in metabolic changes are planned, and two experiments will fly on the 1992 Biosatellite Mission.
Author (CISTI)

N93-21085# Health and Welfare Canada, Ottawa (Ontario).
THE DEVELOPMENT OF AN AUTOMATED CELL CULTURE SYSTEM FOR USE IN SPACE LIFE SCIENCE RESEARCH
J. MCLEAN, R. BRADLEY, D. BROWN (Ottawa Univ., Ontario.), D. GIBBONS (Ottawa Univ., Ontario.), F. JOHNSON (Ottawa Univ., Ontario.), A. MORTIMER (Canadian Space Agency, Ottawa, Ontario.), M. GODDARD, F. MANDY, G. FRAPPIER, and F. RYAN *In* Canadian Space Agency, Spacebound 1991 p 72-73 1991
Avail: Canadian Space Agency, P.O. Box 7275, Ottawa, ON, Canada K1L 8E3 HC

A cell culture laboratory has been designed to provide support for the research biologist studying the effects of hostile environments such as space on the growth, viability, and physiological state of mammalian cells. The laboratory is a miniature, ruggedly constructed, cell incubator with the built-in capacity to measure and record, at programmed intervals, both the number and the size of cells in the incubation chamber. The cell detector comprises a charge coupled device camera and an objective lens which give a resolution of 2 microns. An image analyzer provides limited information on cell morphology and cell membrane topology. Physiological conditions are monitored within the culture chamber by miniature pH and temperature sensors. Radiation exposure is measured by passive detectors and active dosimeters. Author (CISTI)

N93-21097# Dalhousie Univ., Halifax (Nova Scotia). Dept. of Biology.
HOW DO ZOOPLANKTON FEED? A CRITICAL MICROGRAVITY EXPERIMENT
DANIEL L. JACKSON, SCOTT M. GALLAGER, and RONALD K. ODOR *In* Canadian Space Agency, Spacebound 1991 p 137-140 1991
Avail: Canadian Space Agency, P.O. Box 7275, Ottawa, ON, Canada K1L 8E3 HC

A series of experiments is proposed to improve understanding of how zooplankton capture phytoplankton. A summary of recent research on possible feeding mechanisms is presented, discussing the effects of such factors as gravity, cilia movements, and hydrodynamics. It is suggested that by manipulating gravity, direct effects should be seen on the prey encounter rate, capture efficiency of prey, and larval growth. One set of experiments would be conducted in parabolic flight and observations of swimming pattern, geometry, and behavior of scallop larvae would be compared at 1 gravity and at zero gravity. A longer duration study is also proposed for an experiment in the Canadian Space Agency's Aquatic Research Facility aboard the NASA shuttle. The effects of microgravity on feeding success, growth, and biogenic crystal precipitation in the larval shell would be assessed. These studies should provide missing elements for a comprehensive model of zooplanktonic feeding. Author (CISTI)

N93-21098# British Columbia Univ., Vancouver. Dept. of Oceanography and Zoology.
GRAVITY AS A FACTOR IN THE ORIENTATION AND VERTICAL MIGRATION OF MARINE ZOOPLANKTON
A. G. LEWIS and J. POWLIK *In* Canadian Space Agency, Spacebound 1991 p 141-145 1991
Avail: Canadian Space Agency, P.O. Box 7275, Ottawa, ON, Canada K1L 8E3 HC

The proposed Aquatic Research Facility of the Canadian Space Agency offers a chance to isolate, at least partially, the effects of gravity from other factors that affect vertical migration in plankton and near-benthic organisms. It is proposed that zooplankton and near-benthic crustaceans orient with respect to the Earth's gravitational field, and a series of experiments is proposed to test this hypothesis in microgravity conditions in the Aquatic Research Facility aboard the NASA shuttle. The test organism will be the supralittoral copepod Tigriopus californicus. Laboratory work will provide background details such as the response of T. californicus to a surface during its 12-stage life cycle. The copepods will be subjected in the shuttle to static (microgravity) and centrifuge (1-gravity) conditions. Video images of the specimens will be recorded and analysis of the images will enable evaluation of the surface preferences of the organisms, their orientation, and feeding habits. Orientation under microgravity conditions, combined with the surface associations, will be used to suggest whether T. californicus actively uses gravity to orient towards a surface.
Author (CISTI)

N93-21099*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
STUDYING THE EFFECTS OF MICROGRAVITY ON LOWER VERTEBRATE DEVELOPMENT AND BEHAVIOR Progress Report
RICHARD J. WASSERSUG (Dalhousie Univ., Halifax, Nova Scotia.), SCOTT PRONYCH (Dalhousie Univ., Halifax, Nova Scotia.), and KENNETH A. SOUZA *In* Canadian Space Agency, Spacebound 1991 p 146-150 1991
Avail: Canadian Space Agency, P.O. Box 7275, Ottawa, ON, Canada K1L 8E3 HC

Lower vertebrates have been used in space research for at least 3 decades, and have a number of advantages such as the ability to be maintained safely in space conditions, high development rates, easy observability, and small size. Several major investigations with lower vertebrates are in the flight queue in various countries, and some of this research with amphibians that has Canadian Space Agency sponsorship is reviewed. In connection with NASA's frog embryology experiment, Canadian

scientists will conduct postflight experiments on live tadpoles brought back from space to determine whether larvae that develop from these embryos are behaviorally normal. Swimming kinematics in particular will be examined, since a distinctive looping behavior of Xenopus tadpoles under microgravity has been noted. A collaborative study with the Institute of Biomedical Problems in Moscow is designed to elucidate the relationship between buoyancy regulation and lung development in tadpoles, and is scheduled to fly on a Biocosmos satellite in 1992. Author (CISTI)

N93-21230# Federal Coordinating Council for Science, Engineering and Technology, Washington, DC.
PROLOGUE TO ACTION. LIFE SCIENCES EDUCATION AND SCIENCE LITERACY
Mar. 1992 71 p Conference held in Columbus, OH, Jun. 1991; sponsored by US Public Health Service
(PB93-107514) Avail: CASI HC A04/MF A01

In recommendations springing from the Prologue to Action -- Life Sciences Education and Science Literacy Conference in Ohio, attendees overwhelmingly agreed that Public Health Service (PHS) should become an aggressive advocate for excellence and equality in life sciences education. Conference participants called for PHS to mobilize its corps of intramural and extramural scientists in the service of life sciences education and literacy by creatively combining the knowledge of scientists with the practical teaching skills of classroom teachers. Scientists should help train science teachers and other educators and help structure learning experiences to ensure that all students have a chance to develop the ability to think and learn on their own. Scientists should help train student teachers at the university level, for instance, and help revise undergraduate science curriculums. They should become local or national speakers, be mentors to local teachers, loan equipment to science class projects in local schools, and get involved in undergraduate and precollege curriculum development. The following summary of reports from the seven subcommittees includes overview and discussions of their perspectives, issues, and recommendations for PHS. GRA

N93-21931# State Univ. of Western Connecticut, Danbury.
THE CHALLENGE OF BIODETECTION FOR SCREENING PERSONS CARRYING EXPLOSIVES
CURT DAVID WEINSTEIN, SIDNEY WEINSTEIN, and RONALD DROZDENKO (NeuroCommunication Research Labs., Inc., Danbury, CT.) *In* FAA, Proceedings of the First International Symposium on Explosive Detection Technology p 759-769 May 1992
Avail: CASI HC A03/MF A10

Only vapor detection is safe enough to be used to screen persons for carrying explosives into airline terminals, ball games, controlled-access political gatherings, corporate buildings, bus terminals, etc. Although there are many vapor detection techniques available, none, as yet, surpass the following parameters, which are based on a biodetection model -- a specific animal model developed at NCRL. Thus, this biodetection technology becomes the benchmark with which other detection technologies may be judged. The parameters reflect those of NCRL's SYS-5(tm). The 12 parameter model is very general; one expression is NCRL's SYS-5 in which 5 detecting elements are employed in simultaneous independent detection. The detecting element is the rat, a specially prepared rat. Information about the detection behaviors of this detecting element is presented, considering both clean and explosively dirty environments. Derived from text

N93-21933# Defence Research Agency, Seveuales (England).
EXPLOSIVES SEARCH DOGS
STAN LOVETT *In* FAA, Proceedings of the First International Symposium on Explosive Detection Technology p 774-775 May 1992
Avail: CASI HC A01/MF A10

The use of dogs in detecting explosives is discussed. The following topics are discussed: training, breeds, the olfactory epithelium, olfactory perception, and bioelectricity. CASI

52

AEROSPACE MEDICINE

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

A93-26245
COLOUR IS WHAT THE EYE SEES BEST
A. CHAPARRO, C. F. STROMEYER, III, E. P. HUANG, R. E. KRONAUER (Harvard Univ., Cambridge, MA), and RHEA T. ESKEW, JR. (Northeastern Univ., Boston, MA) Nature (ISSN 0028-0836) vol. 361, no. 6410 Jan. 28, 1993 p. 348-350. Research supported by NIH, USAF, and Ford Foundation refs
Copyright

It has been argued by Watson, Barlow and Robson (1983) that the visual stimulus that humans detect best specifies the spatial-temporal structure of the receptive field of the most sensitive visual neurons. To investigate 'what the eye sees best' they used stimuli that varied in luminance alone. Because the most abundant primate retinal ganglion cells, the P cells, are color-opponent we might expect that a colored pattern would also be detected well. We generalized Watson et al.'s study to include variations in color as well as luminance. We report here that our best detected colored stimulus was seen 5-9-fold better than our best luminance spot and 3-8-fold better than Watson's best luminance stimulus. The high sensitivity to color is consistent with the prevalence and high color contrast-gain of retinal P cells, and may compensate for the low chromatic contrasts typically found in natural scenes. Author

A93-26570
AUDIMIR - DIRECTIONAL HEARING AT MICROGRAVITY
A. PERSTERER (Akustische und Kino-Geraete GmbH, Vienna, Austria), M. BERGER (Innsbruck, Univ. Neurological Clinic, Austria), C. KOPPENSTEINER (Akustische und Kino-Geraete GmbH, Vienna; Graz, Technische Univ., Austria), C. MUELLER (Vienna, Univ. Neurological Clinic, Austria), M. NEFEDOVA (Inst. for Biomedical Problems, Moscow, Russia), M. OPITZ (Akustische und Kino-Geraete GmbH, Vienna, Austria), and P. SCHNIDER (Vienna, Univ. Neurological Clinic, Austria) Space Technology - Industrial and Commercial Applications (ISSN 0892-9270) vol. 13, no. 2 March 1993 p. 185-192. refs
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Project AUDIMIR started from the assumption that, in the absence of gravity, orientation by acoustic cues would play a much more important role for a human being than on Earth. To verify this assumption, and thus to verify the usefulness of binaural audio technology for communication systems of future spacecrafts and spacestations, the experiment should investigate the accuracy of directional hearing and the role of directional hearing as part of the human orientation system at microgravity. The realization of the experiment is based on recent psycho-acoustical discoveries as well as technological advances in digital audio signal processing which enable these discoveries to be put into practice. Author

A93-26571
OPTOVERT: AN AUSTROMIR 91 EXPERIMENT - ORIENTATIONAL EFFECTS FROM OPTOKINETIC STIMULATION
CH. MUELLER (Vienna, Univ. Neurological Clinic, Austria), L. KORNILOVA (Inst. for Biomedical Problems, Moscow, Russia), G. WIEST, and L. DECKE (Vienna, Univ. Neurological Clinic, Austria) Space Technology - Industrial and Commercial Applications (ISSN 0892-9270) vol. 13, no. 2 March 1993 p. 193-198. refs
Copyright

The OPTOVERT experiment was carried out on the third and fifth day of the AUSTROMIR 91 space flight by the Austrian cosmonaut Franz Viehbock. The main aim of the experiment was to explore in microgravity the Vertical Vection Illusion which was elicited by means of an optokinetic stimulator system. The cosmonaut was instructed to fixate a central LED on a spherical

screen (60 deg of visual angle in diameter) during up- and down-motion of a dot pattern. In addition optokinetically induced eye movements were examined as well as the ability for setting the Visual Vertical correctly. A slight preponderance for downward vection and the occurrence of 'inverted vection' with extreme phase shift during sinusoidal stimulation were considered to be the most striking orientational phenomena inflight. Author

A93-26572
INFLUENCE OF MICROGRAVITY ON IMMUNE SYSTEM AND GENETIC INFORMATION
H. TUSCHL, R. KOVAC, W. KLEIN, E. OTT (Oesterreichisches Forschungszentrum, Seibersdorf, Austria), I. I. VORONKOV, and M. CHAIDAKOV (Inst. for Biomedical Problems, Moscow, Russia) Space Technology - Industrial and Commercial Applications (ISSN 0892-9270) vol. 13, no. 2 March 1993 p. 199-203. refs
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The effect of spaceflight on immune parameters and DNA structure in lymphocytes was investigated by analyzing appropriate parameters of the immune system and the genetic apparatus in blood of the Austrian cosmonaut before and after a spaceflight aboard Mir. A comparison of pre- and postflight data showed a pronounced decrease of the number of the natural killer cells (CD16(+)) and a decreased expression of Interleukin-2 receptor by stimulated lymphocytes. The sedimentation profile of lymphocyte DNA was also affected by spaceflight, indicating a possibility of a structural modification of DNA. I.S.

A93-26832
A METHOD FOR THE THEORETICAL CALCULATION OF THE PARAMETERS OF SINGLE-STAGE DECOMPRESSION WITH EQUAL PROBABILITY OF SAFETY [METOD TEORETICHESKOGO RASCHETA PARAMETROV RAVNOVEROIATNO BEZOPASNOI ODNOSTUPENCHATOI DEKOMPRESSII]
V. P. NIKOLAEV (Inst. Mediko-Biologicheskikh Problem, Moscow, Russia) Rossiiskaia Akademiia Nauk, Doklady (ISSN 0869-5652) vol. 326, no. 5 1992 p. 924-927. In Russian. refs
Copyright

A decompression safety theory is developed which is based on the mathematical modeling of the stochastic formation and growth of gas bubbles in humans, thus reflecting the probabilistic nature of the decompression disease affecting divers, pilots, and astronauts. A method is developed for predicting the equal-probability safety conditions for single-state decompression with different initial conditions. V.L.

A93-27048* National Aeronautics and Space Administration, Washington, DC.
EFFECTS OF RUNNING THE BOSTOM MARATHON ON PLASMA CONCENTRATIONS OF LARGE NEUTRAL AMINO ACIDS
L. A. CONLAY, R. J. WURTMAN, I. LOPEZ G-COVIELLA, J. K. BLUSZTAJN, C. A. VACANTI, M. LOGUE, M. DURING, B. CABALLERO, T. J. MAHER, and G. EVONIUK (MIT, Cambridge; Massachusetts General Hospital; Harvard Univ., Boston) Journal of Neural Transmission (ISSN 0300-9564) vol. 76 1989 p. 65-71. Research supported by USAF, NASA, and NIH refs
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Plasma large neutral amino acid concentrations were measured in thirty-seven subjects before and after completing the Boston Marathon. Concentrations of tyrosine, phenylalanine, and methionine increased, as did their 'plasma ratios' (i.e., the ratio of each amino acid's concentration to the summed plasma concentrations of the other large neutral amino acids which compete with it for brain uptake). No changes were noted in the plasma concentrations of tryptophan, leucine, isoleucine, nor valine; however, the 'plasma ratios' of valine, leucine, and isoleucine all decreased. These changes in plasma amino acid patterns may influence neurotransmitter synthesis. Author

A93-27172* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
AN IMPROVED SIMULATION BASED BIOMECHANICAL MODEL TO ESTIMATE STATIC MUSCLE LOADINGS
SUDHAKAR L. RAJULU (Lockheed Engineering and Sciences Co., Houston, TX), WILLIAM S. MARRAS (Ohio State Univ., Columbus), and BARBARA WOOLFORD (NASA, Johnson Space Center, Houston, TX) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 Santa Monica, CA Human Factors Society 1991 p. 790-794. refs
Copyright

The objectives of this study are to show that the characteristics of an intact muscle are different from those of an isolated muscle and to describe a simulation based model. This model, unlike the optimization based models, accounts for the redundancy in the musculoskeletal system in predicting the amount of forces generated within a muscle. The results of this study show that the loading of the primary muscle is increased by the presence of other muscle activities. Hence, the previous models based on optimization techniques may underestimate the severity of the muscle and joint loadings which occur during manual material handling tasks. Author

A93-27192
CARDIORESPIRATORY MEASURES OF WORKLOAD DURING CONTINUOUS MANUAL PERFORMANCE
RICHARD W. BACKS, ARTHUR M. RYAN (Wright State Univ., Dayton, OH), and GLENN F. WILSON (USAF, Armstrong Lab., Wright-Patterson AFB, OH) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 2 Santa Monica, CA Human Factors Society 1991 p. 1495-1499. refs
(Contract F49620-88-C-0053)
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Six male and six female subjects were used in an investigation of the distinctive effects of cognitive and physical effort on cardiac and pulmonary measures of workload, for the case of a continuous manual tracking task in which tracking system order was changed over pure velocity, pure acceleration, and combined velocity/acceleration levels. The results obtained vindicate the need for a multiple-measures approach to workload assessment, and suggest the inclusion of both cardiorespiratory and respiration interactions in such workload measures. O.C.

A93-27649
THE ROLE OF RHEOENCEPHALOGRAPHY IN THE PRACTICE OF AVIATION MEDICINE [ZNACHENIE REOENTSEFALOGRAFII V PRAKTIKE VRACHEBNO-LETNOI EKSPERTIZY]
P. M. SUVOROV, IU. K. CHURILOV, A. V. KONDAKOV, K. A. SIDOROVA, and E. G. STARSHINOVA Voenno-Meditsinskii Zhurnal (ISSN 0026-9050) no. 10 Oct. 1992 p. 57-60. In Russian.
Copyright

The feasibility of using rheoencephalography (REG) for diagnosing abnormalities in cranial bloodflow was investigated by obtaining in 266 hospitalized aircraft personnel REG records of frontomastoidal and occipitomastoidal standard leads and correlating the results with the patients' hemodynamics indices. Results showed that, in about 89 percent of the subjects, changes in REG indices could be correlated with changes of blood flow rate in the medium-cranial and vertebral arteries, indicating that REG data reflect the condition of intracranial hemodynamics. It is suggested that REG data can be used in diagnosing atherosclerosis, deficiency in cerebral blood supply, and dyscircular disorders caused by the osteochondrosis of neck vertebra. I.S.

A93-27685
THE PROBLEM OF OXYGEN REGIMEN IN EXTREME CONDITIONS [PROBLEMA KISLORODNOGO REZHIMA V EKSTREMAL'NYKH USLOVIIAKH]
O. E. LAN'SHINA, E. A. KOVALENKO, and V. A. LOGINOV (Inst. Mediko-Biologicheskikh Problem, Moscow, Russia) Fiziologiia

Cheloveka (ISSN 0131-1646) vol. 19, no. 1 Jan.-Feb. 1993 p. 99-104. In Russian. refs
Copyright

The parameters of oxygen consumption by some human body tissues were investigated in experiments where subjects placed into a pressure chamber were breathing pure oxygen under low pressure, simulating extravehicular activity in space. These conditions were found to induce an increase of partial oxygen pressure in arterial blood, with only insignificant changes observed in skin cells. Immediate postexperimental changes included an increase of the antioxidant activity and of thiobarbituric acid products in the venous blood. I.S.

A93-27686
SOME BIOCHEMICAL AND FUNCTIONAL CHARACTERISTICS OF BODY STATE DURING MULTIHOUR OPERATOR ACTIVITY UNDER EXTREME CONDITIONS [NEKOTORYE BIOKHIMICHESKIE I FUNKTSIONAL'NYE POKAZATELI SOSTOIANIIA ORGANIZMA PRI MNOGOCHASOVOI OPERATORSKOI DEIATEL'NOSTI V EKSTREMAL'NYKH USLOVIIAKH]
I. G. DLUSSKAIA, S. V. KALINKIN, R. K. KISELEV, and L. IU. DZHENZHERA (Inst. Mediko-Biologicheskikh Problem, Moscow, Russia) Fiziologiia Cheloveka (ISSN 0131-1646) vol. 19, no. 1 Jan.-Feb. 1993 p. 105-111. In Russian. refs
Copyright

The effect of uninterrupted 20-hr-long operator activity at elevated temperature on some biochemical blood parameters, the functional state of erythrocytes, and the psychophysiological condition of the operator was investigated in eight healthy subjects, each placed into a 9-cu-m chamber at +35 C and asked to solve problems continuously supplied from outside. The rate of problem solving was regulated by the subject. Results of correlation studies indicate that a lowering of oxygen resistance of erythocytes and an increase of bilirubin in peripheral blood can be used as objective criteria of fatigue development in operators. I.S.

A93-28049* National Aeronautics and Space Administration, Washington, DC.
LONG-RANGE ANTICORRELATIONS AND NON-GAUSSIAN BEHAVIOR OF THE HEARTBEAT
C.-K. PENG (Boston Univ., MA), J. MIETUS, J. M. HAUSDORFF (Harvard Medical School, Boston, MA), S. HAVLIN (Boston Univ., MA; NIH, Div. of Computer Research and Technology, Bethesda, MD), H. E. STANLEY (Boston Univ., MA), and A. L. GOLDBERGER (Harvard Medical School, Boston, MA) Physical Review Letters (ISSN 0031-9007) vol. 70, no. 9 March 1, 1993 p. 1343-1346. Research supported by NIH, U.S. Navy, NASA, et al refs
Copyright

We find that the successive increments in the cardiac beat-to-beat intervals of healthy subjects display scale-invariant, long-range anticorrelations (up to 10 exp 4 heart beats). Furthermore, we find that the histogram for the heartbeat intervals increments is well described by a Levy (1991) stable distribution. For a group of subjects with severe heart disease, we find that the distribution is unchanged, but the long-range correlations vanish. Therefore, the different scaling behavior in health and disease must relate to the underlying dynamics of the heartbeat. Author

A93-28676
INCREASED ORTHOSTATIC BLOOD PRESSURE VARIABILITY AFTER PROLONGED HEAD-DOWN TILT
A. D. TEN HARKEL, F. BAISCH, and J. M. KAREMAKER (Amsterdam Univ., Academic Medical Centre, Netherlands) Acta Physiologica Scandinavica Supplement (ISSN 0302-2994) vol. 604 1992 p. 89-99.
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The effect of simulated weightlessness on orthostatic blood pressure regulation was evaluated with passive 70 degrees head-up tilt (HUT) after 10 days 6 degrees head-down tilt (HDT). Six healthy male volunteers were studied. Continuous recording of finger blood pressure (BP) was obtained non-invasively with a Finapres device. Instantaneous heart rate (HR) was derived from the electrocardiogram. To quantify orthostatic BP variability, a fast fourier transform (FFT) of the beat-by-beat BP- and RR-interval values was performed. Control HR before HUT after the 10-day HDT period was increased, probably due to an arousal state of the test subjects. The change in BP induced by HUT was not influenced by 10 days' HDT, in contrast to the HR rise which increased from 24 +/- 2 beats/min to 41 +/- 7 beats/min (P less than 0.05). After HDT the total variance in orthostatic BP almost doubled. FFT indicated that this increase in variance can be ascribed to BP oscillations with a frequency of around 0.1 Hz. In three subjects transient HR decelerations during HUT after HDT were observed. Analysis of the relationship between BP and HR in the transients showed that each HR decrease was preceded by a BP increase above normal. These HR decelerations seemed, therefore, to be an effect of the vagal part of the arterial baroreflex and did not necessary signal an impending vasovagal syncope. The present study indicates that although 10 days' HDT do not influence absolute BP responses to 70 degrees HUT BP was maintained by an increased sympathetic activity, reflected by an increased HR response and an augmented variance in BP around 0.1 Hz. Author

A93-28677
INFLUENCE OF POSTURE AND PROLONGED HEAD-DOWN TILT ON CARDIOVASCULAR REFLEXES
A. D. TEN HARKEL, L. BECK, and J. M. KAREMAKER (Amsterdam Univ., Academic Medical Centre, Netherlands) Acta Physiologica Scandinavica Supplement (ISSN 0302-2994) vol. 604 1992 p. 77-87.
Copyright

We investigated the influence of ten days 6 degrees head-down tilt (HDT) on short-term cardiovascular control. To help differentiate between the effects of HDT-induced fluid redistribution and changed autonomic cardiovascular modulation under prolonged HDT, the effect of acute posture changes was investigated as well. Six healthy male volunteers were studied. Continuous finger blood pressure was measured non-invasively by means of Finapres. Heart rate (HR) was derived from the electrocardiogram. Responses to forced breathing (FRSA), Valsalva's manoeuvre (VM), Mental Stress (MS) and Sustained Handgrip (SHG) were measured. Changing posture from HDT to standing enhanced the BP and HR responses to VM, both during straining and after release. During prolonged HDT, responses to VM changed toward the pattern seen in the upright posture before HDT, suggesting a strong influence of fluid redistribution. Neither posture nor prolonged HDT influenced HR variation during FRSA and responses to MS and SHG. BP variation during FRSA was influenced by posture but not by prolonged HDT. Thus, cardiovascular reflex tests which reflect the parasympathetic (FRSA) or the sympathetic (MS and SHG) efferents to the heart were not influenced by posture or prolonged HDT. Only the responses to VM were affected by both posture and prolonged HDT. These results are probably due to a decrease in blood volume and stroke volume under prolonged HDT, an increase in venous distensibility and, to a lesser extent, to inadequate cardiovascular regulatory responses. Author

A93-28678
INFLUENCE OF TEN-DAY HEAD-DOWN BEDREST ON HUMAN CAROTID BARORECEPTOR-CARDIAC REFLEX FUNCTION
D. L. ECKBERG and J. M. FRITSCH (USVA, Medical Center, Richmond, VA) Acta Physiologica Scandinavica Supplement (ISSN 0302-2994) vol. 604 1992 p. 69-76. Research supported by PHS
Copyright

We studied the effects of simulated microgravity on baroreceptor-cardiac reflex mechanisms, with complex pressure changes delivered to neck chambers worn by six healthy young men, before, during (days 1, 3, 6, and 10), and after ten days' 6 degrees head-down bedrest. During held expiration, a computer-driven bellows increased neck pressure to 40 mmHg for about 4 s, and then decreased pressure to -65, by 15 mmHg

R-wave triggered decrements. We plotted R-R intervals as functions of carotid distending pressures (systolic less neck chamber pressures). Each experimental session comprised seven stimulus sequences delivered over about 15 min and averaged. Comparisons between results before bedrest and on the tenth day of bedrest showed that average baseline R-R intervals increased from 933 +/- (SEM) 24 to 1077 +/- 35 msec (P less than 0.05, Wilcoxon signed rank test); maximum slopes (R-R interval/carotid distending pressure) decreased from 4.5 +/- 0.4 to 3.6 +/- 0.7 msec/mmHg (P = 0.11); R-R interval response ranges decreased from 263 +/- 31 to 182 +/- 18 msec (P = 0.03); and operational points (positions of R-R intervals at resting pressures on the stimulus-response relation) remained constant. Our results suggest that head-down bedrest progressively impairs baroreceptor-cardiac reflex responses in healthy human subjects. Author

A93-28679
RESPONSE OF ADRENERGIC RECEPTORS TO 10 DAYS HEAD-DOWN TILT BEDREST
H. MAASS, J. TRANSMONTANO, and F. BAISCH (DLR, Inst. fuer Flugmedizin, Cologne, Germany) Acta Physiologica Scandinavica Supplement (ISSN 0302-2994) vol. 604 1992 p. 61-68.
Copyright

Adrenergic receptor responses to 10 days head-down tilt (HDT) bed-rest were measured in six healthy young males. The densities of alpha 2-receptors on platelets, beta 2-receptors on lymphocytes, and the responsiveness of beta 2-receptors to isoproterenol stimulation were assessed, as were the urinary catecholamine excretion rates. The densities of alpha 2- and beta 2-receptors were low before HDT, and were high during HDT. While the density of alpha 2-receptors decreased after HDT, that of beta 2-receptors remained high. No changes in the responsiveness of beta 2-receptors were observed. The urinary catecholamine levels were high before HDT, decreased during the bedrest period. After HDT urinary norepinephrine excretion increased significantly. It is likely that the receptors were down-regulated before HDT in response to a situation that was perceived as being stressful. There were no changes in receptor characteristics specifically attributable to HDT. Author

A93-28680
EFFECTS OF HEAD-DOWN TILT FOR 10 DAYS ON THE COMPLIANCE OF THE LEG
J. C. BUCKEY, L. D. LANE, F. A. GAFFNEY, and C. G. BLOMQVIST (Texas Univ., Southwestern Medical Center, Dallas) Acta Physiologica Scandinavica Supplement (ISSN 0302-2994) vol. 604 1992 p. 53-59.
Copyright

The purpose of this investigation was to measure lower leg compliance before, during and after a 10-day period of bedrest at head-down tilt to test the hypothesis that leg compliance and the capacity for venous pooling is increased by the adaptation to stimulated microgravity. Venous occlusion plethysmography with multiple proximal occlusion pressures was used to obtain compliance measurements in six male subjects. Calf circumference decreased significantly during the tilt (corresponding to a decrease in cross sectional area of 7 percent) and had not returned to baseline seven days after the end of tilt. Compliance post-tilt was significantly greater than pre-tilt, probably mainly due to a reduction in muscle mass. This study supports the need for investigations to define: (a) the degree of protection against orthostatic hypotension that can be achieved by maintaining leg muscle mass and tone, and (b) efficient and specific exercise programs to prevent loss of muscle mass and function-particularly during spaceflight. Author

A93-28681
CARDIOVASCULAR RESPONSE TO LOWER BODY NEGATIVE PRESSURE BEFORE, DURING, AND AFTER TEN DAYS HEAD-DOWN TILT BEDREST
L. BECK, F. BAISCH, F. A. GAFFNEY, J. C. BUCKLEY, P. ARBEILLE, F. PATAT, A. D. TEN HARKEL, A. HILLEBRECHT, H. SCHULZ, J. M. KAREMAKER (DLR, Inst. fuer Flugmedizin, Cologne, Germany) et al. Acta Physiologica Scandinavica Supplement (ISSN 0302-2994) vol. 604 1992 p. 43-52.
Copyright

The haemodynamic response to lower body negative pressure (LBNP) was studied in 6 test subjects before (baseline), during, and after (recovery) ten days of 6 degrees head-down bedrest. The LBNP protocol consisted of a 35 min control period, application of a staircase differential pressure profile (15 min at -15 mmHg; 5 min at -30 mmHg; 15 min at -40 mmHg), and a 10 min post-stress observation period. Cardiac output was measured by a foreign gas rebreathing technique. Finger plethysmographic arterial blood pressure (BP), ECG, and heart rate (HR), lower limb cross-sectional area, and the electrical impedance of three body segments were recorded continuously. As expected, HDT caused a decrease in plasma volume and total body fluid volume. Resting CO at the end of HDT was 16 percent below the baseline level and similar to CO in the upright position before HDT. Stroke volume (SV) was also reduced, but there were no significant changes in control HR or BP. Absolute changes in CO and SV during LBNP were similar at baseline and during HDT, but the relative changes were larger during HDT. HR and vasoconstriction responses were enhanced, but presyncope occurred in two subjects. Reduced cardiac filling with decreased stroke volume at rest is the apparent primary cause of the altered LBNP response during HDT. Author

A93-28682
PULMONARY RESPONSES TO LOWER BODY NEGATIVE PRESSURE AND FLUID LOADING DURING HEAD-DOWN TILT BEDREST
A. HILLBRECHT, H. SCHULZ, M. MEYER, F. BAISCH, L. BECK, and C. G. BLOMQVIST (Max Planck Inst. for Experimental Medicine, Goettingen, Germany) Acta Physiologica Scandinavica Supplement (ISSN 0302-2994) vol. 604 1992 p. 35-42.
Copyright

Exposure to microgravity redistributes body fluids with important secondary effects on cardiovascular function. We tested the hypothesis that the fluid shifts also affect pulmonary gas exchange. Microgravity was simulated in six male volunteers by a 10-day period of bedrest at 6 degrees head-down tilt (HDT). Lower body negative pressure (LBNP) and intravenous saline loading superimposed acute changes in fluid distribution on the prolonged effects of HDT. HDT produced relative dehydration and hypovolemia with decreased pulmonary blood flow and diffusing capacity. Before bedrest, pulmonary blood flow decreased by 24 percent during LBNP and diffusing capacity by 7 percent, while functional residual capacity increased by 14 percent (p less than 0.05). Intravenous saline loading caused a 24 percent increase in pulmonary blood-flow (p less than 0.05). Functional residual capacity decreased by 10 percent and diffusing capacity by 6 percent (p less than 0.05). Lung tissue volume did not change significantly. Head-down tilt had only minor effects on the responses to LBNP and saline loading. We conclude that LBNP and intravenous saline loading produce major changes in pulmonary blood-flow and minor effects on pulmonary gas exchange, and that the response to acute changes in fluid distribution is not significantly altered during simulated microgravity. Author

A93-28683
CARDIOPULMONARY FUNCTION DURING 10 DAYS OF HEAD-DOWN TILT BEDREST
H. SCHULZ, A. HILLBRECHT, J. M. KAREMAKER, A. D. TEN HARKEL, L. BECK, F. BAISCH, and M. I. MEYER (Max Planck Inst. for Experimental Medicine, Goettingen, Germany) Acta Physiologica Scandinavica Supplement (ISSN 0302-2994) vol. 604 1992 p. 23-32.
Copyright

Pulmonary and cardiovascular responses to simulated weightlessness, i.e. 6 degrees head-down tilt bedrest (HDT) were investigated in six healthy male volunteers (mean age 26 yrs). Pulmonary diffusing capacity, functional residual capacity, pulmonary capillary blood flow, and lung tissue volume were measured by inert gas rebreathing. Heart rate and mean arterial blood pressure were obtained from finger blood pressure readings

using a plethysmographic technique (Finapres). The short-term (20 min) response to HDT consisted of a 22 percent increase in pulmonary blood flow, and 13 percent and 31 percent falls in blood pressure and heart rate relative to standing. Functional residual capacity fell by 33 percent, while lung tissue volume increased insignificantly. Subsequent measurements during 10 days of HDT and 5 days of recovery revealed no further changes in lung volume, lung tissue volume, or blood pressure. However, diffusing capacity fell gradually and remained 4 percent-5 percent below baseline values after the 7th day of bedrest and during recovery (p less than 0.05). Pulmonary blood flow decreased by 16 percent during head-down bedrest and recovered partially within the following 5 days (p less than 0.05). We conclude that during and after simulated weightlessness marked alterations in cardiovascular function and marginal affections of gas exchange can be demonstrated already at rest. They may be considered as contributing factors to orthostatic and exercise intolerance observed after space flight. A.U.T.

A93-28684
EFFECT OF HEAD-DOWN TILT BEDREST (10 DAYS) ON LYMPHOCYTE REACTIVITY

F. K. GMUNDER, F. BAISCH, B. BECHLER, A. COGOLI, M. COGOLI, P. W. JOLLER, H. MAASS, J. MULLER, and W. H. ZIEGLER (Zuerich, Eidgenoessische Technische Hochschule, Switzerland) Acta Physiologica Scandinavica Supplement (ISSN 0302-2994) vol. 604 1992 p. 131-141.
Copyright

Immunological responses of six healthy males to 10 days of head-down tilt bedrest (HDT) were assessed. Lymphocyte responsiveness was severely reduced immediately before, during, and immediately after the HDT, even though the lymphocyte numbers did not change. By contrast, delayed-type hypersensitivity was not affected. No dramatic changes were found in WBC counts and lymphocyte subpopulations, with the only exception of natural killer (NK) cells which transiently decreased immediately after HDT. Plasma cortisol levels were elevated above normal immediately before and during the HDT. The data suggest that the mitogenic response of lymphocytes was affected by psychological and fluid shift stress. These results are compared with data obtained during and after spaceflight. We conclude that the stress of HDT induces changes in immunological responsiveness that are strikingly similar to those arising from the stress of spaceflight. A.U.T.

A93-28685
EFFECTS OF HEAD-DOWN TILT AND SALINE LOADING ON BODY WEIGHT, FLUID, AND ELECTROLYTE HOMEOSTASIS IN MAN

M. HEER, C. DRUMMER, F. BAISCH, H. MAASS, R. GERZER, J. KROPP, and C. G. BLOMQVIST (DLR, Inst. fuer Flugmedizin, Cologne, Germany) Acta Physiologica Scandinavica Supplement (ISSN 0302-2994) vol. 604 1992 p. 13-22.
Copyright

We studied the effects of head-down tilt bedrest (HDT) on body weight, fluid and sodium homeostasis. A fluid load session with rapid intravenous infusion of 22 ml/kg body weight (BW) isotonic saline was performed before, during and after HDT. During the pre- and post HDT periods the test subjects were given a diet containing 2600 kcal/day. The energy intake was reduced to 2000 kcal/day during HDT. Water intake was kept constant at 40 ml/kg BW, sodium intake was 2.2 mmol/kg BW and protein intake was 1.4 g/kg BW, while the daily fat and carbohydrate intake was reduced during the HDT period. As expected plasma volume and BW changed rapidly in the beginning of HDT and during early recovery. A total body water loss of 0.6 l was observed within the second day after tilting. Plasma volume was reduced by 16 percent during HDT-bedrest. The time course of the body fluid loss paralleled a decrease in body sodium that then remained fairly constant during the HDT-bedrest period (except for the interference caused by the fluid loading on day S06). A restoration of body fluid and body sodium content occurred early in the recovery period. Fluid loading caused a negative fluid balance of 0.6-0.9 l over a 48 hr period following infusion regardless of the phase of the HDT study. These results demonstrate that under our strictly controlled conditions 1) HDT alters body fluid and sodium balances, 2) a standard fluid loading causes a net negative 3-day fluid balance during all phases of the study. A.U.T.

A93-28686
THE EFFECTS OF A 10-DAY PERIOD OF HEAD-DOWN TILT ON THE CARDIOVASCULAR RESPONSES TO INTRAVENOUS SALINE LOADING

F. A. GAFFNEY, J. C. BUCKEY, L. D. LANE, A. HILLEBRECHT, H. SCHULZ, M. MEYER, F. BAISCH, L. BECK, M. HEER, H. MAASS (Texas Univ., Southwestern Medical Center, Dallas) et al. Acta Physiologica Scandinavica Supplement (ISSN 0302-2994) vol. 604 1992 p. 121-130.
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We tested the hypothesis that adaptation to microgravity, simulated by a 10-day period of head-down tilt (HDT), alters the responses to an intravenous fluid load by causing a larger fraction of the infused volume to be retained and magnifying the acute hemodynamic effects. HDT caused a significant (p less than 0.01) decrease in blood volume (-0.72 liters) and weight (-1.6 kg). Rapid infusion (22 ml/kg over 20 min.) of isotonic saline before, during, and after HDT produced a transient bloodvolume expansion with 18 percent of the infusate retained intravascularly after 2 hours. HDT had no effect on this response. Control hemodynamics were significantly different with lower cardiac output and higher total peripheral resistance (TPR) during and after HDT. Saline caused significant increases in cardiac output, heart rate, and stroke volume and a decrease in TPR. The magnitude and time course of these changes were not altered by HDT. The results refute the hypothesis and suggest that during HDT new set points or operating points were established for the control of intravascular volume and hemodynamic state. A.U.T.

A93-28687
EFFECT OF HEAD-DOWN BEDREST ON BLOOD/PLASMA DENSITY AFTER INTRAVENOUS FLUID LOAD

G. HAAS, H. HINGHOFER-SZALKAY, F. BAISCH, H. MAASS, L. LANE, and C. G. BLOMQVIST (Graz Univ., Austria) Acta Physiologica Scandinavica Supplement (ISSN 0302-2994) vol. 604 1992 p. 113-120.
Copyright

Using the mechanical oscillator technique, the mass density of antecubital venous blood and plasma samples was measured in 6 men before and after infusion of 22 ml/kg isotonic NaCl solution before, on day 7 during, and on day 3 after ten days of 6 degrees head-down bedrest. We studied 1) the distribution volumes of the infused NaCl solution, 2) the magnitude and time-course of induced fluid shifts to the extravascular spaces after rapid volume expansion, and 3) the protein concentration of the translocated fluid. The NaCl distribution volume was 16.7 +/- 2.9 percent body weight (BW) before, 15.0 +/- 3.0 percent BW during (P less than 0.05) and 13.0 +/- 1.3 percent BW after the head-down tilt (HDT) period (P less than 0.01). The volume of fluid shifted 120 min after infusion was not different in the control (12.9 +/- 7.4 percent plasma volume and 8.3 +/- 3.2 percent blood volume), during HDT (14.7 +/- 3.8 percent plasma volume and 7.4 +/- 5.6 percent blood volume), during HDT HDT conditions (14.6 +/- 2.2 percent plasma volume, and 8.2 +/- 1.3 percent blood volume, respectively). The density of the shifted fluid which reflects protein concentration was also unchanged (1004.2 +/- 4.2 g/l, 1002.6 +/- 4.3 g/l and 1003.9 +/- 8.2 g/l in the control, during, and after HDT periods, respectively). The mass density of red cells did not change with any condition. It is concluded that the distribution volume of isotonic saline solution decreases with diminished body mass. Densitometry provides a means of monitoring volume changes and protein shifts under the circumstances of our study. A.U.T.

A93-28688
DIURESIS AND NATRIURESIS FOLLOWING ISOTONIC SALINE INFUSION IN HEALTHY YOUNG VOLUNTEERS BEFORE, DURING, AND AFTER HDT

C. DRUMMER, M. HEER, F. BAISCH, C. G. BLOMQVIST, R. E. LANG, H. MAASS, and R. GERZER (Munich Univ., Germany) Acta Physiologica Scandinavica Supplement (ISSN 0302-2994) vol. 604 1992 p. 101-111.
Copyright

In the present study the response to acute saline loading was investigated. During a 24-day study period six male subjects followed a standardized diet including a daily intake of 40 ml water and 125 mg NaCl per kg body weight. Before, during, and after a ten-day period of 6 degrees head down tilt (HDT) each volunteer received an intravenous 0.9 percent saline infusion of 22 ml/kg body weight over 20 minutes. HDT produced significant losses in body weight and in blood volume, but the responses to saline loading were similar during all phases of the study. Plasma levels of atrial natriuretic peptide (ANP) did not increase, while plasma levels of cyclic GMP increased by about 40 percent 90 minutes after each infusion. Urine flow nearly doubled during second hour post-infusion. Sodium excretion showed a 3-fold increase and remained elevated during the third hour, while potassium excretion was significantly reduced. Urinary excretion of cyclic GMP reached a peak during the second hour post-infusion. At the end of these short-term periods the cumulative water- and sodium-balance data disclosed that only about 20 percent of the infused water and less than 15 percent of the infused sodium was excreted during each experiment. In addition to the short-term renal response, urine flow and sodium excretion remained significantly elevated for more than 48 hours after each saline load. The long-term renal response was paralleled by an increased excretion of urinary cyclic GMP. HDT produced significant changes in body fluid distribution, but only minor changes in the regulatory responses to an acute saline load. We conclude from these data that the excretion of an acute isotonic saline load requires several days and that the renal response appears to be independent of the secretion of ANP from the heart. A.U.T.

A93-28689
HEAD-DOWN TILT BEDREST: HDT'88 - AN INTERNATIONAL COLLABORATIVE EFFORT IN INTEGRATED SYSTEMS PHYSIOLOGY
F. BAISCH, J. M. KAREMAKER, P. ARBEILLE, F. A. GAFFNEY, and C. G. BLOMQVIST (DLR, Inst. fuer Flugmedizin, Cologne, Germany) Acta Physiologica Scandinavica Supplement (ISSN 0302-2994) vol. 604 1992 p. 1-12.
Copyright

An international collaborative project, initiated by the DLR-NASA Life Sciences Working Group, led to the performance of a head-down tilt bedrest (HDT) study at the DLR Institute for Aerospace Medicine. Scientific and operational questions were addressed in preparation for the D-2 Spacelab mission. Principal areas of interest were cardiovascular regulation and fluid/electrolyte metabolism. The results are detailed in a series of 13 reports to which the present paper serves as an introduction. A.U.T.

A93-28690
FLIGHT PHYSIOLOGY - CLINICAL CONSIDERATIONS
I. J. BLUMEN, M. K. ABERNETHY, and M. J. DUNNE (Chicago Univ. Hospitals, IL) Critical Care Clinics (ISSN 0749-0704) vol. 8, no. 3 July 1992 p. 597-618.
Copyright

Altitude-related complications and the stresses of flight represent the components of flight physiology. Understanding the complexities associated with patient management relative to barometric pressure changes and hypoxia is of paramount concern to air medical personnel. This article reviews flight physiology as well as appropriate precautions and interventions that must be practiced to provide optimal patient care at various altitudes. A.U.T.

A93-28696* National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.
CAROTID-CARDIAC BAROREFLEX RESPONSE AND LBNP TOLERANCE FOLLOWING RESISTANCE TRAINING
D. L. TATRO, G. A. DUDLEY, and V. A. CONVERTINO (Bionetics Corp.; NASA, Kennedy Space Center, Cocoa Beach, FL) Medicine and Science in Sports and Exercise (ISSN 0195-9131) vol. 24, no. 7 July 1992 p. 789-796.
Copyright

The purpose of this study was to examine the effect of lower body resistance training on cardiovascular control mechanisms and blood pressure maintenance during an orthostatic challenge. Lower body negative pressure (LBNP) tolerance, carotid-cardiac baroreflex function (using neck chamber pressure), and calf compliance were measured in eight healthy males before and after 19 wk of knee extension and leg press training. Resistance training sessions consisted of four or five sets of 6-12 repetitions of each exercise, performed two times per week. Training increased strength 25 +/- 3 (SE) percent ($P = 0.0003$) and 31 +/- 6 percent ($P = 0.0004$), respectively, for the leg press and knee extension exercises. Average fiber size in biopsy samples of m. vastus lateralis increased 21 +/- 5 percent ($P = 0.0014$). Resistance training had no significant effect on LBNP tolerance. However, calf compliance decreased in five of the seven subjects measured, with the group average changing from 4.4 +/- 0.6 ml.mm Hg-1 to 3.9 +/- 0.3 ml.mm Hg-1 ($P = 0.3826$). The stimulus-response relationship of the carotid-cardiac baroreflex response shifted to the left on the carotid pressure axis as indicated by a reduction of 6 mm Hg in baseline systolic blood pressure ($P = 0.0471$). In addition, maximum slope increased from 5.4 +/- 1.3 ms.mm Hg-1 before training to 6.6 +/- 1.6 ms.mm Hg-1 after training ($P = 0.0141$). Our results suggest the possibility that high resistance, lower extremity exercise training can cause a chronic increase in sensitivity and resetting of the carotid-cardiac baroreflex. A.U.T.

A93-28697* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
RETT SYNDROME - STIMULATION OF ENDOGENOUS BIOGENIC AMINES
R. PELLIGRA, R. D. NORTON, R. WILKINSON, H. A. LEON, and W. R. MATSON (NASA, Ames Research Center, Moffett Field, CA) Neuropediatrics (ISSN 0174-304X) vol. 23, no. 3 June 1992 p. 131-137.
Copyright

Transient hypercapnic hyperoxemia was induced in two Rett syndrome children by the administration of a gaseous mixture of 80 percent O2 and 20 percent CO2. Time course studies of neurotransmitters and their metabolites showed an immediate and marked increase in central biogenic amine turnover following inhalation of the gas mixture. The increased turnover of biogenic amines was associated with improved clinical changes. This suggests a coupled relationship and provides further support for an etiological role of neurotransmitter dysfunction in Rett syndrome. In a complementary study, elevation of pulmonary CO2 by application of a simple rebreathing device resulted in improvement of abnormal blood gases and elimination of the Cheyne-Stokes-like respiratory pattern of the Rett syndrome. Near normalization of the EEG occurred when a normal respiratory pattern was imposed by means of a respirator. Taken together, these results lead to the preliminary conclusion that cerebral hypoxemia secondary to abnormal respiratory function may contribute to diminished production of biogenic amines in Rett syndrome. A.U.T.

A93-28699
CIVIL AVIATION AND CARDIOLOGY - ADMISSION RULES AND FOLLOW-UP OF THE TECHNICAL FLYING PERSONNEL OF TAP-AIR PORTUGAL [AVIACAO CIVIL E CARDIOLOGIA - NORMAS DE ADMISSAO E FOLLOW-UP DO PESSOAL NAVEGANTE TECNICO DA TAP-AIR PORTUGAL]
J. NAZARE, J. CARMONA, P. MATOS, F. CABRAL, and S. LEAS (TAP Air Portugal, Lisbon) Revista Portuguesa de Cardiologia (ISSN 0304-4750) vol. 11, no. 6 June 1992 p. 583-593. In Portuguese.
Copyright

The authors, based in European and American rules, consensus positions of Clinical Aerospace Congresses and their own experience, marked admission and follow-up rules of conduct for TAP Air Portugal aircrew. They stressed the importance of modern

technology in arterial pressure ambulatory diagnosis and pointed the necessity of arterial pressure treatment in the other cardiovascular risk factors context. They relief ischemic myocardial disease because it is incompatible with flying safety, even in those submitted to coronary angioplasty or bypass graft surgery. For those with arrhythmias, valvular heart disease, myocarditis, cardiomyopathy and adult life congenital heart disease, we emphasize admission and follow-up rules. A.U.T.

A93-28701
INFLUENCE OF GRAVITOINERTIAL FORCE LEVEL ON VESTIBULAR AND VISUAL VELOCITY STORAGE IN YAW AND PITCH
P. DIZIO and J. R. LACKNER (Brandeis Univ., Waltham, MA) Vision Research (ISSN 0042-6989) vol. 32, no. 1 Jan. 1992 p. 111-120.
Copyright

Velocity storage is an important aspect of sensory-motor control of body orientation. The effective decay rate and three-dimensional organization of velocity storage are dependent upon body orientation relative to gravity and also are influenced by gravitoinertial force (G) level. Several of the inputs to velocity storage including otolithic, somatosensory, proprioceptive, and possibly motor are highly dependent on G level. To see whether the G dependency of velocity storage is related to changes in the effective coupling of individual sensory inputs to the velocity storage mechanism or to alterations in the time constant of velocity storage per se, we have studied horizontal vestibular nystagmus, horizontal optokinetic after nystagmus (OKAN) and vertical vestibular nystagmus as a function of force level. Horizontal OKAN and vestibular nystagmus both showed no effect of G level on their initial or peak slow phase velocities but their decay rates were quicker in 0G and 1.8G than in 1G. Vertical vestibular nystagmus also showed no effect of G level on peak velocity but decayed quicker in 0G relative to 1G. These-findings indicate that the intrinsic decay rate of a common velocity storage mechanism is affected by the magnitude of G. A negligible amount of slow phase eye velocity was observed in planes outside the planes of stimulation, thus short-term changes in G across multiple body axes can change velocity storage, but the change is restricted to the axis common to the rotary stimulus and the G vector. A.U.T.

A93-28702
CASES FROM THE AEROSPACE MEDICINE RESIDENT'S TEACHING FILE: CASE NO.51 - HYPERCHOLESTEROLEMIA AND HEME POSITIVE STOOLS IN A 69-YEAR-OLD AVIATOR (CLINICAL CONFERENCE)
W. S. BESSER (USAF, School of Aerospace Medicine, Brooks AFB, TX) Aviation, Space, and Environmental Medicine (ISSN 0095-6562) vol. 63, no. 9 Sept. 1992 p. 839, 840.
Copyright

This case reports the evaluation of hypercholesterolemia and heme positive stools in an asymptomatic 69-year-old helicopter instructor pilot. It progresses though the work-up of this unique individual and makes recommendations for his continued care and evaluation. A.U.T.

A93-28705
ALTERATION IN HUMAN MONONUCLEAR LEUCOCYTES FOLLOWING SPACE FLIGHT
R. T. MEEHAN, L. S. NEALE, E. T. KRAUS, C. A. STUART, M. L. SMITH, N. M. CINTRON, and C. F. SAMS (Colorado Univ., Denver) Immunology (ISSN 0019-2805) vol. 76, no. 3 July 1992 p. 491-497.
Copyright

Reduced in vitro mitogen-stimulated proliferative responses have routinely been observed from astronauts' mononuclear leucocytes following space flight. This study investigated the effect of space flight on subpopulations of peripheral blood mononuclear cells from 30 shuttle astronauts prior to launch, upon landing and 3 days after flight. The total number of peripheral blood leucocytes, granulocytes and monocytes were increased after space flight (5.7 +/- 0.2 versus 7.0 +/- 0.2; 3.1 +/- 0.1 versus 5.0 +/- 0.1; and 0.16 +/- 0.02 versus 0.25 +/- 0.28 x 10(3) cells/mm3, respectively) whereas lymphocytes were decreased (2.2 +/- 0.1 versus 1.7 +/- 0.1 x 10(3) cells/mm3). Flow cytometry analysis on Ficoll-Hypaque isolated mononuclear cells upon landing revealed significant decreases in T-inducer (CD4+, Leu-8+; 32 +/- 2 versus 23 +/- 2 percent) and T-cytotoxic lymphocytes (CD8+, CD11b-; 17 +/- 1 versus 12 +/- 1 percent), and increases in monocytes (CD14+; 13 +/- 1 versus 21 +/- 1 percent) compared to pre-flight and post-flight samples whereas B cells (CD19+), T-helper (CD4+, Leu-8-) and T-suppressor (CD8+, CD11b+) populations did not change. Additional phenotypic analysis of these mononuclear leucocytes from 10 crew members upon landing revealed a reduction in natural killer (NK) cells (CD16+ or CD56+; 9 +/- 1 versus 3 +/- 1 percent) and an increase in monocytes that were negative for insulin and insulin-like growth factor-1 (IGF-1) receptor expression. Flow cytometric analysis indicated these hormone receptor negative monocytes were smaller and less granular than receptor positive monocytes. Therefore, a novel population of monocytes may be released into the peripheral blood during the stress of space flight or upon landing. These findings may explain some of the diverse in vitro immunological and endocrine changes observed in crew members following space flight. A.U.T.

A93-28708
RATED PERFORMANCE, CARDIOVASCULAR AND QUANTITATIVE EEG PARAMETERS DURING SIMULATED INSTRUMENT FLIGHT UNDER THE EFFECT OF TERFENADINE
K. OFFENLOCH and G. ZAHNER (Frankfurt Univ., Frankfurt am Main, Germany) Arzneimittel-Forschung/Drug Research (ISSN 0004-4172) vol. 42, no. 6 June 1992 p. 864-868.
Copyright

In a double-blind placebo-controlled randomized two-phase cross-over study comprising 10 (5/5) male subjects the effect of oral therapeutic doses of terfenadine (Teldane, CAS 50679-08-8) on rated performance, systolic and diastolic blood pressure, heart rate and the electroencephalogram of the subjects in an instrument flight (IF) procedure trainer was investigated. Terfenadine did not influence systolic and diastolic blood pressure, heart rate and the specific performance of subjects during instrument flight procedures. Under terfenadine the quantitative EEG (qEEG) showed more percentalpha, especially percentalpha 2 during rest and to a lesser extent during instrument flight procedures of the subjects. As a result the vigilance dynamics was increased. In the percentbeta band especially percentbeta 2 was increased only during instrument flight activities. The ratio theta/alpha was reduced during rest and during activities. Thus all these quantitative EEG indicators do not show a decrease in the level of vigilance nor are they indicative of signs of drowsiness during rest and during instrument flight activities under terfenadine. The results are discussed. A.U.T.

A93-28709
GRAVITATIONAL STRESS AND VOLUME REGULATION
P. NORSK (Danish Aerospace Medical Center of Research, Copenhagen, Denmark) Clinical Physiology (ISSN 0144-5979) vol. 12, no. 5 Sept. 1992 p. 505-526.
Copyright

During the past 3 decades, groundbased experiments have been performed in order to investigate the effects of increased and decreased gravitational stress, respectively, on the renal response in humans. Experiments that simulate an increase in gravitational load (+Gz) to the subjects (centrifugation, passive head-up titlt or lower body negative pressure have clearly demonstrated a decrease in renal sodium and water excretion. Simultaneously, increases in plasma levels of arginine vasopressin (AVP), renin activity (PRA), aldosterone (PA), norepinephrine (NE) and decreases in ANP have been observed. Additionally, experiments that have utilized immersion of seated subjects to simulate a decreased gravitational stress (approximately 0 Gz) have demonstrated that renal water and sodium excretion increases by 100-400 percent and that plasma AVP, PRA, PA, and NE

concentrations are reduced and ANP levels increased. Alternative experimental models conducted to simulate the effects of weightlessness in humans such as head-down tilt (HDT) and lower body positive pressure (LBPP) have yielded less consistent results than those of water immersion (WI) with respect to renal function. However, compared to a seated control HDT clearly induces an increased rate of renal fluid and sodium excretion. The demonstration that central volume expansion during WI is accompanied by an increase in renal fluid and electrolyte excretion and that central hypovolaemia during centrifugation, HUT, and LBNP is accompanied by the opposite effects indicate that changes in central blood volume is an important determinant of the renal functional changes. Results of experiments in humans during weightlessness in space are inconsistent and difficult to interpret. However, they have indicated that a cephalad redistribution of blood and fluid occurs and that this is accompanied by a decrease in total body fluid. Experimental models that, respectively, increase and decrease the gravitational stress in humans A.U.T.

A93-28710
LIVING AND WORKING IN SPACE - EVOLUTION OF NURSING IN A NEW ENVIRONMENT
JANET M. BURGE (Alabama Univ., Huntsville) Holistic Nursing Practice (ISSN 0887-9311) vol. 6, no. 4 July 1992 p. 67-74. refs
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A93-28712* National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.
EMERGENCY MEDICAL OPERATIONS AT KENNEDY SPACE CENTER IN SUPPORT OF SPACE SHUTTLE
K. J. MYERS, D. A. TIPTON, D. WOODARD, and I. D. LONG (Bionetics Corp.; NASA, Kennedy Space Center, Cocoa Beach, FL) Florida Medical Association, Journal (ISSN 0015-4148) vol. 79, no. 8 Aug. 1992 p. 557-561.
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The unique environment of the Kennedy Space Center includes a wide variety of industrial processes culminating in launch and spaceflight. Many are potentially hazardous to the work force and the astronauts. Technology, planning, training, and quality control are utilized to prevent contingencies and expedite response should a contingency occur. A.U.T.

A93-28713* National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.
KENNEDY SPACE CENTER ENVIRONMENTAL HEALTH PROGRAM
G. M. MARMARO, M. A. CARDINALE, B. R. SUMMERFIELD, and D. A. TIPTON (NASA, Kennedy Space Center, Cocoa Beach, FL) Florida Medical Association, Journal (ISSN 0015-4148) vol. 79, no. 8 Aug. 1992 p. 553-556.
Copyright

The Kennedy Space Center's environmental health organization is responsible for programs which assure its employees a healthful workplace under diverse and varied working conditions. These programs encompass the disciplines of industrial hygiene, radiation protection (health physics), and environmental sanitation/pollution control. Activities range from the routine, such as normal office work, to the highly specialized, such as the processing of highly toxic and hazardous materials. A.U.T.

A93-28718* National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.
SKELETAL MUSCLE RESPONSES TO UNLOADING WITH SPECIAL REFERENCE TO MAN
G. A. DUDLEY, B. M. HATHER, and P. BUCHANAN (NASA, Kennedy Space Center, Cocoa Beach, FL) Florida Medical Association, Journal (ISSN 0015-4148) vol. 79, no. 8 Aug. 1992 p. 525-529.
Copyright

The limited space flight data suggest that exposure to microgravity decreases muscle strength in humans and muscle mass in lower mammals. Several earth-based models have been used to address the effect of unloading on the human neuromuscular system due to the limited access of biological research to long-term space flight. Bedrest eliminates body weight bearing of both lower limbs. Unilateral lower limb suspension (ULLS), where all ambulatory activity is performed on crutches with an elevated sole on the shoe of one foot, has recently been used to unload one lower limb. The results from studies using these two models support their efficacy. The decrease in strength of m. quadriceps femoris, for example, after four to six weeks of bedrest, ULLS or space flight is 20 to 25 percent. The results from the earth-based studies show that this response can be attributed in part to a decrease in the cross-sectional area of the KE which reflects muscle fiber atrophy. The results from the ground based studies also support the limited flight data and show that reductions in strength are larger in lower than upper limbs and in extensor than flexor muscle groups. They also raise issue with the generally held concept that postural muscle is most affected by unweighting. Slow-twitch fibers in lower limb muscles of mixed fiber type composition and muscle composed mainly of slow-twitch fibers do not preferentially atrophy after bedrest or ULLS. Taken together, the data suggest that unloading causes remarkable adaptations in the neuromuscular system of humans. It should be appreciated, however, that this area of research is in its infancy. A.U.T.

A93-28719* National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.
CARDIOVASCULAR PHYSIOLOGY - EFFECTS OF MICROGRAVITY
V. CONVERTINO and G. W. HOFFLER (NASA, Kennedy Space Center, Cocoa Beach, FL) Florida Medical Association, Journal (ISSN 0015-4148) vol. 79, no. 8 Aug. 1992 p. 517-524.
Copyright

Experiments during spaceflight and its groundbase analog, bedrest, provide consistent data which demonstrate that numerous changes in cardiovascular function occur as part of the physiological adaptation process to the microgravity environment. These include elevated heart rate and venous compliance, lowered blood volume, central venous pressure and stroke volume, and attenuated autonomic reflex functions. Although most of these adaptations are not functionally apparent during microgravity exposure, they manifest themselves during the return to the gravitational challenge of earth's terrestrial environment as orthostatic hypotension and instability, a condition which could compromise safety, health and productivity. Development and application of effective and efficient countermeasures such as saline 'loading,' intermittent venous pooling, pharmacological treatments, and exercise have become primary emphases of the space life sciences research effort with only limited success. Successful development of countermeasures will require knowledge of the physiological mechanisms underlying cardiovascular adaptation to microgravity which can be obtained only through controlled, parallel groundbased research to complement carefully designed flight experiments. Continued research will provide benefits for both space and clinical applications as well as enhance the basic understanding of cardiovascular homeostasis in humans. A.U.T.

A93-28720
CHANGES IN VITAMIN A STATUS FOLLOWING PROLONGED IMMOBILIZATION (SIMULATED WEIGHTLESSNESS)
S. TAKASE, T. GODA, H. YOKOGOSHI, and T. HOSHI (Shizuoka Univ., Japan) Life Sciences (ISSN 0024-3205) vol. 51, no. 18 1992 p. 1459-1466.
Copyright

A study was conducted to investigate the effects of a simulated weightlessness induced by chronic immobilization on vitamin A status. To simulate the stress condition of weightlessness, rats were suspended for 10 days in a special jacket to which metal chains were attached. Animals received a commercial stock diet. Control rats were pair-fed in reference to the suspended rats. As compared with the control, prolonged immobilization resulted in a decrease in body weight gain and an increase in adrenal weight

occurred. In the suspended rats, serum concentrations of retinol and retinol-binding protein (RBP) declined. Hepatic retinyl palmitate content increased, and the hepatic retinol level was decreased. The prolonged immobilization led to significantly reduced retinyl palmitate levels in the testis and lung as well as lowered testicular retinol levels. The results suggest that the stress state induced by prolonged immobilization caused accumulation of hepatic retinyl palmitate, decreasing the serum retinol concentration and retinyl ester content in the extrahepatic tissues. A.U.T.

A93-28721
AEROBIC FITNESS. I - RESPONSE OF VOLUME REGULATING HORMONES TO HEAD-DOWN TILT
X. SHI, W. G. SQUIRES, J. W. WILLIAMSON, C. G. CRANDALL, J. J. CHEN, L. P. KROCK, and P. B. RAVEN (Texas College of Osteopathic Medicine, Fort Worth) Medicine and Science in Sports and Exercise (ISSN 0195-9131) vol. 24, no. 9 Sept. 1992 p. 991-998.
Copyright

We investigated the relationship of aerobic fitness to the response of volume-regulating hormones to acute simulated microgravity. Six untrained (UT) and six endurance-trained (ET) healthy young males were studied in the head-down tilt (HDT) position of -6 degrees for 4 h. Peak oxygen uptake (VO2peak) and plasma volume (PV) were significantly greater in the ET (VO2peak = 61.7 +/- 1.6 ml.min-1.kg-1 and PV = 53.1 +/- 2.8 ml.kg-1) than in the UT (VO2peak = 38.4 +/- 1.7 ml.min-1.kg-1 and PV = 38.8 +/- 1.0 ml.kg-1). Plasma concentrations of atrial natriuretic peptide (ANP), arginine vasopressin (AVP), norepinephrine (NE), renin activity (PRA), and aldosterone (PA) were measured prior to HDT and at minutes 2, 5, 15, 30, 60, 120, 180, and 240 during HDT. PRA and PA significantly decreased during the time of HDT in both groups. The changes in ANP and NE concentrations were not significantly different between the groups nor across time. However, in the ET subjects, the changes in PRA and NE were significantly correlated with the changes in ANP ($r = 0.49$, P less than 0.01; and $r = 0.86$, P less than 0.001, respectively); in the UT subjects, the changes in AVP, PRA, and PA were significantly associated with changes in NE ($r = 0.34$, P less than 0.03; and $r = 0.59$; and $r = 0.53$, P less than 0.01, respectively). PV significantly decreased during HDT, and was primarily related to the decrease in PA in both groups.(ABSTRACT TRUNCATED AT 250 WORDS) A.U.T.

A93-28723* Jet Propulsion Lab., California Inst. of Tech., Pasadena.
IMAGE ENHANCEMENT FILTERS SIGNIFICANTLY IMPROVE READING PERFORMANCE FOR LOW VISION OBSERVERS
T. B. LAWTON (JPL, Pasadena, CA) Ophthalmic and Physiological Optics (ISSN 0275-5408) vol. 12, no. 2 April 1992 p. 193-200.
Copyright

As people age, so do their photoreceptors; many photoreceptors in central vision stop functioning when a person reaches their late sixties or early seventies. Low vision observers with losses in central vision, those with age-related maculopathies, were studied. Low vision observers no longer see high spatial frequencies, being unable to resolve fine edge detail. We developed image enhancement filters to compensate for the low vision observer's losses in contrast sensitivity to intermediate and high spatial frequencies. The filters work by boosting the amplitude of the less visible intermediate spatial frequencies. The lower spatial frequencies. These image enhancement filters not only reduce the magnification needed for reading by up to 70 percent, but they also increase the observer's reading speed by 2-4 times. A summary of this research is presented. A.U.T.

A93-28729
PREDICTING INCREASES IN SKIN TEMPERATURE USING HEAT STRESS INDICES AND RELATIVE HUMIDITY IN HELICOPTER PILOTS
P. FROOM, E. KRISTAL-BONEH, J. RIBAK, and Y. G. CAINE (Israel Air Force, Aeromedical Center, Ramat Gan) Israel Journal of Medical Sciences (ISSN 0021-2180) vol. 28, no. 8-9 Aug.-Sept. 1992 p. 608-610.
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We used measurements of heat stress in the cockpit of Bell 206 and 212 helicopters manned by a crew of two to predict changes in the skin temperatures of 50 pilots over a 1-h ground standby period. Cockpit wet bulb globe temperatures increased from 28.1 +/- 5.6 degrees C to 32.9 +/- 3.9 degrees C over the 1-h ground standby period. Skin temperatures increased from 34.7 +/- 1.1 to 35.4 +/- 1.1 degrees C, while heart rate increased from 79.4 +/- 9.6 to 82.6 +/- 9.8 bpm. Cockpit wet bulb temperatures explained 26.9 percent of the variance of the increase in skin temperature ($P = 0.0002$). Wet bulb globe temperatures, discomfort index and dry bulb temperatures did not improve the predictive value of wet bulb temperatures alone. Relative humidity was not significantly associated with the increase in skin temperature. We conclude that wet bulb temperatures predict changes in skin temperature as well as other heat stress indices. Furthermore, despite high cockpit temperatures, pilots experienced only minimal strain during the 1-h ground standby period. Extrapolation of our results to the effects on body temperature of higher degrees of heat stress and physical activity is unwarranted and deserves further study. A.U.T.

A93-28732* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
IN VIVO TESTING CONFIRMS A BLUNTING OF THE HUMAN CELL-MEDIATED IMMUNE MECHANISM DURING SPACE FLIGHT
G. R. TAYLOR and R. P. JANNEY (NASA, Johnson Space Center, Houston, TX) Journal of Leukocyte Biology (ISSN 0741-5400) vol. 51, no. 2 Feb. 1992 p. 129-132.
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The cell-mediated immune (CMI) mechanism was evaluated in 10 space shuttle astronauts by measuring their delayed-type hypersensitivity response to seven common recall antigens. The Multitest CMI test system was used to administer antigens of tetanus, diphtheria, Streptococcus, Proteus, old tuberculin, Candida, and Trichophyton to the forearm 46 h before nominal mission termination; readings were conducted 2 h after landing. The mean number of reactions was reduced from 4.5 preflight to 3.0 inflight, and the mean reaction score was reduced from 21.4 to 13.7 mm inflight. The data presented suggest that the CMI system is still being degraded by space flight conditions on day 4 and that between day 5 and day 10, the depression maximizes and the system begins to adjust to the new conditions. The relation of these in vivo findings to previously reported in vitro results is discussed. A.U.T.

A93-28734
MANAGEMENT OF TRAUMA AND EMERGENCY SURGERY IN SPACE
K. E. MCCUAIG and B. A. HOUTCHENS (Alberta Univ., Edmonton, Canada) Journal of Trauma (ISSN 0022-5282) vol. 33, no. 4 Oct. 1992 p. 610-625; Discussion, p. 625, 626.
Copyright

Trauma may cause morbidity or mortality in expeditionary spaceflight settings. Physiologic and mechanical changes related to microgravity may increase susceptibility to and complicate the management of injuries in spaceflight. Limited surgical experience in microgravity suggests that special apparatuses and techniques will be needed to maintain the stability of patients, surgeons, and equipment, and to control fluids. A prototype microgravity surgical workstation and suction unit and modifications of standard procedures were devised to address these needs. Using these devices and methods and selected surgical supplies during repeated 25-second intervals of microgravity generated by parabolic arc flight, the 'ABCs' of trauma management, limb traction and immobilization, and minor surgical procedures were performed in flight and problems were identified. Convincing 'qualification' of spaceflight surgical equipment and protocols will require evaluations in continuous microgravity. As on Earth, the major determinant of

emergency surgical care in spaceflight may be the presence or absence of a well-trained surgeon. A.U.T.

A93-28735* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
NEUROLOGY OF MICROGRAVITY AND SPACE TRAVEL
M. D. FUJII and B. M. PATTEN (Wright State Univ.; NASA, Johnson Space Center, Houston, TX) Neurologic Clinics (ISSN 0733-8619) vol. 10, no. 4 Nov. 1992 p. 999-1013.
Copyright

Exposure to microgravity and space travel produce several neurologic changes, including SAS, ataxia, postural disturbances, perceptual illusions, neuromuscular weakness, and fatigue. Inflight SAS, perceptual illusions, and ocular changes are of more importance. After landing, however, ataxia, perceptual illusions, neuromuscular weakness, and fatigue play greater roles in astronaut health and readaptation to a terrestrial environment. Cardiovascular adjustments to microgravity, bone demineralization, *and possible decompression sickness and excessive radiation* exposure contribute further to medical problems of astronauts in space. A better understanding of the mechanisms by which microgravity adversely affects the nervous system and more effective treatments will provide healthier, happier, and longer stays in space on the space station Freedom and during the mission to Mars. A.U.T.

A93-28736
SIMULATED WEIGHTLESSNESS AND BONE METABOLISM - GRAVITATIONAL STIMULATION ENHANCES INSULIN SENSITIVITY
M. YAMAGUCHI and T. HOSHI (Shizuoka Univ., Japan) Research in Experimental Medicine (ISSN 0300-9130) vol. 192, no. 5 1992 p. 345-353.
Copyright

The effect of simulated weightlessness on bone metabolism was investigated in skeletal unloading for 4 days. Skeletal unloading was designed using the model of hindlimb hang in rats. Skeletal unloading with hindlimb hang cased a significant decrease of alkaline phosphatase activity, deoxyribonucleic acid (DNA) content, and glucose consumption in the femoral diaphysis, but not in the calvaria. When femoral-diaphyseal tissues were cultured in the presence of insulin (10(-8) M), the hormone produced a significant increase of alkaline phosphatase activity and decrease of glucose consumption in the femoral-diaphyseal tissues obtained from normal rats. This hormonal effect was not seen in the femoral diaphysis, but in the calvaria, of rats with skeletal unloading. However, insulin effect was seen in the femoral diaphysis obtained at 3 days after the removal of skeletal unloading. Meanwhile, the presence of other bone-regulating factors (10(-8) M parathyroid hormone and 10(-4) M zinc sulfate) revealed an appreciable effect on alkaline phosphatase activity in the femoral diaphysis from rats with skeletal unloading. These results suggest that gravitational stimulation can directly enhance a specific insulin sensitivity in the regulation of bone metabolism. A.U.T.

A93-28737
ASEPTIC TECHNIQUE IN MICROGRAVITY
K. MCCUAIG (Alberta Univ., Edmonton, Canada) Surgery, Gynecology & Obstetrics (ISSN 0039-6087) vol. 175, no. 5 Nov. 1992 p. 466-476.
Copyright

Within the next decade, the United States will launch a space station into low Earth orbit as a preliminary step toward a manned mission to Mars. Provision of asepsis in the unique microgravity environment, essential in operative and invasive procedures, is addressed. An assessment of conventional terrestrial aseptic methods and possible modifications for a microgravity environment was done during the microgravity portion of parabolic flight on NASA KC-135 aircraft. During 110 parabolas on three flight days, a 'surgical team' (surgeon, scrub nurse and circulating nurse) using a life size mannequin fastened to a prototype surgical 'work station' (operating table), evaluated open and closed gloving (ten parabolas), skin preparation (six parabolas), surgical scrub methods (24 parabolas), gowning (22 parabolas) and draping (48 parabolas). Evaluated were povidone iodine solution, 1 percent povidone iodine detergent, Chloroxylenol with detergent, wet prep soap sponge, a water insoluble iodophor polymer (DuraPrep, 3M), disposable towels, disposable and reusable gowns, large and small disposable drapes with and without adhesive edges, disposable latex surgeon's gloves with and without packaging modifications and restraint mechanisms (tether, swiss seat, waist and foot restraint devices, fairfield and wire clamps and clips). Ease of use, provision of restraint for supplies and personnel and waste disposal were assessed. The literature was reviewed and its relevance to the space environment discussed, including risk factors, environmental contamination, immune status and microbiology. The microgravity environment, limited water supply and restricted operating area mandated that modifications of fabrication and packaging of supplies and technique be made to create and preserve asepsis. Material must meet stringent flammability and off-gassing standards. Either a chlorhexidine or povidone iodine detergent prepackaged brush and sponge would provide an adequate scrub plus prelimi A.U.T.

A93-28739
FLUOROCARBON 113 EXPOSURE AND CARDIAC DYSRHYTHMIAS AMONG AEROSPACE WORKERS
G. M. EGELAND, T. F. BLOOM, T. M. SCHNORR, R. W. HORNUNG, A. J. SURUDA, and K. K. WILLE (PHS, National Inst. for Occupational Safety and Health, Cincinnati, OH) American Journal of Industrial Medicine (ISSN 0271-3586) vol. 22, no. 6 1992 p. 851-857.
Copyright

We investigated the cardiotoxic effects of 1,1,2-Trichloro-1,2,2-Trifluoroethane (fluorocarbon 113 or FC113) exposures among healthy workers cleaning rocket and ground support equipment for the National Aeronautic and Space Administration (NASA) programs. Exposure and ambulatory electrocardiographic (ECG) monitoring data were evaluated on 16 workers, each of whom was examined on exposed and nonexposed workdays. We examined whether there was a greater rate of dysrhythmias on an exposed workday relative to a nonexposed workday. Overall, we found no within subject differences in the rate of ventricular and supraventricular premature beats (number per 1,000 heart beats), fluctuations in the length of the P-R interval, or heart rate. We found that levels of FC113 exposures below the Occupational Safety and Health Administration (OSHA) 8-hour time-weighted-average (TWA) standard of 1,000 ppm did not induce cardiac dysrhythmias or subtle changes in cardiac activity. However, because fluorocarbons may sensitize the heart to epinephrine, this study's negative findings based on sedentary and fairly healthy workers may not be generalizable to other populations of workers who are not as healthy or engaged in more physically demanding work. A.U.T.

A93-28740
CASES FROM THE AEROSPACE MEDICINE RESIDENTS' TEACHING FILE: CASE NO.52 - A FLYER WITH SYNCOPE (CLINICAL CONFERENCE)
G. MOORE (USAF, School of Aerospace Medicine, Brooks AFB, TX) Aviation, Space, and Environmental Medicine (ISSN 0095-6562) vol. 63, no. 12 Dec. 1992 p. 1118, 1119.
Copyright

The clinical presentation, evaluation, and diagnosis of various types of syncope were discussed. The case also demonstrates the aeromedical management and disposition. This case was unique in that the aviator was initially denied a waiver and permanently grounded, but later returned to flying status. A.U.T.

A93-28741
ASSESSING PILOT WORKLOAD - WHY MEASURE HEART RATE, HRV AND RESPIRATION?
A. H. ROSCOE (Britannia Airways, Ltd., Luton, United Kingdom) Biological Psychology (ISSN 0301-0511) vol. 34, no. 2-3 Nov. 1992 p. 259-287.
Copyright

The application of heart rate and respiratory measures to the human factors of flight is discussed. The concept of pilot workload is related to the concept of arousal and distinguished from physical workload. Finds from studies of pilot workload using heart rate measures are reviewed for flight, simulated flight and related real-life challenges. Measurement techniques and transducers are discussed from the perspective of field measurement. Recommended procedures are presented as are directions for future work. A.U.T.

A93-28744
GRAVITOINERTIAL FORCE LEVEL AFFECTS THE APPRECIATION OF LIMB POSITION DURING MUSCLE VIBRATION
J. R. LACKNER and P. DIZIO (Brandeis Univ., Waltham, MA) Brain Research (ISSN 0006-8993) vol. 592, no. 1-2 Oct. 2, 1992 p. 175-180.
Copyright

Illusory motion and displacement of the restrained forearm can be elicited by vibrating the biceps brachii or triceps brachii muscle. We measured the influence of gravitoinertial force level on these perceptual responses to vibration during parabolic flight maneuvers where normal (1G) and high force (1.8G) background levels alternated with microgravity (0G). Subjects indicated the apparent forearm position of the vibrated arm with the other forearm and also made verbal reports. Biceps brachii vibration induced illusory extension of the forearm and triceps brachii, illusory flexion; these apparent motions and displacements were highly G force-dependent being enhanced at 1.8G and diminished at 0G relative to normal 1G force level. These alterations are discussed in terms of vestibulo-spinal and propriospinal influences on alpha-gamma motoneuronal control of muscle tone and the varying requirements for postural load support in different force backgrounds. Their implications for the control and appreciation of limb movements during exposure to different G force levels are also described. A.U.T.

A93-28747
VESTIBULAR PROBLEMS IN DIVING AND IN SPACE
O. I. MOLVAER (Norwegian Underwater Technology Centre, Laksevaag, Norway) Scandinavian Audiology Supplement (ISSN 0107-8593) vol. 34 1991 p. 163-170.
Copyright

On firm ground our sense of balance is supplied by super abundant input from several sensoric sources. In other environments insufficient or conflicting input may cause vestibular problems. In diving, vertigo may be caused by a variety of influences, like sensory deprivation, optokinetic illusion, asymmetric vestibular stimulation, inner ear barotrauma, decompression sickness, breathing gas toxicity, high pressure neurological syndrome, sea sickness and intense noise. During space flight some of the mentioned mechanisms may contribute to vestibular problems, although space motion sickness being the main cause of concern in this connection. A.U.T.

A93-28750
VESTIBULAR ATAXIA FOLLOWING SHUTTLE FLIGHTS - EFFECTS OF MICROGRAVITY ON OTOLITH-MEDIATED SENSORIMOTOR CONTROL OF POSTURE
W. H. PALOSKI, F. O. BLACK, M. F. RESCHKE, D. S. CALKINS, and C. SHUPERT (Krug Life Sciences, Houston, TX) American Journal of Otology (ISSN 0192-9763) vol. 14, no. 1 Jan. 1993 p. 9-17.
Copyright

Orbital spaceflight exposes astronauts to an environment in which gravity is reduced to negligible magnitudes of 10(-3) to 10(-6) G. Upon insertion into earth orbit, the abrupt loss of the constant linear acceleration provided by gravity removes the otolith stimulus for vestibular sensation of vertical orientation constantly present on Earth. Since the central nervous system (CNS) assesses spatial orientation by simultaneously interpreting sensory inputs from the vestibular, visual, and proprioceptive systems, loss of the otolith-mediated vertical reference input results in an incorrect estimation of spatial orientation, which, in turn, causes a degradation in movement control. Over time, however, the CNS adapts to the loss of gravitational signals. Upon return to Earth, the vertical reference provided by gravitational stimulation of the otolith organ reappears. As a result, a period of CNS readaptation must occur upon return to terrestrial environment. Among the physiological changes observed during the postflight CNS readaptation period is a disruption of postural equilibrium control. Using a dynamic posturography system (modified NeuroCom EquiTest), 16 astronauts were tested at 60, 30, and 10 days preflight and retested at 1 to 5 hours, and 8 days postflight. All astronauts tested demonstrated decreased postural stability immediately upon return to Earth. The most dramatic increases in postural sway occurred during those sensory conditions in which both the visual and proprioceptive feedback information used for postural control were altered by the dynamic posturography system, requiring reliance primarily upon vestibular function for control of upright stance. Less marked but statistically significant increases in sway were observed under those conditions in which visual and foot support surface inputs alone were altered.(ABSTRACT TRUNCATED AT 250 WORDS) A.U.T.

A93-28751
OXYGEN TENSION AND WATER-SOLUBLE PRODUCTS OF LIPID PEROXIDATION IN BLOOD OF VOLUNTEERS IN HYPOBARIC HYPEROXIAL
O. E. LAN'SHINA, V. A. LOGINOV, and E. A. KOVALENKO Biulleten' Eksperimental'noi Biologii i Meditsiny (ISSN 0365-9615) vol. 114, no. 9 Sept. 1992 p. 254, 255. In Russian.
Copyright

Oxygen tension in the arterial blood with transcutaneous method (tcPO2) and TBA-active products of venous blood plasma were measured during simulation of extravehicular activity. There was a parallel increase of tcPO2 and the level of TBA-active products upon introduction of hypobaric hyperoxia factor. Detrimental action of lipid peroxidation products on erythrocyte membranes can be one of the factors of anemia during space flight. A.U.T.

A93-28754
THE CLINICAL CHEMISTRY AND IMMUNOLOGY OF LONG-DURATION SPACE MISSIONS
A. H. WU, G. R. TAYLOR, G. A. GRAHAM, and B. A. MCKINLEY (Texas Univ., Houston) Clinical Chemistry (ISSN 0009-9147) vol. 39, no. 1 Jan. 1993 p. 22-36.
Copyright

Clinical laboratory diagnostic capabilities are needed to guide health and medical care of astronauts during long-duration space missions. Clinical laboratory diagnostics, as defined for medical care on Earth, offers a model for space capabilities. Interpretation of laboratory results for health and medical care of humans in space requires knowledge of specific physiological adaptations that occur, primarily because of the absence of gravity, and how these adaptations affect reference values. Limited data from American and Russian missions have indicated shifts of intra- and extracellular fluids and electrolytes, changes in hormone concentrations related to fluid shifts and stresses of the missions, reductions in bone and muscle mass, and a blunting of the cellular immune response. These changes could increase susceptibility to space-related illness or injury during a mission and after return to Earth. We review physiological adaptations and the risk of medical problems that occur during space missions. We describe the need for laboratory diagnostics as a part of health and medical care in space, and how this capability might be delivered. A.U.T.

A93-28755
MEDICAL-CARE SYSTEMS FOR LONG-DURATION SPACE MISSIONS
B. A. HOUTCHENS (Utah Univ., Salt Lake City) Clinical Chemistry (ISSN 0009-9147) vol. 39, no. 1 Jan. 1993 p. 13-21.
Copyright

As in the opening of frontiers on Earth, human physiological maladaptation, illness, and injury--rather than defective transportation systems--are likely to be the pace-limiting variables

in efforts to expand the presence of humans into the solar system. Because of the inability of individuals to return to Earth rapidly and conveniently, the capability of delivering medical care on site will be key to the success of a manned space station, lunar base, and Mars mission. Spaceflight medical care equipment must meet stringent constraints of size, weight, and power requirements, and then must function accurately in remote, self-contained, microgravity settings after extended intervals of storage, with neither expert operators nor repair technicians on site. Satisfying these unusually rigorous requirements will require sustained direct involvement of clinically up-to-date health-care providers, medical scientists, and biomedical engineers, as well as astronauts and aerospace engineers and managers. Solutions will require validation in clinical settings with real patients, as well as in simulated operational settings. A.U.T.

A93-28756
SKIN CARE IN THE SPACE ENVIRONMENT
B. S. CZERWINSKI and A. C. TOBACK Dermatology Nursing (ISSN 1060-3441) vol. 4, no. 5 Oct. 1992 p. 369-376, 418.
Copyright

Envisioned in the 21st century is the United States Space Program's establishment of a permanent human presence in a space station and a moon colony. Mid-21st century humans will take part in an exploratory trip to Mars from the moon (Collins, 1988; Ride, 1987). Fundamental to achieving these space goals will be human health care management. Skin, the largest human organ, will require care. The purpose of this article is to provide an understanding of skin care in the space environment. A.U.T.

A93-28757
ELECTROENCEPHALOGRAM EPILEPTIFORM ABNORMALITIES IN CANDIDATES FOR AIRCREW TRAINING
R. P. GREGORY, T. OATES, and R. T. MERRY (Princess Alexandra Hospital, Swindon, United Kingdom) Electroencephalography and Clinical Neurophysiology (ISSN 0013-4649) vol. 86, no. 1 Jan. 1993 p. 75-77.
Copyright

For 30 years the Royal Air Force has used the EEG as part of the medical screening of candidates for aircrew training. A total of 13,658 males aged 17-25 years have been examined. None had a previous history of significant illness. Sixty-nine (0.5 percent) of these showed unequivocal epileptiform discharges, 44 (58 percent) occurring only on photic stimulation. Those with EEG discharges of uncertain significance such as 6 and 14 Hz positive spikes, 6 Hz spike and wave, and non-specific paroxysmal activity were not included. A group of 43 with a follow-up period of 5-29 years have been reviewed. Only one person developed unequivocal epilepsy. If this rate is combined with results from similar studies, the chance of healthy individuals with EEG abnormalities of this type subsequently developing epilepsy is 2-3 percent. A.U.T.

A93-28758
AN ASSESSMENT OF THE DEFLECTING EFFECT ON HUMAN MOVEMENT DUE TO THE CORIOLIS INERTIAL FORCES IN A SPACE VEHICLE
P. Y. HENNION and R. MOLLARD (Paris VI, Univ., France) Journal of Biomechanics (ISSN 0021-9290) vol. 26, no. 1 Jan. 1993 p. 85-90.
Copyright

Under conditions of prolonged space flight, it may be feasible to restore gravity artificially using centrifugal inertial forces in a spinning vehicle. As a result, the motion of the passengers relative to the vehicle is affected by Coriolis forces. The aim of this study is to propose a theoretical method to evaluate the extent of these effects compared to other inertial or motor forces affecting movement. We investigated typical right upper limb movement in a numerical model with a two-solid-links mechanism, including a spherical joint for the shoulder and a hinge joint for the elbow. The inertial and dimensional characteristics of this model derive from measurements and computations obtained on laboratory subjects. The same is true for the movements assigned to the model. These were inferred from actual recordings of arm movement when the subject presses a button placed in front of him with his index finger. From these relative velocities, the resulting forces and moments applied to the elbow and the shoulder were computed for a 1 rad s-1 rotational speed of transport motion, using classical kinetic relations. The result is that the Coriolis moments are of the same order of magnitude as the corresponding inertial moments and one-tenth of the value of a typical elbow flexion moment. Thus, they should cause a significant disturbance in movement. A.U.T.

A93-28759* Jet Propulsion Lab., California Inst. of Tech., Pasadena.
WALL SHEAR STRESS ESTIMATES IN CORONARY ARTERY CONSTRICTIONS
L. H. BACK and D. W. CRAWFORD (JPL, Pasadena, CA) Journal of Biomechanical Engineering (ISSN 0148-0731) vol. 114, no. 4 Nov. 1992 p. 515-520.
Copyright

Wall shear stress estimates from laminar boundary layer theory were found to agree fairly well with the magnitude of shear stress levels along coronary artery constrictions obtained from solutions of the Navier Stokes equations for both steady and pulsatile flow. The relatively simple method can be used for in vivo estimates of wall shear stress in constrictions by using a vessel shape function determined from a coronary angiogram, along with a knowledge of the flow rate. A.U.T.

A93-28760
EFFECT OF EXERCISE AND BISPHOSPHONATE ON MINERAL BALANCE AND BONE DENSITY DURING 360 DAY ANTIORTHOSTATIC HYPOKINESIA
A. I. GRIGOR'EV, B. V. MORUKOV, V. S. OGANOV, A. S. RAKHMANOV, and L. B. BURAVKOVA (Inst. of Biomedical Problems, Moscow, Russia) Journal of Bone and Mineral Research (ISSN 0884-0431) vol. 7, Supplement 2 Dec. 1992 p. S449-S455.
Copyright

As we enter a phase of space exploration that will involve long-duration flights, there is a need to use ground-based models to study the long-term effects of countermeasures to prevent the loss of bone mineral in microgravity. Mineral balances, hormone levels, and bone density were measured for 360 days in nine bed rest subjects treated with an exercise program used by cosmonauts. Four of these subjects received the bisphosphonate, ethane-1-hydroxy-1-disphosphonate , 900 mg daily, a drug known to inhibit bone resorption. Compared to a 120 day control period, the bisphosphonate combined with exercise reduced negative calcium balances by 50 percent for the first 120 days, 80 percent for the second 120 days, and 69 percent during the third 120 days. Exercise alone had no effect until the second 120 day period, when calcium balance improved 52 percent. Negative phosphorus balances were not affected by either treatment. Magnesium balances were negative during the first 120 days and returned to nearly normal during the last 240 days in both groups. The combined exercise and bisphosphonate treatment prevented increases in serum ionized calcium and decreases in plasma calcitonin during the first 120 days, as well as trends toward decreases in the mineral density of the femoral neck. These results suggest that bisphosphonates can be efficiently used together with exercise to reduce calcium loss and prevent some of the changes in mineral metabolism during long-term simulated microgravity. A.U.T.

A93-28761
MICROGRAVITY AND BONE ADAPTATION AT THE TISSUE LEVEL
L. VICO and C. ALEXANDRE (Saint-Etienne Univ., France) Journal of Bone and Mineral Research (ISSN 0884-0431) vol. 7, Supplement 2 Dec. 1992 p. S445-S447.
Copyright

Our knowledge of the adaptation of human bone microgravity remains poor despite long-term Russian spaceflights and the recent use of accurate techniques for bone mass measurements. The

extent of bone deficits in the adaptation of the whole skeleton is not clear. At the tissue level, bone resorption and formation activities have been studied only in bones from rats after spaceflights lasting a few days to 3 weeks. In these animals, architectural features consistent with osteoporosis have been found in the proximal tibia. In pregnant animals the osteoclast population is increased at other skeletal sites. In areas of weight-bearing bones that are not protected by muscular insertions, bone resorption is not markedly altered after 7 days of spaceflight and bone formation is reduced. In areas of weight-bearing bones with muscular insertions and in non-weight-bearing bones, similar changes in bone cell activity are delayed. The severity of the response seems to vary with the location of the bone in the skeleton and its initial level of bone turnover. After 12.5 days the acute bone changes are less and no additional changes are observed after 21 days in space. We conclude that generalized bone deficits do not appear to be a consequence of microgravity but occur in localized areas according to the level of modeling and remodeling and of the support function of each bone at 1 g. A.U.T.

A93-28762
WORKING HOURS AND FATIGUE OF JAPANESE FLIGHT ATTENDANTS (FA)
Y. ONO, S. WATANABE, S. KANEKO, K. MATSUMOTO, and M. MIYAO (Nagoya Univ., Japan) Journal of Human Ergology (ISSN 0300-8134) vol. 20, no. 2 Dec. 1991 p. 155-164.
Copyright

There have been some reports concerning high complaint rates of fatigue or fatigue-related symptoms including lower back pain in flight attendants (FA). Thus, the relations of working conditions with work stress and fatigue symptoms were studied chiefly by focusing on working hours. From analysis of the time-table and fatigue symptoms of workers on international flights, it was suspected that there were some work-related factors jointly causing serious FA fatigue symptoms; night time and early morning work, long flight hours and a large time difference, thus disturbing their biological rhythms. On domestic flights, showing up early in the morning and debriefing late in the night were often observed together with a highly irregular FA time schedule. By statistical analyses, some factors including long working hours, frequent landing and late debriefing hours were considered to contribute significantly to the high fatigue complaint rates. Thus, it should be emphasized that many countermeasures are necessary to improve FA working conditions including working hours, rest on the airplane (ONO et al., 1990) and sleep during layover, in order to reduce their work stress and fatigue symptoms. A.U.T.

A93-28765
ROTATING-WALL VESSEL COCULTURE OF SMALL INTESTINE AS A PRELUDE TO TISSUE MODELING - ASPECTS OF SIMULATED MICROGRAVITY
T. J. GOODWIN, W. F. SCHROEDER, D. A. WOLF, and M. P. MOYER (Krug Life Sciences, Houston, TX) Society for Experimental Biology and Medicine, Proceedings (ISSN 0037-9727) vol. 202, no. 2 Feb. 1993 p. 181-192.
Copyright

A new low shear stress, low turbulence microcarrier culture system has been developed at NASA's Johnson Space Center that permits large-scale three-dimensional tissue culture. Tissue culture bioreactors called rotating-wall vessels were used in conjunction with multicellular cocultivation to develop a unique in vitro tissue-modeling system. Normal small intestine epithelium and mesenchymal cells were cocultivated on Cytodex-3 microcarriers and were initiated in two phases. Normal small intestine mesenchymal cells were inoculated into the rotating-wall vessel at 2 x 10(5) cells/ml and allowed to attach and proliferate for 2 to 3 days. Normal small intestine epithelium was then added at an innoculum of 2 x 10(5) cells/ml and cultivation continued for 30 to 40 days. These cocultures attained cell numbers of 4-6 x 10(6) cells/ml and differentiated to form tissue-like masses of 0.4-0.5 cm with minimal necrosis. The masses displayed apical brush borders, differentiated epithelial cells, cellular polarity, extracellular matrix, and basal lamina. Verification of mesenchymal and epithelial cell expression was determined by immunocytochemistry and scanning electron microscopy. These data suggest that the rotating-wall vessel affords a new tissue culture model for investigation of growth, regulatory, and differentiation processes within normal tissues. A.U.T.

A93-28766
CANCER RISK ASSESSMENT WITH INTERMITTENT EXPOSURE
D. J. MURDOCH, D. KREWSKI, and J. WARGO (Waterloo Univ., Kingston, Canada) Risk Analysis (ISSN 0272-4332) vol. 12, no. 4 Dec. 1992 p. 569-577.
Copyright

Applications of methods for carcinogenic risk assessment often focus on estimating lifetime cancer risk. With intermittent or time-dependent exposures, lifetime risk is often approximated on the basis of a lifetime average daily dose (LADD). In this article, we show that there exists a lifetime equivalent constant dose (LECD) which leads to the same lifetime risk as the actual time-dependent exposure pattern. The ratio C = LECD/LADD then provides a measure of accuracy of risk estimates based on the LADD, as well as a basis for correcting such estimates. Theoretical results derived under the classical multistage model and the two-stage birth-death-mutation model suggest that the maximum value of C, which represents the factor by which the LADD may lead to underestimates of risk, will often lie in the range of 2- to 5-fold. The practical application of these results is illustrated in the case of astronauts subjected to relatively short-term exposure to volatile organics in a closed space station environment, and in the case of the ingestion of pesticide residues in food where consumption patterns vary with age. A.U.T.

N93-20563# Duke Univ., Durham, NC.
RETINAL INFORMATION PROCESSING FOR MINIMUM LASER LESION DETECTION AND CUMULATIVE DAMAGE Final Report, 1 May 1989 - 30 Apr. 1992
MYRON L. WOLBARSHT 17 Sep. 1992 24 p
(Contract DAMD17-89-C-9027; DA PROJ. 3M1-62787-A-878)
(AD-A259195) Avail: CASI HC A03/MF A01

Minimum ophthalmoscopically visual lesions are not perceived very well by the injured person either from clinical experience or other forms of testing, certainly not with the detail that retinal images of the same size are seen. Previous experiments have suggested a model for retinal organization suitable for small detail detection but which will not detect retinal small lesions very well. Smaller lesions of a sub-threshold nature can cause histological damage but are not visible ophthalmoscopically, nor can they be demonstrated to cause a loss of function. A series of animal experiments has been carried out to test the electrophysiological responses of retinal ganglion cells with sufficient resolution to detect threshold laser exposures with possible deficits in perceiving moving spot/edges and other optical discontinuities. The results are accurate with high resolution and the results should be correlated with supra-threshold exposures of a level to cause sub-retinal hemorrhages and/or vitreous hemorrhages. Both qualitative and quantitative comparisons are needed between the kind of damage caused by sub-threshold, barely threshold, and markedly supra-threshold lesions on this aspect of retinal organization. GRA

N93-20580# Naval Aerospace Medical Research Lab., Pensacola, FL.
SUBJECTIVE FATIGUE IN A-6, F-14, AND F/A-18 AIRCREWS DURING OPERATIONS DESERT SHIELD AND STORM Interim Report
C. A. DEJOHN, S. A. SHAPPELL, and D. F. NERI Oct. 1992 19 p
(Contract PROJ. MM3-3-P-30)
(AD-A259243; NAMRL-1377) Avail: CASI HC A03/MF A01

Fatigue during naval air combat can reduce performance, impair operational effectiveness, and compromise safety. This study examines the effect of combat missions on the subjective fatigue

of naval aircrews deployed aboard USS AMERICA during Desert Shield and Desert Storm. Fatigue was determined using three questionnaires that were completed before and after each mission. Although fatigue significantly increased during combat missions, it usually returned to preflight levels by the next day without noticeably increasing as the operation progressed. We feel that judicious aircrew scheduling on the part of operational planners was one of the most important factors contributing to this result. To minimize fatigue during naval air combat operations, we recommend that, as resources permit, 'no-fly' days be regularly scheduled, only one or two missions should be scheduled per day, and adequate crew rest should be planned between missions. GRA

N93-20587# Naval Submarine Medical Research Lab., Groton, CT.
STATISTICALLY BASED DECOMPRESSION TABLES. 7: SELECTION AND TREATMENT OF PRIMARY AIR AND N2O2 DATA Final Report, Aug. 1986 - Feb. 1992
P. K. WEATHERSBY, S. S. SURVANSHI, R. Y. NISHI, and E. D. THALMANN 18 Sep. 1992 120 p
(Contract PROJ. M00-99)
(AD-A259090; NSMRL-1182; NMRI-92-85) Avail: CASI HC A06/MF A02

Probabilistic models of decompression sickness (DCS) require high quality data of diving profiles and DCS occurrence to get reliable predictions of the probability of DCS, P(DCS). Over 400 experimental dives performed since 1977 in the U.S., U.K., and Canada were collected, verified, and formatted for use in probabilistic models. In most cases the dive profile precision is within 1 fsw in depth, 30 sec in time, and 0.1 ATA in PO2. DCS outcome and other medical records are of the highest quality expected for test dives done in military laboratories. The data sources, steps used in the review and formatting process, and summaries of the data collection are described. GRA

N93-20736*# Florida Inst. of Tech., Melbourne. Dept. of Biological Sciences.
RAPID SUSCEPTIBILITY TESTING OF MYCOBACTERIUM AVIUM COMPLEX AND MYCOBACTERIUM TUBERCULOSIS ISOLATED FROM AIDS PATIENTS Interim Report, 1 Oct. 1992 - 31 Jan. 1993
ARVIND M. DHOPLE 31 Jan. 1993 14 p
(Contract NAG10-0106)
(NASA-CR-192382; NAS 1.26:192382) Avail: CASI HC A03/MF A01

In ominous projections issued by both U.S. Public Health Service and the World Health Organization, the epidemic of the Human Immunodeficiency Virus (HIV) infection will continue to rise more rapidly worldwide than predicted earlier. The Acquired Immunodeficiency Syndrome (AIDS) patients are susceptible to diseases called opportunistic infections of which tuberculosis and M. avium Complex (MAC) infection are most common. This has created an urgent need to uncover new drugs for the treatment of these infections. In the seventies, NASA scientists at Goddard Space Flight Center, Greenbelt, Maryland, had adopted a biochemical indicator, adenosine triphosphate (ATP), to detect presence of life in extraterrestrial space. Therefore, we proposed to develop ATP assay technique to determine sensitivity of antibacterial compounds against MAC and M. tuberculosis. The work was initiated in June 1992. In the last report, we described our efforts in developing ATP assay method using MAC. Studies were continued further, and during the period of this report, we established the relationship between colony forming units and ATP levels of these organisms during the growth cycle. Also, we evaluated the effects of standard antimycobacterial drugs using ATP assay technique and compared the results with those obtained with conventional tube dilution proportional method.
Derived from text

N93-20889* National Aeronautics and Space Administration, Washington, DC.
AEROSPACE MEDICINE AND BIOLOGY: A CUMULATIVE INDEX TO A CONTINUING BIBLIOGRAPHY (SUPPLEMENT 371)
Jan. 1993 276 p
(NASA-SP-7011(371); NAS 1.21:7011(371)) Avail: CASI HC A13

This publication is a cumulative index to the abstracts contained in Supplements 359 through 370 of Aerospace Medicine and Biology: A Continuing Bibliography. It includes seven indexes: subject, personal author, corporate source, foreign technology, contract number, report number, and accession number. Author

N93-20998*# National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.
TOXIC SUBSTANCES REGISTRY SYSTEM: INDEX OF MATERIAL SAFETY DATA SHEETS
Jul. 1992 839 p
(NASA-TM-108582; NASA-GP-23-1; NAS 1.15:108582) Avail: CASI HC A99/MF A10

The Jul. 1992 Revision of the KSC Toxic Substances Registry System (TSRS) Index of Material Safety Data Sheets (MSDS's) is presented. The listed MSDS's reflect product inventories and associated MSDS's which were submitted to the Toxic Substance Registry Data Base maintained by the Base Operations Contractors of the Biomedical Operations and Research Office of KSC. The purpose of the index is to provide a means of accessing information on the hazards associated with the toxic and otherwise hazardous chemicals stored and used at KSC. Indices are provided for manufacturers, trademarks, and stock numbers. CASI

N93-21044* National Aeronautics and Space Administration, Washington, DC.
AEROSPACE MEDICINE AND BIOLOGY: A CONTINUING BIBLIOGRAPHY WITH INDEXES (SUPPLEMENT 372)
Feb. 1993 79 p
(NASA-SP-7011(372); NAS 1.21:7011(372)) Avail: CASI HC A05

This bibliography lists 208 reports, articles and other documents introduced into the NASA Scientific and Technical Information System during Jan. 1993. Subject coverage includes: aerospace medicine and physiology, life support systems and man/system technology, protective clothing, exobiology and extraterrestrial life, planetary biology, and flight crew behavior and performance.
Author

N93-21046# Health Effects Research Lab., Research Triangle Park, NC. Neurotoxicology Div.
MEASUREMENT OF BEHAVIORAL THERMOREGULATION
CHRISTOPHER J. GORDON and ROBERTO REFINETTI (College of William and Mary, Williamsburg, VA.) 1992 34 p Submitted for publication
(PB92-217033; EPA/600/A-92/166) Avail: CASI HC A03/MF A01

The measurement of thermoregulatory behavior by the techniques of thermal gradient and operant conditioning allows the study of many parameters of the behavioral control of body temperature in particular species as well as the comparative study of thermo-regulatory capabilities of different species. In neuroscience research, these techniques provide a reliable dependent variable for the investigation of the action of specific neurotransmitters and the specificity of particular brain loci involved in the regulation of body temperature. Much of the current knowledge about the neural control of thermoregulatory behavior has been obtained by using thermal gradients and operant conditioning in conjunction with systemic and intracerebral injections of neurotransmitters, local thermal stimulation of brain regions, and selective destruction of particular brain sites by electrolytic lesions. GRA

N93-21047# Federal Aviation Administration, Washington, DC. Office of Aviation Medicine.
GUIDE FOR AVIATION MEDICAL EXAMINERS

1992 191 p Revised
(PB92-219690) Avail: CASI HC A09/MF A02

The Guide for Aviation Medical Examiners was prepared to assist designated Aviation Medical Examiners in the efficient and effective performance of their duties and responsibilities as representatives of the Federal Aviation Administration (FAA). All material contained in the Guide is keyed to the corresponding item number contained on FAA Form 8500-8, Application for Airman Medical Certificate or Airman Medical and Student Pilot Certificate. Medical standards established by law are those contained in the Federal Aviation Regulations (FAR), Part 67 (14 CFR 67), a copy of which is included in the Guide for convenience and easy reference. The Guide includes the Federal Air Surgeon's interpretation of the Federal Aviation Regulations, Part 67, Medical Standards and Certification. GRA

N93-21112# Canadian Space Agency, Ottawa (Ontario).
CEREBRAL AUTOREGULATION IN MICROGRAVITY
R. AASLID, R. L. BONDAR, M. S. KASSAM (Ryerson Polytechnical Inst., Toronto, Ontario.), F. STEIN (Ryerson Polytechnical Inst., Toronto, Ontario.), and P. DUNPHY (Ryerson Polytechnical Inst., Toronto, Ontario.) *In its* Spacebound 1991 p 224-227 1991
Avail: Canadian Space Agency, P.O. Box 7275, Ottawa, ON, Canada K1L 8E3 HC

Experiments were conducted aboard the NASA KC-135 parabolic flight laboratory to assess the cerebral autoregulatory function after transition to microgravity. Cerebral blood flow velocities were measured by transcranial Doppler methods. Typical response of blood flow velocity was an increase just after transition to microgravity, followed by a return to the pre-microgravity value. A simple mathematical model was developed to facilitate the analysis of autoregulation dynamics. The increase was predicted by the increase in arterial blood pressure. The decrease in the later microgravity phase could only be predicted by a model incorporating autoregulation. The cerebral autoregulation seemed to have the same dynamic response characteristics as in normal subjects tested under normal gravity in the supine position.
Author (CISTI)

N93-21114# Waterloo Univ. (Ontario). Dept. of Kinesiology.
RESPIRATORY RESPONSE TO VARYING DEGREES OF TILT AND LOWER BODY NEGATIVE PRESSURE
A. BLABER, M. FRAZER, K. SHOEMAKER, and M. SHARRATT *In* Canadian Space Agency, Spacebound 1991 p 229-234 1991
Avail: Canadian Space Agency, P.O. Box 7275, Ottawa, ON, Canada K1L 8E3 HC

The effects of head up tilt (HUT) and head down tilt (HDT), as well as lower body negative pressure (LBNP), on ventilatory mechanics were studied. The results from three subjects are presented with measurements of functional residual capacity (FRC), intra-abdominal pressure (IAP), minute ventilation (MV), ventilatory frequency (f), and the relative changes in abdominal and chest movements during rest at 90 deg HUT to 6 deg HDT and 0 mmHg to -40 mmHg LBNP. Functional residual capacity and IAP decreased, and the relative proportion of chest movements increased, from HUT to HDT. Since LBNP is thought to mimic standing, it was predicted that with increased LBNP the ventilatory parameters would return to standing values. However, only FRC changed significantly in the direction of standing values. In two of the subjects, this increase in FRC was not seen until -40 mmHg, indicating that the conditions for going from 0 to -40 mmHg may not be enough to override the effects of being in the supine position on FRC. Changes occurred in IAP and chest contribution to breathing but varied from subject to subject. These results suggest differential effects of gravity (tilt) and suction (LBNP) on ventilatory mechanics as well as strategies employed by subjects to compensate for LBNP between 0 and -40 mmHg.
Author (CISTI)

N93-21369*# National Aeronautics and Space Administration, Washington, DC.
ENVIRONMENTAL HEALTH DISCIPLINE SCIENCE PLAN
1991 28 p
(NASA-TM-108042; NAS 1.15:108042) Avail: CASI HC A03/MF A01

The purpose of this plan is to provide a conceptual strategy for NASA's Life Sciences Division research and development activities in environmental health. It covers the significant research areas critical to NASA's programmatic requirements for the Extended Duration Orbiter, Space Station Freedom, and exploration mission science activities. These science activities include ground-based and flight; basic, applied, and operational; animal and human subjects; and research and development. This document summarizes the history and current status of the program elements, outlines available knowledge, establishes goals and objectives, identifies scientific priorities, and defines critical questions in the three disciplines: (1) Barophysiology, (2) Toxicology, and (3) Microbiology. This document contains a general plan that will be used by both NASA Headquarters Program Officers and the field centers to review and plan basic, applied, and operational research and development activities, both intramural and extramural, in this area. The document is divided into sections addressing these three disciplines. Author

N93-21498# National Academy of Sciences - National Research Council, Washington, DC.
MONITORING HUMAN TISSUES FOR TOXIC SUBSTANCES Final Report
1991 216 p
(PB92-223239; ISBN-0-309-04437-5; LC-91-61252) Avail: CASI HC A10/MF A03

The National Human Monitoring Program (NHMP) was established in 1967 within the U.S. Public Health Service to study changes in pesticide residues in the U.S. population. The primary activities of the NHMP are the National Human Adipose Tissue Survey (NHATS) and special studies that support other programs requiring data relevant to chemical exposures. The NHMP, including NHATS, was transferred to the Environmental Protection Agency (EPA) in 1970. The NHATS is now out of date and only partially fulfills its objectives. Design and management problems have been compounded by insufficient financial support for the changing and expanding objectives, and the overall quality of the NHATS has deteriorated. In 1987 EPA announced its intention to eliminate the NHMP. Congress responded by instructing EPA to retain the program, pending a review of its usefulness. EPA asked the National Research Council (NRC) to review and evaluate the effectiveness and potential applications of the NHMP. The report evaluates the current activities of the NHMP; identifies important scientific, technical, and programmatic issues; and makes recommendations regarding the design of the program and use of its products. GRA

N93-22163*# Johns Hopkins Univ., Laurel, MD. Applied Physics Lab.
AUTOMATED SYSTEM FOR ANALYZING THE ACTIVITY OF INDIVIDUAL NEURONS
ISAAC N. BANKMAN, KENNETH O. JOHNSON, ALEX M. MENKES, STEVE D. DIAMOND, and DAVID M. OSHAUGHNESSY *In* NASA, Washington, Technology 2002: The Third National Technology Transfer Conference and Exposition, Volume 2 p 138-145 Feb. 1993
(Contract N00039-91-C-0001; NS-072226)
Avail: CASI HC A02/MF A04

This paper presents a signal processing system that: (1) provides an efficient and reliable instrument for investigating the activity of neuronal assemblies in the brain; and (2) demonstrates the feasibility of generating the command signals of prostheses using the activity of relevant neurons in disabled subjects. The system operates online, in a fully automated manner and can recognize the transient waveforms of several neurons in extracellular neurophysiological recordings. Optimal algorithms for detection, classification, and resolution of overlapping waveforms are developed and evaluated. Full automation is made possible by an algorithm that can set appropriate decision thresholds and

an algorithm that can generate templates on-line. The system is implemented with a fast IBM PC compatible processor board that allows on-line operation. Author

N93-22164*# Brookhaven National Lab., Upton, NY. Medical Dept.
IMPROVED INHALATION TECHNOLOGY FOR SETTING SAFE EXPOSURE LEVELS FOR WORKPLACE CHEMICALS
BRUCE O. STUART *In* NASA, Washington, Technology 2002: The Third National Technology Transfer Conference and Exposition, Volume 2 p 146-149 Feb. 1993
Avail: CASI HC A01/MF A04

Threshold Limit Values recommended as allowable air concentrations of a chemical in the workplace are often based upon a no-observable-effect-level (NOEL) determined by experimental inhalation studies using rodents. A 'safe level' for human exposure must then be estimated by the use of generalized safety factors in attempts to extrapolate from experimental rodents to man. The recent development of chemical-specific physiologically-based toxicokinetics makes use of measured physiological, biochemical, and metabolic parameters to construct a validated model that is able to 'scale-up' rodent response data to predict the behavior of the chemical in man. This procedure is made possible by recent advances in personal computer software and the emergence of appropriate biological data, and provides an analytical tool for much more reliable risk evaluation and airborne chemical exposure level setting for humans. Author

N93-22188*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
OPTIMAL DESIGN OF COMPOSITE HIP IMPLANTS USING NASA TECHNOLOGY
T. A. BLAKE (Case Western Reserve Univ., Cleveland, OH.), D. A. SARAVANOS, D. T. DAVY (Case Western Reserve Univ., Cleveland, OH.), S. A. WATERS (Case Western Reserve Univ., Cleveland, OH.), and D. A. HOPKINS *In* NASA, Washington, Technology 2002: The Third National Technology Transfer Conference and Exposition, Volume 2 p 377-386 Feb. 1993
(Contract NAG3-1027)
Avail: CASI HC A02/MF A04

Using an adaptation of NASA software, we have investigated the use of numerical optimization techniques for the shape and material optimization of fiber composite hip implants. The original NASA inhouse codes, were originally developed for the optimization of aerospace structures. The adapted code, which was called OPORIM, couples numerical optimization algorithms with finite element analysis and composite laminate theory to perform design optimization using both shape and material design variables. The external and internal geometry of the implant and the surrounding bone is described with quintic spline curves. This geometric representation is then used to create an equivalent 2-D finite element model of the structure. Using laminate theory and the 3-D geometric information, equivalent stiffnesses are generated for each element of the 2-D finite element model, so that the 3-D stiffness of the structure can be approximated. The geometric information to construct the model of the femur was obtained from a CT scan. A variety of test cases were examined, incorporating several implant constructions and design variable sets. Typically the code was able to produce optimized shape and/or material parameters which substantially reduced stress concentrations in the bone adjacent of the implant. The results indicate that this technology can provide meaningful insight into the design of fiber composite hip implants. Author

N93-22189*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
FINITE ELEMENT ANALYSIS OF A COMPOSITE ARTIFICIAL ANKLE
LEIGH ANN PERKINS, LAWRENCE JOHNSTON, CHARLES DENNISTON, and BLAISE E. CZEKALSKI (Intergraph Corp., Madison, AL.) *In* NASA, Washington, Technology 2002: The Third National Technology Transfer Conference and Exposition, Volume 2 p 387-389 Feb. 1993
Avail: CASI HC A02/MF A04

Ultra-light carbon fiber composite materials are being utilized in artificial limbs with increasing frequency in recent years. Dr. Arthur Copes, an orthotist from Baton Rouge, Louisiana, has developed a graphite expoxy composite material artificial ankle (Copes/Bionic Ankle) that is intended to be used by amputees who require the most advanced above-and-below-the-knee prosthetic devices. The Copes/Bionic Ankle is designed to reproduce the function of the natural ankle joint by allowing the composite material to act as a spring mechanism without the use of metal mechanical parts. NASA Marshall Space Flight Center has agreed to participate in the design effort by providing the structural analysis of the artificial ankle design. Author

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BEHAVIORAL SCIENCES

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

A93-26569
COGIMIR - A STUDY OF COGNITIVE FUNCTIONS IN MICROGRAVITY
TH. BENKE (Innsbruck, Univ. Clinic, Austria), O. KOSERENKO (Inst. for Biomedical Problems, Moscow, Russia), and F. GERSTENBRAND (Innsbruck, Univ. Clinic, Austria) Space Technology - Industrial and Commercial Applications (ISSN 0892-9270) vol. 13, no. 2 March 1993 p. 181-183. Research supported by BMFWF refs
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Nonspecific (attention, psychomotor speed) and specific (mental flexibility, time estimation, visuospatial perception and memory) cognitive functions were measured in a single case study during a six day visit on the Russian orbital complex Mir using computer-based psychometric tasks. Reaction times and accuracy scores showed only minor, nonsignificant changes between preflight, flight and postflight measurements. These results suggest that several important cognitive functions, among them complex visuospatial processing skills remain essentially unimpaired during short space visits, provided that physical conditions are stable during the period of microgravity. Computerized psychometric tasks are a highly sensitive and flexible tool to measure behavioral functions in space life science. Author

A93-26950 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
HUMAN SPEED PERCEPTION IS CONTRAST DEPENDENT
LELAND S. STONE (NASA, Ames Research Center, Moffett Field, CA) and PETER THOMPSON (York Univ., United Kingdom) Vision Research (ISSN 0042-6989) vol. 32, no. 8 1992 p. 1535-1549. refs
(Contract RTOP 199-16-12-37; RTOP 506-71-51)
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When two parallel gratings moving at the same speed are presented simultaneously, the lower-contrast grating appears slower. This misperception is evident across a wide range of contrasts (2.5-50 percent) and does not appear to saturate (e.g. a 50 percent contrast grating appears slower than a 70 percent contrast grating moving at the same speed). On average, a 70 percent contrast grating must be slowed by 35 percent to match a 10 percent contrast grating moving at 2 deg/sec ($N = 6$). Furthermore, the effect is largely independent of the absolute contrast level and is a quasi-linear function of log contrast ratio. A preliminary parametric study shows that, although spatial frequency has little effect, relative orientation is important. Finally, the misperception of relative speed appears lessened when the stimuli to be matched are presented sequentially. Author

A93-27130
THE EFFECT OF ROLL-STABILIZED SENSOR INFORMATION ON PILOT PERFORMANCE
M. A. MONTAZER (New Haven Univ., West Haven, CT) and MICHAEL J. FERRANTI (Sikorsky Aircraft, Stratford, CT) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 Santa Monica, CA Human Factors Society 1991 p. 17-21. Research supported by Univ. of New Haven refs
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A study of the night vision sensor systems on helicopters was conducted at the flight simulation facilities at Sikorsky Aircraft. The study was concerned with determining possible pilot performance improvements with the sensor system being roll-stabilized with respect to the airframe as opposed to it being non-roll-stabilized. A six-pilot x two-sensor factorial experiment was designed and data were collected with respect to nine response variables. The results of the statistical analysis performed on the data were mixed in terms of the superiority of one sensor design over the other. The power collective input was significantly greater for the roll-stabilized design. However, the pilots also flew faster and made fewer errors, though the differences were not significant. One reason for such results might be that the pilots were less familiar with the roll-stabilized design, as it is a more recent technology. Author

A93-27135
ERRORS IN AVIATION MAINTENANCE - TAXONOMY AND CONTROL
COLIN G. DRURY (New York State Univ., Buffalo) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 Santa Monica, CA Human Factors Society 1991 p. 42-46. Research supported by FAA refs
Copyright
Maintenance errors account for a small, but highly visible, portion of aviation-related accidents and fatalities. To measure, and hence eventually control, errors in any field requires a taxonomy which enumerates and classifies the errors. This taxonomy can come from reported errors, but a pro-active system is needed to cover potential errors, as well as those which happen to have been committed and recorded so far. A standard starting point for human and system errors is the description and analysis of those tasks necessary to complete the maintenance-inspection requirements of aircraft in an approved manner. As each step of this Task Description is listed, the failure modes associated with that step can be logically deduced. Following an extensive Task Description and Analysis of aircraft maintenance, an error taxonomy was developed from the failure modes of each task. From current theoretical approaches to human error come ways of extending this classification, and of relating potential errors to levels of human functioning within the system. Author

A93-27137
INDIVIDUAL PILOT DIFFERENCES RELATED TO SITUATION AWARENESS
CHERYL A. BOLSTAD (Northrop Corp., Aircraft Div., Hawthorne, CA) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 Santa Monica, CA Human Factors Society 1991 p. 52-56. refs
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A pilot's ability to maintain a high level of situation awareness (SA) has been widely recognized as an important component of misssion success and survivability in the air combat arena. The need for SA enhancement has led to the creation of a test battery designed to measure pilot attributes that are thought to correlate to SA. By correlating SA performance measures with results from the selected attribute tests, it will be possible to develop highly focused instructional methods that will improve performance in the attributes, thus enhancing SA. Author

A93-27138
INSIGHTS INTO PILOT SITUATION AWARENESS USING VERBAL PROTOCOL ANALYSIS
CHRISTOPHER SULLIVAN and HAROLD S. BLACKMAN (Idaho National Engineering Lab., Idaho Falls) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 Santa Monica, CA Human Factors Society 1991 p. 57-61. Research supported by USAF refs
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The relationship between long-term memory structures and working memory in maintaining pilot situation awareness was investigated using verbal protocol analysis. Two groups of pilots were studied: experts and novices. Each group of pilots flew 3 scenarios on an F-16 Air Intercept Trainer. Each scenario simulated air-to-air interception of one, two, or four enemy aircraft by one F-16 fighter pilot. Verbal reports were segmented and encoded according to a functional model of training F-16 pilots receive. In addition subjective workload ratings were measured in each experimental condition. Preliminary analyses of the data only provide a modicum of support for this hypothesis. Further analysis is being done. Author

A93-27139
WORKLOAD OR SITUATIONAL AWARENESS? TLX VS. SART FOR AEROSPACE SYSTEMS DESIGN EVALUATION
S. J. SELCON, R. M. TAYLOR (RAF, Inst. of Aviation Medicine, Farnborough, United Kingdom), and E. KORITSAS (Cranfield Inst. of Technology, United Kingdom) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 Santa Monica, CA Human Factors Society 1991 p. 62-66. refs
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The sensitivity and diagnosticity of two subjective techniques used for the measurement of workload and situational awareness (SA) were compared: the NASA TLX workload scale and the Situation Awareness Rating Technique (SART). In the experiment, 12 RAF pilots were divided into groups according to their flying experience and were asked to rate a videotape of air combat flight simulation sequences, with task difficulty varying between the flight sequences, using the TLX and or SART techniques. The analysis of results showed that, although both the TLX and SART scales were sensitive to the task difficulty, only SART showed any differences between experience conditions, indicating that SART may have an added utility where operator capability or domain expertise is a design variable. I.S.

A93-27140
THE EFFECT OF TYPE OF TASK, DEGREE OF INTEGRATION, AND MODALITY ON THE PERFORMANCE OF CONCURRENT TASKS
RICHARD J. THOME (Montclair State College, Upper Montclair, NJ) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 Santa Monica, CA Human Factors Society 1991 p. 67-71. refs
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Sixteen subjects performed a continuous, visual-manual, tracking task while simultaneously performing a visual-manual or auditory speech discrete task. The discrete tasks were either integrated with or not integrated with the continuous task and involved either verbal or spatial central processing. Tracking accuracy, discrete task response latency, and discrete task accuracy were measured. The major findings were that when a discrete task involving verbal central processing was performed concurrently with a visual-manual tracking task, better performance was obtained on both the discrete task and the tracking task when the discrete task was performed with auditory input and speech response, rather than with visual input and manual response. However when the discrete task involved spatial processing codes, use of the auditory-speech modalities resulted in no advantage on the discrete task and the advantage of the tracking task was diminished. It was also found that tracking performance was better when the tracking and discrete tasks were integrated. This was true of discrete task performance only with

spatial codes and the auditory-speech modalities. Findings suggest that discrete task accuracy, rather than tracking accuracy, may be the area in which the effects of mental workload are of greatest practical significance. Author

A93-27142
BEHAVIORAL VALIDATION OF A HAZARDOUS THOUGHT PATTERN INSTRUMENT
ROBERT W. HOLT, DEBORAH A. BOEHM-DAVIS, KAREN A. FITZGERALD, MARGARET M. MATYUF, WAYNE A. BAUGHMAN, and DAVID C. LITTMAN (George Mason Univ., Fairfax, VA) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 Santa Monica, CA Human Factors Society 1991 p. 77-81. refs
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One approach to examining errors or potential errors in aviation has focused on measuring the hazardous thought patterns of pilots. Previous research identified five thought patterns and assumed that all pilots fall into one of these categories. The current research was designed to develop and behaviorally validate a new instrument to measure hazardous thought patterns. The research confirmed previous work in finding five hazardous thought patterns. However, the research also suggested the presence of a sixth factor related to confidence/competence. The validation suggested that the individual hazardous thought patterns differentially predicted accidents and incidents. The behavioral validation also identified relationships between particular hazardous thought patterns and specific driving behaviors that supported the validity and utility of the newly designed instrument. Author

A93-27143* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
HEADPHONE LOCALIZATION OF SPEECH STIMULI
DURAND R. BEGAULT and ELIZABETH M. WENZEL (NASA, Ames Research Center, Moffett Field, CA) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 Santa Monica, CA Human Factors Society 1991 p. 82-86. Research supported by FAA and National Research Council refs
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Recently, three dimensional acoustic display systems have been developed that synthesize virtual sound sources over headphones based on filtering by Head-Related Transfer Functions (HRTFs), the direction-dependent spectral changes caused primarily by the outer ears. Here, 11 inexperienced subjects judged the apparent spatial location of headphone-presented speech stimuli filtered with non-individualized HRTFs. About half of the subjects 'pulled' their judgements toward either the median or the lateral-vertical planes, and estimates were almost always elevated. Individual differences were pronounced for the distance judgements; 15 to 46 percent of stimuli were heard inside the head with the shortest estimates near the median plane. The results infer that most listeners can obtain useful azimuth information from speech stimuli filtered by nonindividualized RTFs. Measurements of localization error and reversal rates are comparable with a previous study that used broadband noise stimuli. Author

A93-27144* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
ELECTRONIC MAP INTERPRETATION IN A DUAL-TASK CONTEXT
HENRY P. WILLIAMS and CHRISTOPHER D. WICKENS (Illinois Univ., Urbana) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 Santa Monica, CA Human Factors Society 1991 p. 92-96. refs
(Contract NAG2-308)
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The present experiment was designed to assess the extent to which spatial and verbal-analytic (VA) information processing resources are used in performing a simulated aircraft navigation task. Subjects were required to decide whether a 'match' or a mismatch' existed between a schematic 3D perspective forward field of view and a 2D top-down map. On dual-task trials, this navigation task was concurrently performed with either a VA side-task or with one of two tracking tasks. The data suggest that a VA strategy was most likely to be used when stimuli were simple or were mismatches, whereas a spatial mental rotation strategy was apparently used to confirm complex match stimuli. These results indicate that it may be possible to specify conditions wherein navigation is likely to compete for resources critical to other cockpit activities, such as aircraft control and communication. Author

A93-27147
RESPONSE TO AUTOMATED FUNCTION FAILURE CUE - AN OPERATIONAL MEASURE OF COMPLACENCY
ROBERT K. KNAPP and JENNIFER J. VARDAMAN (Wichita State Univ., KS) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 Santa Monica, CA Human Factors Society 1991 p. 112-115. refs
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This report describes an experiment whose purpose was to operationally define complacency. Non-pilots performed an airspeed and altitude maintenance task on a desktop approach procedures trainer, while responding to three unpredictable reaction time cues each minute during a 20 minute trial. A separate reaction time cue was yoked to come on with this cue and extinguish automatically with it; but subject were instructed that they had to respond to this second cue if it failed to extinguish by itself. This otherwise irrelevant cue simulated an automated function whose persistence signaled a system failure and called for detection and response on the part of the subject. The delay in response to this complacency probe, compared with the latencies of the ongoing reaction time task, comprised the measure of complacency. Complacency reaction time was significantly longer and, while a second complacency probe led to improved response times, evidence for complacency persisted. Non-pilot subjects tended to keep the trainer within 100 feet of the assigned altitude, and within 10 knots of the assigned airspeed. There was no evidence of degradation of performance of either the flying tasks or the reaction times as a function of time-sharing. Author

A93-27158
AN ANALYTICAL STUDY OF THE EFFECTS OF AGE AND EXPERIENCE ON FLIGHT SAFETY
PATRICK C. GUIDE and RICHARD S. GIBSON (Embry-Riddle Aeronautical Univ., Daytona Beach, FL) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 Santa Monica, CA Human Factors Society 1991 p. 180-184. refs
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The purpose of this study was to determine whether there are any significant decreases in the safety and effectiveness of pilots by age 60. The data for this study comes from records of general aviation accidents (i.e., for private pilots, commercial pilots, and air transport pilots). This accident data has been acquired from many specialized aviation data banks, these include: NTSB, AOPA, FAA, and the COMSIS Research Corporation. The data were organized into groups according to age of the pilot-in-command (PIC) responsible for the accident. The grouping progresses in five-year increments starting at 20-24, and ending with 55-59. The data were analyzed in terms of different accident statistics (i.e., based upon the number of pilots and the number of hours flown). The results indicate that age and experience both affect safety. The magnitude of these effects and their implications for aviation safety are discussed. Author

A93-27169
CREW PERFORMANCE IN SPACELAB
HARVEY WICHMAN and STEWART I. DONALDSON (Claremont McKenna College, CA) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 Santa Monica, CA Human Factors Society 1991 p. 571-574. refs
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The paper describes two studies of crew performance aboard

two flights of Spacelab, in which the work and the behavior of crewmembers in micro-g environment was recorded on videotapes. In the first study, four performances were quantified: (1) movement between work stations (translation), (2) holding on with one hand to stabilize while working (hand-hold), (3) use of provided foot restraints while working (foot restraint), and (4) out-of-control body movements (struggle). The second study evaluated the use of built-in foot restraints. The average responses of the four performances were as follows (in percent): translating, 9.4; hand-hold, 32.2; foot restraint, 35.3; and struggle, 3.7. The foot-restraint study indicated that hand stabilization occurred more often when using a single cloth foot loop than when using two. I.S.

A93-27171
MOVEMENT TRACKING PERFORMANCE AS A FUNCTION OF REQUIRED FORCE LEVEL

JACK P. BERKOWITZ (CTA, Inc., McKee City, NJ) and JEFFREY C. WOLDSTAD (Virginia Polytechnic Inst. and State Univ., Blacksburg) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 Santa Monica, CA Human Factors Society 1991 p. 772-775. refs
Copyright

An isometric, zero-order (position), one dimensional pursuit tracking task was used to investigate the effects of alterations in the speed of target movement and the control/response ratio (C/R ratio) on human tracking performance. The speed of target movement was varied through different frequency sine-wave forcing functions. The C/R ratio was controlled by varying the force level required to track the target. It was hypothesized that higher frequencies of forcing function (5 levels) and higher required force levels (5 levels) would result in degraded tracking performance. The dependent variable investigated was absolute tracking error as a proportion of the required force level for the trial. Results revealed significant main effects for both frequency and force, but not for any of the two- or three-way interactions. The trend was linear for frequency, with superior tracking occurring at slower frequencies. The effect of force level was modelled using a second-order polynomial, indicating that superior tracking occurred at the middle required force levels. Results are interpreted with regard to selecting optimum system gains for human manual control. Author

A93-27173
EFFECTS OF FATIGUE AND HEAT STRESS ON VIGILANCE OF WORKERS IN PROTECTIVE CLOTHING

PAUL S. RAY, PHILLIP A. BISHOP, and GENA SMITH (Alabama Univ., Tuscaloosa) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 Santa Monica, CA Human Factors Society 1991 p. 885-889. Research supported by USAF refs
Copyright

The purpose of the present study was to examine the influence of acute and extended bouts of work and heat storage on performance of a six minute vigilance task. After establishing a vigilance performance baseline, 15 subjects were studied under the following conditions: a continuous progressive treadmill run to exhaustion, a bout of hard work consisting of bench stepping in chemical protective clothing (CPC) followed by 40 minute rest in the CPC, and prolonged lower-intensity treadmill walking interspersed with 40 minute rest periods. The vigilance task presented a series of consecutive numbers for six minutes. For the first two minutes, numbers changed at one per second, and the two subsequent two minute periods, numbers were presented at two, and three per second, respectively. Every two minute period, 14 digits were skipped. Subjects were required to recognize, within one second, each time a number was skipped for each two minute period. Group mean scores were not changed significantly after any treatment. However, subsequent division of subjects into two groups based upon vigilance response following bench stepping revealed that the groups were different on several treatments. Workers may be able to perform short vigilance tasks without diminished performance despite fatigue and heat storage. Author

A93-27174
PERFORMANCE DIFFERENCES IN PSYCHOMOTOR AND DICHOTIC LISTENING TESTS AMONG LANDING CRAFT AIR CUSHION VEHICLE OPERATOR TRAINEES

T. NONTASAK, D. L. DOLGIN, and D. J. BLOWER (U.S. Navy, Naval Aerospace Medical Research Lab., Pensacola, FL) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 2 Santa Monica, CA Human Factors Society 1991 p. 987-990. Research sponsored by U.S. Navy refs
Copyright

Changes in the selection procedures for the U.S. Navy's landing craft air cushion (LCAC) vehicle operator training program are under development. Several cognitive, personality, and psychomotor selection tests are being evaluated. This study analyzed the performance of 36 LCAC operator trainees on an automated series of single and multiple psychomotor (PMT) and dichotic listening (DLT) tests that measure abilities involving eye-hand-foot coordination and divided attention. Point-biserial correlational analyses between test measures and training criteria resulted in a number of statistically significant correlations. In multiple task conditions, where PMT and DLT were administered simultaneously, only performance on PMT subtasks indicated significant differences between the two groups. These findings suggest that psychomotor tests have the potential to predict LCAC training program outcome. Author

A93-27175* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
INDIVIDUAL DIFFERENCES IN AIRLINE CAPTAINS' PERSONALITIES, COMMUNICATION STRATEGIES, AND CREW PERFORMANCE

JUDITH ORASANU (NASA, Ames Research Center, Moffett Field, CA) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 2 Santa Monica, CA Human Factors Society 1991 p. 991-995. refs
Copyright

Aircrew effectiveness in coping with emergencies has been linked to captain's personality profile. The present study analyzed cockpit communication during simulated flight to examine the relation between captains' discourse strategies, personality profiles, and crew performance. Positive Instrumental/Expressive captains and Instrumental-Negative captains used very similar communication strategies and their crews made few errors. Their talk was distinguished by high levels of planning and strategizing, gathering information, predicting/alerting, and explaining, especially during the emergency flight phase. Negative-Expressive captains talked less overall, and engaged in little problem solving talk, even during emergencies. Their crews made many errors. Findings support the theory that high crew performance results when captains use language to build shared mental models for problem situations. Author

A93-27176
INDIVIDUAL DIFFERENCES IN COMPUTERIZED TEST PERFORMANCE FOR SYSTEMS INTEGRATION IN COCKPIT MANAGEMENT

RANDALL M. CHAMBERS and MIHRIBAN WHITMORE (Wichita State Univ., KS) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 2 Santa Monica, CA Human Factors Society 1991 p. 996-1000. refs
Copyright

Significant test effects have been demonstrated and characterized by individual performance during the execution of cockpit management tasks. Important clusterings are noted in cognitive tests in which varying clusters differed significantly from other clusters and patterns. Inferences may be drawn regarding the types of cognitive performance that may be efficiently integrated with automated cockpit instrumentation. O.C.

A93-27177
COMPARING THE CATTELL 16PF PROFILES OF MALE AND FEMALE COMMERCIAL AIRLINE PILOTS
MARLA L. GALLOWAY, CHARLES D. OGLE, and FREDERICK V. MALMSTROM (Embry-Riddle Aeronautical Univ., Daytona Beach, FL) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, *Proceedings. Vol. 2* Santa Monica, CA Human Factors Society 1991 p. 1001-1004. refs
Copyright
Returned Cattell 16PF Personality Factor Questionnaires for 92 female and 57 male commercial pilots show the women to exhibit great personality similarities to the male pilot profile. Of the 16 personality factors tested, seven were showed no significant difference, and six showed minor-to-marginal differences. The three factors exhibiting major divergences between men and women were dominance, sensitivity, and anxiety. O.C.

A93-27178
AN INDIVIDUAL DIFFERENCES APPROACH TO FITNESS-FOR-DUTY ASSESSMENT
ROBERT S. KENNEDY (Essex Corp., Orlando, FL), WILLIAM P. DUNLAP (Louisiana, Tulane Univ., New Orleans), and JANET J. TURNAGE (Central Florida Univ., Orlando, FL) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 2 Santa Monica, CA Human Factors Society 1991 p. 1020-1023. refs
Copyright
An account is given of the performance changes measured by the standardized Automated Performance Test System (APTS) set of performance tests with changes in graduated dosages of alcohol. Twenty subjects were thus 'dose-equivalency' tested. A dose-response relationship was confirmed for all performance tests, and multiple regression was used to select subtests that maximally predicted alcohol level. Four subtests were combined into a linear composite, and the performance decrements on APTS were indexed to performance decrements on the Armed Services Vocational Aptitude Battery. O.C.

A93-27179
CREWCUT - A NEW TOOL FOR PREDICTING HUMAN PERFORMANCE IN CONCEPTUAL SYSTEMS
TOM PLOCHER (Honeywell Systems and Research Center, Minneapolis, MN), JOHN F. LOCKETT, III (U.S. Army, Human Engineering Lab., Aberdeen Proving Ground, MD), PETER KOVACH (Alliant Techsystems, Hopkins, MN), and JEFFREY POWERS (FMC Corporate Technology Center, Santa Clara, CA) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 2 Santa Monica, CA Human Factors Society 1991 p. 1206-1209. refs
Copyright
The development of the 'CREWCUT' analysis tool allows prediction of the effects of automation on operator workload and system performance by integrating workload estimation algorithms into a dynamic human performance simulation framework. The performance consequences of excessive overload are in this way both observable and quantifiable. The workload algorithms used are based on a multiple-resource theoretical model encompassing (1) single-task demands, (2) cognitive interference, and (3) structural interference. O.C.

A93-27180
CREWCUT - A TOOL FOR MODELING THE EFFECTS OF HIGH WORKLOAD ON HUMAN PERFORMANCE
BETH HAHLER, SUSAN DAHL, RON LAUGHERY (Micro Analysis and Design, Boulder, CO), JOHN LOCKETT, and BRENDA THEIN (U.S. Army, Human Engineering Lab., Aberdeen Proving Ground, MD) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 2 Santa Monica, CA Human Factors Society 1991 p. 1210-1214. refs
Copyright
The CREWCUT analysis system addresses the problems associated with high crew workloads by means of a workload performance/prediction tool whose modeling constructs represent the relationship between excessive workload and performance degradation. The tool considers the dynamic effect of high workload on task reallocation, task error rates and performance times, and task dumping. CREWCUT may be applied to aircraft piloting, vehicle control, ATC, and similar human performance-critical tasks. O.C.

A93-27183
TESTING A SUBJECTIVE METRIC OF SITUATION AWARENESS
MICHAEL A. VIDULICH (USAF, Armstrong Lab., Wright-Patterson AFB, OH) and EDWARD B. HUGHES (USAF, Crew Station Evaluation Facility, Wright-Patterson AFB, OH) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 2 Santa Monica, CA Human Factors Society 1991 p. 1307-1311. refs
Copyright
The Situation Awareness-Subjective Workload Dominance ('SA-SWORD') technique for subjective situation awareness has undergone testing in a simulator evaluation of cockpit displays, using USAF pilots as subjects. The evaluation was of the Fire Control Radar and the Horizontal Situation Format (HSF) displays. Pilots rated their SA higher when using the HSF display. The role of SA-SWORD in the justification of these subjective assessments is discussed. O.C.

A93-27185* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
SPATIAL ORIENTATION AND DYNAMICS IN VIRTUAL REALITY SYSTEMS - LESSONS FROM FLIGHT SIMULATION
MICHAEL E. MCCAULEY and THOMAS J. SHARKEY (Monterey Technologies, Inc., Carmel, CA) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 2 Santa Monica, CA Human Factors Society 1991 p. 1348-1352. Research sponsored by U.S. Army refs (Contract NAS2-12927)
Copyright
Artificial representations of virtual worlds are becoming more common due to advances in the technology of image generation and display systems. Application areas include flight simulation, mission rehearsal, teleoperator systems, and virtual reality systems. System developers should be forewarned that some proportion of users will experience perceptual anomalies and symptoms of motion sickness as a result of travel through virtual space. Author

A93-27187
CONTEXTUAL CHANGE AND SKILL ACQUISITION IN VISUAL SEARCH - DOES THE RATE OF CHANGE AFFECT PERFORMANCE?
MARK D. LEE (Georgia Inst. of Technology, Atlanta), WENDY A. ROGERS (Memphis State Univ., TN), and ARTHUR D. FISK (Georgia Inst. of Technology, Atlanta) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 2 Santa Monica, CA Human Factors Society 1991 p. 1377-1381. refs
Copyright
The present investigation examined the effects of training context on the development of a skill in a semantic category visual search task. Thirty-two subjects were trained in a visual search task which allowed the separate examination of feature learning and attention strengthening. Subjects were trained in a consistently mapped (CM) condition which allowed both feature learning and attention strengthening, 'attenuated strength' search conditions which allowed only feature learning, and a variably mapped (VM) condition which allowed neither feature learning or attention strengthening. The present experiment also examined the temporal characteristics of feature learning by manipulating the training context which was defined as the number of trials in a row that a particular search condition appeared. There were four different training contexts used (1, 5, 10, and 50) and eight subjects were assigned to each. Each subject performed 11,000 training trials. Analysis of the reaction time (RT) data indicated

that within each training context, RT was fastest for the CM condition, intermediate for the Attenuated Strength conditions, and slowest for the VM condition. Author

A93-27188* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
NETWORKED SIMULATION FOR TEAM TRAINING OF SPACE STATION ASTRONAUTS, GROUND CONTROLLERS, AND SCIENTISTS - A TRAINING AND DEVELOPMENT ENVIRONMENT
ANKUR R. HAJARE, DANIEL T. WICK, and JAMES J. BOVENZI (Mitre Corp., Houston, TX) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 2 Santa Monica, CA Human Factors Society 1991 p. 1395-1399. refs
(Contract NAS9-18057)
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The purpose of this paper is to describe plans for the Space Station Training Facility (SSTF) which has been designed to meet the envisioned training needs for Space Station Freedom. To meet these needs, the SSTF will integrate networked simulators with real-world systems in five training modes: Stand-Alone, Combined, Joint-Combined, Integrated, and Joint-Integrated. This paper describes the five training modes within the context of three training scenaries. In addition, this paper describes an authoring system which will support the rapid integration of new real-world system changes in the Space Station Freedom Program. Author

A93-27194* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
S-R COMPATIBILITY EFFECTS WITH ORTHOGONAL STIMULUS AND RESPONSE DIMENSIONS
ANTHONY D. ANDRE, IAN HASKELL, and CHRISTOPHER D. WICKENS (Illinois Univ., Urbana and Savoy) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 2 Santa Monica, CA Human Factors Society 1991 p. 1546-1550. refs
(Contract NCC2-632)
Copyright

An experiment was conducted to assess the relative influence of several factors on performance with orthogonal stimulus-response arrays. Subjects responded to the onset of one of three aligned light circles with a press of one of three aligned response keys. The response array was aligned parallel, angled, or orthogonal to the stimulus array. The results indicated that performance with orthogonal arrays is worse than with parallel or angled S-R arrays. For the orthogonal arrangements, the results also indicate that each hand prefers a mapping directly opposite to the other hand, and that this mapping reverses when the orientation of the stimulus and response arrays are transposed. In addition, the results also revealed that the relative costs of orthogonal S-R arrangements are somewhat attenuated when the assigned mapping associates (i.e., colocates) a given display with its closest control. Author

A93-27195* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
OVERCONFIDENCE, PREVIEW, AND PROBABILITY IN STRATEGIC PLANNING
CHRISTOPHER D. WICKENS, DAVID PIZARRO, and BRIAN BELL (Illinois Univ., Savoy) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 2 Santa Monica, CA Human Factors Society 1991 p. 1556-1560. refs
(Contract NAG2-308)
Copyright

The performance of eight subjects in a 'rescue' video game requiring choices as to which node they should fly to in order to rescue the simulated casualties is presently studied with a view to biases and display support criteria in strategic planning. After each choice, the subjects needed to fly a challenging tracking dynamic along a path to reach the next node. The results obtained indicate that the choices of the subjects were less optimal when full preview was offered, perhaps due to subjects' reliance on the simple strategy of choosing routes with the greatest number of casualties. O.C.

A93-27196
ACTIVE CONTROL VERSUS PASSIVE OBSERVATION IN A SIMULATED FLIGHT TASK
JOHN F. LARISH (Illinois Univ., Urbana) and GEORGE J. ANDERSEN (California Univ., Riverside) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 2 Santa Monica, CA Human Factors Society 1991 p. 1570-1573. Research supported by USAF refs
(Contract NSF BNS-90-21081)
Copyright

A study was conducted examining the effects of active control versus passive observation on the detection of changes in orientation in a simulated flight task. The subjects' task was either to fly through a simulated world by visual reference or to observe trials previously flown by another subject. During each trial the screen would go blank simulating flight into clouds. Following the blackout, subjects were required to correct any unexpected changes in orientation made during the blackout. These changes were equally divided between changes in pitch, roll, and translation along the line of sight. Furthermore, these changes were made in a direction that was either consistent or inconsistent with the direction of motion prior to the blackout onset. Although active controllers were more accurate than passive observers, these effects are mediated by the duration of blackouts, the type of change, and the consistency of changes. In particular, active observers were best at detecting changes that were relevant to the flight control task. Author

A93-27452
PREDICTIVE VALIDITY OF AN AUTOMATED PERSONALITY INVENTORY FOR AIR FORCE PILOT SELECTION
FREDERICK M. SIEM (USAF, Armstrong Lab., Brooks AFB, TX) International Journal of Aviation Psychology (ISSN 1050-8414) vol. 2, no. 4 1992 p. 261-270. refs
Copyright

A study was conducted to assess whether personality measures could contribute predictive utility to current Air Force pilot selection procedures. A personality inventory was given to a sample of 509 pilot candidates before flying training. The inventory was designed to measure five dimensions thought to be associated with flying performance. Of the five characteristics, three measures were related directly to training outcome: hostility, self-confidence, and values flexibility. However, incremental validity analyses did not provide evidence that the inventory could enhance a selection model combining currently used operational test scores with additional measures from the Basic Attributes Tests. Author

A93-27453
THE EFFECT OF LOW BLOOD ALCOHOL LEVELS ON PILOT PERFORMANCE IN A SERIES OF SIMULATED APPROACH AND LANDING TRIALS
MARK DAVENPORT and DON HARRIS (Cranfield Inst. of Technology, United Kingdom) International Journal of Aviation Psychology (ISSN 1050-8414) vol. 2, no. 4 1992 p. 271-280. refs
Copyright

Eight experienced pilots flew a series of approaches and landings in a simulator with the characteristics of a general aviation light twin. One half of the subjects were under the influence of low blood alcohol levels (mean = 11 mg pct). Subjects in the alcohol condition showed significant deteriorations in their performance, as measured by deviations from the optimum approach speed or the optimum glideslope, when performing an instrument approach or when performing an asymmetric approach. The results are discussed with respect to the Federal Aviation Administration regulations concerning drinking and flying. Author

A93-27454
VISUAL AUGMENTATION AND SCENE DETAIL EFFECTS IN FLIGHT TRAINING
GAVAN LINTERN and JEFFERSON M. KOONCE (Illinois Univ., Urbana) International Journal of Aviation Psychology (ISSN 1050-8414) vol. 2, no. 4 1992 p. 281-301. refs
(Contract MDA903-86-C-0169)
Copyright
Flight students were taught landings in a flight simulator with a visual landing display to examine the effects of scene detail, visual augmentation (prediction and guidance), and speed of roll response on the acquisition and transfer of landing skills. Transfer was from moderate-detail and low-detail scenes; from constant, adaptive, and no visual augmentation; and from fast, normal, and slow roll response. Transfer was assessed in the simulator with a moderate-detail pictorial scene, no visual augmentation, and a normal roll response. Training with visual augmentation was superior to training without it, although a Scene Detail x Visual Augmentation interaction revealed that the nonpredictive guidance augmentation enhanced transfer only when it was combined in training with the low-detail scene. Transfer from a low-detail, unaugmented display was poor, and there was some evidence of poor transfer from a fast roll response. Author

A93-27456
THE DEVELOPMENT AND USE OF A GENERIC NONNORMAL CHECKLIST WITH APPLICATIONS IN AB INITIO AND INTRODUCTORY ADVANCED QUALIFICATION PROGRAMS
NEIL JOHNSTON (Trinity College, Dublin, Ireland) International Journal of Aviation Psychology (ISSN 1050-8414) vol. 2, no. 4 1992 p. 323-337. refs
Copyright
This article describes the background to the development and use of a generic nonnormal checklist having potential applications in ab initio pilot training, airline entry, or 'bridge' training and in introductory Advanced Qualification Program pilot training. The associated training course is discussed first. The relevant checklist design criteria are then outlined. The general structure and content of nonnormal checklists are reviewed before the actual generic nonnormal checklist and its uses are examined. This article concludes by assessing the impact of the generic checklist on the acquisition of basic cockpit management skills and on subsequent aircraft type-specific simulator training. Author

A93-27817
DOING TWO THINGS AT THE SAME TIME
HAROLD PASHLER (California Univ., La Jolla) American Scientist (ISSN 0003-0996) vol. 81, no. 1 Jan.-Feb. 1993 p. 48-55. refs
Copyright
Experimental psychologists have undertaken the study of dual-task performance as a basis for the determination of general principles of brain function involving the interference of the activities of one part of the brain with those of other parts. It has been established that 'bottlenecks' can arise at any of three stages in the performance of a cognitive task. Alternative bottleneck hypotheses are discussed with a view to their consistency with common-sense views of cognitive performance. O.C.

A93-28158
EFFECTS OF LASER GLARE ON VISUAL SEARCH PERFORMANCE
JOHN A. D'ANDREA, JAMES C. KNEPTON, and MICHAEL D. REDDIX (U.S. Navy, Naval Aerospace Medical Research Lab., Pensacola, FL) *In* Sensors and sensor systems for guidance and navigation II; Proceedings of the Meeting, Orlando, FL, Apr. 22, 23, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 60-71. Research sponsored by U.S. Navy refs
Copyright
The effects of extraocular glare and its sources on the effectiveness of target detection during visual search of a complex array presented outside the cockpit were evaluated using a cockpit simulator where an A-4 aircraft windscreen assembly was fitted to the cockpit-familiarization trainer. The results obtained in the course of a series of studies showed that the windscreen characteristics and the ambient illumination can interact with laser-induced glare to disrupt visual search performance. In older individuals, the eye-lens opacity may also interact with laser glare and degrade visual search performance. It noted that laser light intensities well below the eye injury threshold may effectively disrupt visually guided performance. I.S.

A93-28692* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
INFLUENCE OF ANIMATION ON DYNAMICAL JUDGMENTS
M. K. KAISER, D. R. PROFFITT, S. M. WHELAN, and H. HECHT (NASA, Ames Research Center, Moffett Field, CA) Journal of Experimental Psychology: Human Perception and Performance (ISSN 0096-1523) vol. 18, no. 3 Aug. 1992 p. 669-689.
Copyright
The motions of objects in the environment reflect underlying dynamical constraints and regularities. The conditions under which people are sensitive to natural dynamics are considered. In particular, the article considers what determines whether observers can distinguish canonical and anomalous dynamics when viewing ongoing events. The extent to which such perceptual appreciations are integrated with and influence common-sense reasoning about mechanical events is examined. It is concluded that animation evokes accurate dynamical intuitions when there is only 1 dimension of information that is of dynamical relevance. This advantage is lost when the observed motion reflects higher dimension dynamics or when the kinematic information is removed or degraded. A.U.T.

A93-28707
THE INFLUENCE OF FLIGHT EXPERIENCE ON MIDAIR COLLISION RISK PERCEPTION
H. P. SHUCH (Pennsylvania College of Technology, Williamsport) Accident Analysis & Prevention (ISSN 0001-4575) vol. 24, no. 6 Dec. 1992 p. 655-660.
Copyright
Although successful collision avoidance is presumed a learned skill, midair collision accidents typically involve highly experienced pilots. It is hypothesized that pilot complacency, arising from a history of incident-free flights, plays a role in the midair collision process. Pilot risk perception is explored using Laplace's Law of Succession, and the resulting perceived collision probability compared to reality. The two converge at around 5,000 hours of flight experience. A.U.T.

A93-28724
AGING, EXPERTISE, AND NARRATIVE PROCESSING
D. G. MORROW, V. O. LEIRER, and P. A. ALTIERI (Decision Systems, Los Altos, CA) Psychology and Aging (ISSN 0882-7974) vol. 7, no. 3 Sept. 1992 p. 376-388. Research supported by PHS
Copyright
In a study of how aviation expertise influences age differences in narrative processing, young and older pilots and nonpilots read and recalled aviation and general narratives. They chose referents for sentences referring to a protagonist or minor character mentioned 1 sentence (recent character) or 3 sentences (distant character) before this target sentence. All groups chose referents less accurately for sentences about distant and minor characters than about recent and protagonist characters, perhaps because these referents were less likely to be in working memory. Young readers and pilots were more accurate for distant and minor character target sentences in aviation narratives, and recalled aviation narratives more accurately. Expertise did not reduce age differences. Expertise differences may reflect decreased demands on working memory capacity, and age declines may reflect reduced capacity. A.U.T.

A93-28731
PREDICTING INDIVIDUAL DIFFERENCES IN COMPLEX SKILL ACQUISITION - DYNAMICS OF ABILITY DETERMINANTS
P. L. ACKERMAN (Minnesota Univ., Minneapolis) Journal of Applied Psychology (ISSN 0021-9010) vol. 77, no. 5 Oct. 1992 p. 598-614.
Copyright

Substantial controversy exists about ability determinants of individual differences in performance during and subsequent to skill acquisition. This investigation addresses the controversy. An information-processing examination of ability-performance relations during complex task acquisition is described. Included are ability testing (including general, reasoning, spatial, perceptual speed, and perceptual/psychomotor abilities) and skill acquisition over practice on the terminal radar approach controller simulation. Results validate and extend Ackerman's (1988) theory of cognitive ability determinants of individual differences in skill acquisition. Benefits of ability component and task component analyses over global analyses of ability-skill relations are demonstrated. Implications are discussed for selection instruments to predict air traffic controller success and for other tasks with inconsistent information-processing demands. A.U.T.

N93-20908*# Georgia Inst. of Tech., Atlanta. School of Industrial and Systems Engineering.
ACQUISITION AND PRODUCTION OF SKILLED BEHAVIOR IN DYNAMIC DECISION-MAKING TASKS Semiannual Status Report M.S. Thesis - Georgia Inst. of Tech., Nov. 1992
ALEX KIRLIK and MERRICK FRANK KOSSACK 5 Mar. 1993 193 p
(Contract NAG2-656)
(NASA-CR-192361; NAS 1.26:192361) Avail: CASI HC A09/MF A03

Previous use of various task analysis processes for the purpose of display interface design or enhancement has run the risk of failing to improve user performance due to the analysis resulting in only a sequential listing of user tasks. Adopting an ecological approach to performing the task analysis, however, may result in the necessary modeling of an unpredictable and variable task domain required to improve user performance. Kirlik has proposed an Ecological Task Analysis framework which is designed for this purpose. It is the purpose of this research to measure this framework's effectiveness at enhancing display interfaces in order to improve user performance. Following the proposed framework, an ecological task analysis of experienced users of a complex and dynamic laboratory task, Star Cruiser, was performed. Based on this analysis, display enhancements were proposed and implemented. An experiment was then conducted to compare this new version of Star Cruiser to the original. By measuring user performance at different tasks, it was determined that during early sessions, use of the enhanced display contributed to better user performance compared to that achieved using the original display. Furthermore, the results indicate that the enhancements proposed as a result of the ecological task analysis affected user performance differently depending on whether they are enhancements which aid in the selection of a possible action or in the performance of an action. Generalizations of these findings to larger, more complex systems were avoided since the analysis was only performed on this one particular system. Author

N93-21402# Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (Germany). Hubschrauber und Flugzeuge.
INSTRUCTIONS AND ADVANCE TRAINING MEASURES FOR THE IMPROVEMENT OF HUMAN RELIABILITY [AUS- UND WEITERBILDUNGSMASSNAHMEN ZUR VERBESSERUNG MENSCHLICHER ZUVERLAESSIGKEIT]
SIEGFRIED STREUBEL 22 May 1992 38 p In GERMAN
Presented at DGLR/VDI-Tagung Menschliche Zuverlaessigkeit, Munich, Germany, May 1992
(MBB-FE-313-S-PUB-0500; ETN-93-93434) Avail: CASI HC A03/MF A01

Responsibility is defined. Its properties and characteristics are given. The acquisition of knowledge and the development of capacities for a professional working qualification are outlined. Learning psychological problems are considered. Rescue measures are presented. Examples are described. Disturbances, such as fatigue, vigilance problems, drugs, and illnesses are reported. ESA

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MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

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

A93-26567
THE STRATEGIC ROLE OF AUTOMATION AND ROBOTICS FOR COLUMBUS UTILIZATION
SIMONETTA DI PIPPO (ASI, Rome, Italy) Space Technology - Industrial and Commercial Applications (ISSN 0892-9270) vol. 13, no. 2 March 1993 p. 171-174. refs
Copyright

The advantages of the automation and robotics (A&R) capability for the Attached Laboratory operations and the Columbus utilization and exploitation are discussed together with examples of A&R implementation. Particular attention is given to the A&R manipulation system designed for the Bioscreening with Robotics (BioRob) experiment, proposed for a flight on the Spacelab E1 mission in the Columbus Precursor Flights Program, and to the Italian Space Agency A&R related programs, including the SPIDER manipulation subsystem, the robot controller, and the Center for Robotics Simulation. It is shown that the SPIDER robotic arm, with small modifications, can be used both for the BioRob and for the Attached Laboratory operations. I.S.

A93-26881
LARGE-SCREEN-PROJECTION, AVIONIC, AND HELMET-MOUNTED DISPLAYS; PROCEEDINGS OF THE MEETING, SAN JOSE, CA, FEB. 26-28, 1991
HARRY M. ASSENHEIM, ED., RICHARD A. FLASCK, ED., THOMAS M. LIPPERT, ED. (Honeywell, Inc., Minneapolis, MN), and JERRY BENTZ, ED. (McDonnell Aircraft Co., Saint Louis, MO) Bellingham, WA Society of Photo-Optical Instrumentation Engineers (SPIE Proceedings. Vol. 1456) 1991 334 p.
(SPIE-1456; ISBN 0-8194-0555-8) Copyright

The present conference discusses projection lenses for HDTV, a high resolution display using a laser-addressed ferroelectric liquid crystal light valve, the development status of HDTV in the U.S., Japan, and Europe, helmet-mounted display (HMD) tracking technologies, visual field information in nap-of-the-earth flight with HMDs, stereo HMDs for combat vehicles, and the design of an optimal single-reflective holographic HMD. Also discussed are a human visual performance model, colorimetry and normal human vision, militarized IR touch panels, disparities in a double-combiner HUD, the chromatic aberrations of imaging holographic optical elements, and the visual characteristics of LED display pushbuttons for avionics applications. (For individual items see A93-26882 to A93-26888) O.C.

A93-26885
DESIGNING THE RIGHT VISOR
PINI GILBOA (Elbit Computers, Advanced Technology Center, Haifa, Israel) *In* Large-screen-projection, avionic, and helmet-mounted displays; Proceedings of the Meeting, San Jose, CA, Feb. 26-28, 1991 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1991 p. 154-163. refs
Copyright

In a Visor Projected Helmet Mounted Display (HMD) the volume and helmet shape are constrained by visor curvature and location. An approach is presented which determines optimal visor and optical configurations which lead to minimal helmet envelope size.

A model based on spherical visor and a criterion for an envelope size is defined. Three parameters are left free to be set by the designer: visor curvature, eye relief, and a degree of optical assembly obscuration. The influence of these free parameters on helmet size and shape are examined for an unobstructed field of view. An adaptation of the model for non-spherical visors is also discussed. Author

A93-26887* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
HUMAN VISUAL PERFORMANCE MODEL FOR CREWSTATION DESIGN
JAMES LARIMER, MICHAEL PREVOST (NASA, Ames Research Center, Moffett Field, CA), ARIES ARDITI, STEVEN AZUETA (Lighthouse, Inc., New York), JAMES BERGEN, and JEFFREY LUBIN (David Sarnoff Research Labs., Princeton, NJ) *In* Large-screen-projection, avionic, and helmet-mounted displays; Proceedings of the Meeting, San Jose, CA, Feb. 26-28, 1991 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1991 p. 196-210. refs
(Contract NCC2-541; NAG2-426; NAS2-12852; NAS2-13210)
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An account is given of a Visibility Modeling Tool (VMT) which furnishes a crew-station designer with the means to assess configurational tradeoffs, with a view to the impact of various options on the unambiguous access of information to the pilot. The interactive interface of the VMT allows the manipulation of cockpit geometry, ambient lighting, pilot ergonomics, and the displayed symbology. Performance data can be displayed in the form of 3D contours into the crewstation graphic model, thereby yielding an indication of the operator's visual capabilities. O.C.

A93-26896* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
PICTORIAL COMMUNICATION IN VIRTUAL AND REAL ENVIRONMENTS
STEPHEN R. ELLIS, ED. (NASA, Ames Research Center, Moffett Field; California Univ., Berkeley) London and Bristol, PA Taylor & Francis 1991 611 p.
(ISBN 0-74840-008-7) Copyright

Papers about the communication between human users and machines in real and synthetic environments are presented. Individual topics addressed include: pictorial communication, distortions in memory for visual displays, cartography and map displays, efficiency of graphical perception, volumetric visualization of 3D data, spatial displays to increase pilot situational awareness, teleoperation of land vehicles, computer graphics system for visualizing spacecraft in orbit, visual display aid for orbital maneuvering, multiaxis control in telemanipulation and vehicle guidance, visual enhancements in pick-and-place tasks, target axis effects under transformed visual-motor mappings, adapting to variable prismatic displacement. Also discussed are: spatial vision within egocentric and exocentric frames of reference, sensory conflict in motion sickness, interactions of form and orientation, perception of geometrical structure from congruence, prediction of three-dimensionality across continuous surfaces, effects of viewpoint in the virtual space of pictures, visual slant underestimation, spatial constraints of stereopsis in video displays, stereoscopic stance perception, paradoxical monocular stereopsis and perspective vergence. (No individual items are abstracted in this volume) C.D.

A93-27001
COOPERATIVE INTELLIGENT ROBOTICS IN SPACE II; PROCEEDINGS OF THE MEETING, BOSTON, MA, NOV. 12-14, 1991
WILLIAM E. STONEY, ED. (Mitre Corp., McLean, VA) Bellingham, WA Society of Photo-Optical Instrumentation Engineers (SPIE Proceedings. Vol. 1612) 1992 431 p.
(SPIE-1612; ISBN-0-8194-0749-6) Copyright

Attention is given to space robot requirements and critical issues, planning approaches for space robots, assembly operations in a dual-arm testbed for space application, vision control systems for space robotics, integrating autonomy with teleoperators, and space robotic testbeds. Particular attention is given to characteristics and requirements of robotic manipulators for space operations; planning and executing visually constrained robot motions; optimal damped least-squares methods for inverse kinematics of robot manipulators; model-based matching using annealing and a minimum-representation-size criterion; robot path planning for space-truss assembly; pose determination using point features; a vision navigator for free-flying robots; virtual display aids for teleoperation; incorporating robot vision in teleautonomous systems; intelligent robotics capabilities of the teleautonomy testbed; and technology test results from an intelligent, free-flying robot for crew and equipment retrieval in space. (For individual items see A93-27002 to A93-27038) O.G.

A93-27002* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
FUTURE NEEDS FOR SPACE ROBOTS FOR SEI
JON D. ERICKSON, CHARLES R. PRICE, and DOUGLAS COOKE (NASA, Johnson Space Center, Houston, TX) *In* Cooperative intelligent robotics in space II; Proceedings of the Meeting, Boston, MA, Nov. 12-14, 1991 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 2-12. refs
Copyright

High level systems engineering modeling and analysis activities for the Space Exploration Initiative (SEI) are reviewed, with emphasis on planet surface systems. Particular attention is given to SEI studies, preliminary space robotic system requirements, and usefulness of space robotic systems developed to operate on planetary surfaces on earth. It is concluded that supervised intelligent systems on the planet surfaces are necessary to make SEI planet surface activities reliable and productive and encompass capabilities for control and monitoring of all elements, including supervised autonomous robotic systems. Amplification of human capabilities due to applying more knowledge and reasoning in more flexible and appropriate ways than conventional automation approaches will provide more robust performance, greater choice of interaction modes with operators, and greater transparency of operation. O.G.

A93-27003* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
CHARACTERISTICS AND REQUIREMENTS OF ROBOTIC MANIPULATORS FOR SPACE OPERATIONS
JAMES F. ANDARY, DENNIS R. HEWITT, PETER D. SPIDALIERE (NASA, Goddard Space Flight Center, Greenbelt, MD), and ROBERT W. LAMBECK (McDonnell Douglas Space Systems Co., Seabrook, MD) *In* Cooperative intelligent robotics in space II; Proceedings of the Meeting, Boston, MA, Nov. 12-14, 1991 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 13-23. refs
Copyright

A robotic manipulator, DTF-1, developed as part of the Flight Telerobotic Servicer (FTS) project at Goddard Space Flight Center is discussed focusing on the technical, operational, and safety requirements. The DTF-1 system design, which is based on the manipulator, gripper, cameras, computer, and an operator control station incorporates the fundamental building blocks of the original FTS, the end product of which was to have been a light-weight, dexterous telerobotic device. For the first time in the history of NASA, space technology and robotics were combined to find new and unique solutions to the demanding requirements of flying a sophisticated robotic manipulator in space. DTF-1 is considered to be the prototype for all future development in space robotics. O.G.

A93-27022
ACCURACY OF LOCATING CIRCULAR FEATURES USING MACHINE VISION
CHERYL SKLAIR, WILLIAM HOFF, and LANCE GATRELL (Martin Marietta Astronautics Group, Denver, CO) *In* Cooperative intelligent robotics in space II; Proceedings of the Meeting, Boston,

MA, Nov. 12-14, 1991 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 222-234. refs
Copyright

The major contributors to centroid error are analyzed as part of an effort to design a video positioning sensor for NASA's flight Telerobitic Servicer. The error sources are classified into spatial quantization errors, errors due to signal noise and random timing errors, circle tilt errors, and errors in modeling camera geometry. Centroid repeatability has been measured under various conditions, including synchronization method, signal-to-noise ratio, and frequency attenuation. Results reveal that it is possible to compensate for some of the error caused by circle tilt and camera characteristics, but the errors caused by spatial quantization and the electronic hardware can be only measured and their effects reduced somewhat. O.G.

A93-27024
INITIAL EXPERIMENTS ON THE END-POINT CONTROL OF A 2-DOF LONG-REACH ELASTIC MANIPULATOR

ERIC SCHMITZ and MADISON RAMEY (Martin Marietta Civil Space Systems Co., Denver, CO) *In* Cooperative intelligent robotics in space II; Proceedings of the Meeting, Boston, MA, Nov. 12-14, 1991 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 245-256. refs
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To support the study of dynamics and control for long-reach, space-based manipulators, an experimental planar manipulator has been developed. The arm has a 15-ft reach with flexible links at the shoulder and elbow joints. The arm's equations of motion are derived with the aid of TREETOPS, a multi-body dynamics analysis program. The resulting model is validated against experimental data. To serve as a baseline for future work, two classically-designed controllers have been implemented. One relies on sensors colocated with the joint actuators, while the other uses an end-point sensor measuring Cartesian displacements. Comparison of the controllers' experimental closed-loop responses demonstrate the performance improvements achievable using end-point position feedback; most notable is the more-than-two-fold increase in control bandwidth. Experimental and simulation results also demonstrate the end-point controller's improved 'Cartesian impedance'. Author

A93-27025
VISION NAVIGATOR FOR FREE-FLYING ROBOTS

ALI J. AZARBAYEJANI and HAROLD L. ALEXANDER (MIT, Cambridge, MA) *In* Cooperative intelligent robotics in space II; Proceedings of the Meeting, Boston, MA, Nov. 12-14, 1991 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 257-265. refs
Copyright

A vision technique applicable to the six degree-of-freedom navigation of free-flying space robots is discussed. The technique consists of a feature finder which matches points in the environment with image locations and a recursive estimator based on the extended Kalman filter which uses measurements of the image locations to update the state estimate recursively. Experimental results are presented which demonstrate the convergence and state tracking properties of the system. Results include that a vision navigator can be implemented with current off-the-shelf equipment if a sufficiently simple object in the environment acts as the navigation target. Author

A93-27027
WORLD MODEL AND ITS UNCERTAINTY IN SUPERVISORY ROBOT CONTROL

JONG H. PARK and THOMAS B. SHERIDAN (MIT, Cambridge, MA) *In* Cooperative intelligent robotics in space II; Proceedings of the Meeting, Boston, MA, Nov. 12-14, 1991 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 278-288. refs
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This paper describes new methods to deal with uncertainty in the position and orientation of objects in the world model in the context of robot teleoperations. The virtual obstacle (object) is defined to represent objects with uncertainty bounds, which are constructed by the operator, who uses geometric data base and a 6 d.o.f. input device, while viewing video displays. These virtual obstacles are updated as the cameras move. Also a new method to build the world model by so called 'flying-and-matching' is introduced. Experiments have been performed with human subjects to evaluate the proposed schemes. Author

A93-27028
EMERGENCE OF TELEROBOTIC CONTROL ENHANCEMENT FROM RESEARCH IN MACHINE AUTONOMY

ALBERT G. HADDAD, SR., JOHN C. ADAMS, PETER A. BERARDO, KENT OHLUND, and DAVID VAN VACTOR (Lockheed Automation and Robotics Lab., Palo Alto, CA) *In* Cooperative intelligent robotics in space II; Proceedings of the Meeting, Boston, MA, Nov. 12-14, 1991 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 289-298. Research supported by Lockheed Missiles & Space Co., Inc refs
Copyright

An approach to advanced robotic control aimed at fusing autonomy with teleoperative control which was developed in the Lockheed Research and Development Division is described. Particular attention is given to the component/enabling technologies, their development status, and computer-aided software engineering tools used in an accelerated development environment. It is concluded that many tasks to be performed in the applications of robot technology are too demanding for an operator to execute alone. Only the robot itself is capable of providing local cognizance for time delays in remote applications including orbital satellite resupply, lunar and Martian exploration, and underwater remote operations. Teleoperations and telerobotic control can benefit from the features inherently essential to autonomous operations. O.G.

A93-27029
VIRTUAL DISPLAY AIDS FOR TELEOPERATION

RAVI CHIRUVOLU, VINCENT HWANG (Mitre Corp., McLean, VA), and THOMAS SHERIDAN (MIT, Cambridge, MA) *In* Cooperative intelligent robotics in space II; Proceedings of the Meeting, Boston, MA, Nov. 12-14, 1991 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 299-310. refs
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This paper describes a concept called a virtual image and discusses its applications to telerobotics. The virtual image is a graphical tool which allows the operator to see the environment from any perspective that he wants. This concept proves critical in two situations: (1) when a sensor (i.e. wrist camera) from which the operator needs information is obscured, and the information is not directly provided by any sensor, and (2) when the task requires moving a selected object relative to another object which is itself moving. These two problems will be discussed in detail along with the method by which the virtual image concept offers the solution. A simulation was created in which the virtual image concept was tested under a varying set of parameters for a teleoperational task. The parameter categories are camera/graphical views, graphical display content, written display content, and operator interface. The simulation will be described in detail along with the results and conclusions. In addition, the possibility of introducing automation as an aid for teleoperation will be discussed and a relevant simulation scenario will be analyzed. Throughout the paper, the real-world applicability of these ideas will be emphasized. Author

A93-27030
A TELEROBOTIC VIRTUAL CONTROL SYSTEM

SHUMIN ZHAI and PAUL MILGRAM (Toronto Univ., Canada) *In* Cooperative intelligent robotics in space II; Proceedings of the Meeting, Boston, MA, Nov. 12-14, 1991 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 311-322. Research supported by Defence and Civil Inst. of Environmental Medicine refs
Copyright

A project to develop a telerobotic virtual control capability, currently underway at the University of Toronto, is described. The project centers on a new mode of interactive telerobotic control based on the technology of combining computer generated stereographic images with remotely transmitted stereoscopic video images. A virtual measurement technique, in conjunction with a basic level of digital image processing, comprising zooming, parallax adjustment, edge enhancement, and edge detection, have been developed to assist the human operator in visualization of the remote environment and in spatial reasoning. The aim is to maintain target recognition, tactical planning and high level control functions in the hands of the human operator, with the computer performing low level computation and control. Control commands initiated by the operator are implemented through manipulation of a virtual image of the robot system, merged with a live video image of the remote scene. This paper discusses the philosophy and objectives of the project, with emphasis on the underlying human factors considerations in the design, and reports the progress made to date in this effort. Author

A93-27031
INCORPORATING ROBOT VISION IN TELE-AUTONOMOUS SYSTEMS
SHAO LEJUN (Nanyang Technological Univ., Singapore), RICHARD VOLZ (Texas A & M Univ., College Station), LYNN CONWAY, and M. W. WALKER (Michigan Univ., Ann Arbor) *In* Cooperative intelligent robotics in space II; Proceedings of the Meeting, Boston, MA, Nov. 12-14, 1991 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 323-333. refs
Copyright

A new method is proposed to tele-control the movement of a remote robot when the movement involves contact with objects and when the control involves a significant time delay. In this method, a vision system is incorporated into the tele-autonomous systems. The vision system is used to do vision sensory information feedback to update local world model and to implement a relative move mode to control the remote robot. This method will effectively overcome some of the limitations of current tele-robot control systems. Author

A93-27032* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
INTERACTIVE SCENE ANALYSIS MODULE - A SENSOR-DATABASE FUSION SYSTEM FOR TELEROBOTIC ENVIRONMENTS
ERIC G. COOPER, SIXTO L. VAZQUEZ, and PLESENT W. GOODE (NASA, Langley Research Center, Hampton, VA) *In* Cooperative intelligent robotics in space II; Proceedings of the Meeting, Boston, MA, Nov. 12-14, 1991 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 334-345. refs
Copyright

Accomplishing a task with telerobotics typically involves a combination of operator control/supervision and a 'script' of preprogrammed commands. These commands usually assume that the location of various objects in the task space conform to some internal representation (database) of that task space. The ability to quickly and accurately verify the task environment against the internal database would improve the robustness of these preprogrammed commands. In addition, the on-line initialization and maintenance of a task space database is difficult for operators using Cartesian coordinates alone. This paper describes the Interactive Scene' Analysis Module (ISAM) developed to provide taskspace database initialization and verification utilizing 3-D graphic overlay modelling, video imaging, and laser radar based range imaging. Through the fusion of taskspace database information and image sensor data, a verifiable taskspace model is generated providing location and orientation data for objects in a task space. This paper also describes applications of the ISAM in the Intelligent Systems Research Laboratory (ISRL) at NASA Langley Research Center, and discusses its performance relative to representation accuracy and operator interface efficiency. Author

A93-27033
REAL TIME PROXIMITY CUES FOR TELEOPERATION USING MODEL BASED FORCE REFLECTION
GUY BRUNO and MATTHEW K. MORGENTHALER (Martin Marietta Civil Space and Communications Co., Denver, CO) *In* Cooperative intelligent robotics in space II; Proceedings of the Meeting, Boston, MA, Nov. 12-14, 1991 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 346-355. refs
Copyright

The problem of providing model based proximity cues using force reflection for teleoperation under time delay is addressed. A novel use of artificial potential fields is proposed as a teleoperator aid to efficiently provide a predictive tactile display. Several new artificial potential models are presented which are used to convey accurate shape and proximity information by generating handcontroller forces based on the potential gradient. These new potential gradients are shown to have an efficient implementation via exact computation as a neural network. A real time prototype implementation and integration with Martin Marietta's teleautonomous testbed, is discussed. Evaluations are made with human operators performing tasks using industrial manipulators under time delay scenarios. Author

A93-27034* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
GRASP SYNTHESIS FOR PLANAR AND SOLID OBJECTS
YU-CHE CHEN (Tulsa Univ., OK), IAN D. WALKER, and JOHN B. CHEATHAM (Rice Univ., Houston, TX) *In* Cooperative intelligent robotics in space II; Proceedings of the Meeting, Boston, MA, Nov. 12-14, 1991 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 356-376. refs
(Contract NAG9-372; NCC9-16; NSF MSS-90-24391)
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This paper presents an analysis of the mechanics for multifingered grasps of planar and solid objects. Squeezing and frictional effects between the fingers and the grasped objects is fully visualized through our approach. An algorithm for qualitively choosing the grasp points is developed based on the mechanics of grasping. It is shown further that our method can be easily extended for the soft-fingered grasp model where the torsional moments along the contact normals can be transmitted through the grasp points. Author

A93-27035
INTELLIGENT ROBOTICS CAPABILITIES OF THE TELEAUTONOMY TESTBED
P. C. DALEY and GUY BRUNO (Martin Marietta Civil Space and Communications Co., Denver, CO) *In* Cooperative intelligent robotics in space II; Proceedings of the Meeting, Boston, MA, Nov. 12-14, 1991 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 378-382. refs
Copyright

This paper presents a multi-armed robotic testbed for space servicing applications. Additional developments in the testbed have increased the intelligent capabilities of the overall robotic system. The testbed includes an autonomous diagnosis capability which is required for advanced space servicing tasks. Modifications to the testbed components that facilitate the additional autonomous operations are presented. The NASREM compliant architecture of the testbed is key to the ease of testbed upgrade and experiment definition. Fluent integration of machine intelligence for autonomous operation and teleoperator control is key to the testbed's utility in exploring the design of multi-arm cooperative intelligent space robots. Author

A93-27037 National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
TECHNOLOGY TEST RESULTS FROM AN INTELLIGENT, FREE-FLYING ROBOT FOR CREW AND EQUIPMENT RETRIEVAL IN SPACE
J. ERICKSON, R. GOODE, K. GRIMM, C. HESS (NASA, Johnson Space Center, Houston, TX), R. NORSWORTHY, G. ANDERSON,

L. MERKEL, and D. PHINNEY (Lockheed Engineering and Sciences Co., Houston, TX) *In* Cooperative intelligent robotics in space II; Proceedings of the Meeting, Boston, MA, Nov. 12-14, 1991 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 402-413. Research supported by NASA refs
Copyright

The ground-based demonstrations of Extra Vehicular Activity (EVA) Retriever, a voice-supervised, intelligent, free-flying robot, are designed to evaluate the capability to retrieve objects (astronauts, equipment, and tools) which have accidentally separated from the Space Station. The EVA Retriever software is required to autonomously plan and execute a target rendezvous, grapple, and return to base while avoiding stationary and moving obstacles with subsequent object handover. The software architecture incorporates a heirarchical decomposition of the control system that is horizontally partitioned into five major functional subsystems: sensing, perception, world model, reasoning, and acting. The design provides for supervised autonomy as the primary mode of operation. It is intended to be an evolutionary system improving in capability over time and as it earns crew trust through reliable and safe operation. This paper gives an overview of the hardware, a focus on software, and a summary of results achieved recently from both computer simulations and air bearing floor demonstrations. Limitations of the technology used are evaluated. Plans for the next phase, during which moving targets and obstacles drive realtime behavior requirements, are discussed. Author

A93-27038* National Aeronautics and Space Administration, Washington, DC.
NEUTRAL BUOYANCY SIMULATION OF SPACE TELEROBOTICS OPERATIONS
DAVID L. AKIN and RUSSELL D. HOWARD (Maryland Univ., College Park) *In* Cooperative intelligent robotics in space II; Proceedings of the Meeting, Boston, MA, Nov. 12-14, 1991 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 414-420.
(Contract NAGW-2245)
Copyright

A number of neutral buoyancy versions of space telerobots have been tested in the Space Research Laboratory to understand the potential roles for telerobotic systems in space operations. Particular attention is given to details of the well-modeled dynamic environment, the existence of sizable data base on EVA operations in neural buoyancy with correlation to flight experience, and routine access to a number of high-fidelity mockups of past and planned operational spacecraft. The compromises necessary for the design and construction of neutral buoyancy telerobotic systems are discussed, and data from a number of past simulations, including correlation of neutral buoyancy structural assembly with EVA flight data, and preliminary tests of telerobotic servicing of Hubble Space Telescope are summarized. O.G.

A93-27126
HUMAN FACTORS SOCIETY, ANNUAL MEETING, 35TH, SAN FRANCISO, CA, SEPT. 2-6, 1991, PROCEEDINGS. VOLS. 1 & 2
Santa Monica, CA Human Factors Society (ISSN 0163-5182) 1991 p. Vol. 1, 921 p.; vol. 2, 756 p.
Copyright

These proceedings discuss human factor issues related to aerospace systems, aging, communications, computer systems, consumer products, education and forensic topics, environmental design, industrial ergonomics, international technology transfer, organizational design and management, personality and individual differences in human performance, safety, system development, test and evaluation, training, and visual performance. Particular attention is given to HUDs, attitude indicators, and sensor displays; human factors of space exploration; behavior and aging; the design and evaluation of phone-based interfaces; knowledge acquisition and expert systems; handwriting, speech, and other input techniques; interface design for text, numerics, and speech; and human factor issues in medicine. Also discussed are cumulative trauma disorders, industrial safety, evaluative techniques for automation impacts on the human operators, visual issues in training, and interpreting and organizing human factor concepts and information. (For individual items see A93-27127 to A93-27196) I.S.

A93-27127
AUTOMATION, AUTHORITY AND ANGST - REVISITED
THOMAS B. SHERIDAN *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 Santa Monica, CA Human Factors Society 1991 p. 2-6. refs
Copyright

Automation of previously human-controlled systems is accelerating. Although various proposals have been made regarding the allocation of functions among human and machine components of systems, the human factors discipline is not keeping pace with automation. Using examples primarily from aviation, a number of questions are raised regarding the relative roles of people and computers. Author

A93-27128
UP/DOWN IN (IM)POSSIBLE FLIGHT ATTITUDE INDICATORS - SOME EFFECTS OF COLOUR, SHAPE AND PATTERN
SVEN DAHLSTEDT (National Swedish Defence Research Inst., Linkoping, Sweden) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 Santa Monica, CA Human Factors Society 1991 p. 7-11.
Copyright

The effects of color, shape, and pattern of the flight attitude indicator design on the ease of interpreting the indicator were investigated in a series of experiments in which a number of pairwise combinations of colors, shapes, and patterns were tested on military pilots and civilian subjects. It was found that subjects could make fairly consistent indications of a 'natural' vertical orientation of ambiguous figures. Most of the subjects expressed very strong spatial associations to some of the combinations, but the agreement between individuals was very poor. Color and shape elicited the strongest responses, with the tested patterns acting more as minor moderators. I.S.

A93-27129
HUD CLIMB/DIVE LADDER CONFIGURATION AND UNUSUAL ATTITUDE RECOVERY
LISA F. WEINSTEIN and WILLIAM R. ERCOLINE (Krug Life Sciences, Brooks AFB, TX) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 Santa Monica, CA Human Factors Society 1991 p. 12-16. refs
Copyright

Twelve HUD experienced pilots participated in a study that examined the effects of articulated lines versus parallel, tapered lines in the top and bottom halves of the climb/dive ladder for recovering from nose-down unusual attitudes in a flight simulator. These configurations were assessed using a moving climb/dive marker (CDM) on half of the trials and a fixed pitch reference for the remaining trials. The results indicated that the climb/dive ladder configuration did not affect a pilot's reaction time to initiate a recovery. However, in terms of accuracy of the initial, significant stick input, the articulated lines in the bottom half of the HUD with a moving CDM resulted in a significantly poorer performance (about 12 percent worse) than that associated with the other three configurations. These findings suggest that articulated lines in the bottom half of the HUD are determined to a pilot's ability to recover from nose-down unusual attitudes. Author

A93-27131
THE EFFECTS OF HEAD AND SENSOR MOVEMENT ON FLIGHT PROFILES DURING SIMULATED DIVE BOMBING
MAXWELL J. WELLS (Logicon Technical Services, Inc., Dayton, OH) and ROBERT K. OSGOOD (USAF, Armstrong Lab., Wright-Patterson AFB, OH) *In* Human Factors Society, Annual

Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 Santa Monica, CA Human Factors Society 1991 p. 22-26.
Copyright

A dive bombing mission was performed in a simulator by 5 experienced USAF pilots. Their view out of the cockpit was provided by an aircraft-fixed or head-steered sensor. Despite significant differences in performance with the two sensors, the mean flight profiles flown with each sensor were similar. However, with the head-steered sensor, some subjects made consistently different head movements. The same subjects also flew different flight profiles. These subjects exploited the mobility of the head-steered sensor to make large amplitude head displacements during ascent. As a result, they sighted the target earlier. It is shown that these early-sighting subjects made changes to their flight profiles during ascent which allowed them, during descent, to aim their aircraft at the target earlier, while higher. Consequently, the early-sighting subjects released their bombs significantly higher than the late-sighting subjects (high bomb release is beneficial to aircraft survival). Author

A93-27141
EXPERIMENTAL VALIDATION OF THE ATTENTION SWITCHING COMPONENT OF THE COGNET FRAMEWORK
JOAN M. RYDER and WAYNE W. ZACHARY (CHI Systems, Inc., Spring House, PA) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 Santa Monica, CA Human Factors Society 1991 p. 72-76. Research supported by U.S. Navy refs
Copyright

COGNET has recently been proposed as a general cognitive model of human-computer interaction in real-time, multi-tasking environments. A main feature is a component that models human operator attention shifts as a product of competing task demands and a dynamic external environment. An experimental validation of that attention switching component was undertaken, using a previously reported COGNET model. Separate data were collected from subjects used to build the original COGNET model, and new (but equally expert) subjects. The model was found to predict 90 percent of all observed task instances (p is less than .01) for the original subjects, and a surprising 94 percent for new subjects. For predicted tasks, the model prediction was also found to lead to actual task initiation by an average of 3.2 min. for original subjects and 2.2 min. for new subjects (over an average problem duration of 90 min). Author

A93-27145
TARGET DESIGNATION IN A PERSPECTIVE VIEW, 3-D MAP USING A JOYSTICK, HAND TRACKER, OR VOICE
KRISTEN K. BARTHELEMY, JOHN M. REISING (USAF, Cockpit Integration Directorate, Wright-Patterson AFB, OH), and DAVID C. HARTSOCK (Midwest Systems Research, Inc., Dayton, OH) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 Santa Monica, CA Human Factors Society 1991 p. 97-101. refs
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The purpose of this study was to determine which of three cursor control techniques would provide the best means of designating targets in three-dimensional space. The three techniques tested were a joystick, a hand tracker, and voice. The current study showed that the quickest and most accurate target designations occurred when using the hand tracker, and when targets were positioned in the front most part of the three-dimensional volume. Author

A93-27148
COMPLEX TASK PERFORMANCE AS A BASIS FOR DEVELOPING COGNITIVE ENGINEERING GUIDELINES IN ADAPTIVE AUTOMATION
JONATHAN P. GLUCKMAN, JEFFREY G. MORRISON, and JOHN E. DEATON (U.S. Navy, Naval Air Development Center, Warminster, PA) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 Santa Monica, CA Human Factors Society 1991 p. 116-120. refs
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This paper describes the first of a series of Cockpit Automation Studies (CAS-1). The study examines performance on two tasks performed separately and in combination. The tasks were selected to represent tasks found in a tactical aircraft cockpit and were derived from standard laboratory tasks. The results of the study have implications for the utility of resource theory in understanding and predicting complex task performance, and for the use of adaptive automation systems. On-going and planned research is also discussed. Author

A93-27151
RECLINED SEATING IN ADVANCED CREWSTATIONS - HUMAN PERFORMANCE CONSIDERATIONS
JOHN E. DEATON and EDWARD HITCHCOCK (U.S. Navy, Naval Air Development Center, Warminster, PA) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 Santa Monica, CA Human Factors Society 1991 p. 132-136. refs
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The present study investigated operator performance based on sensory and cognitive task performance measures obtained during high G in both an upright seat (27 degrees of reclination) and a reclined seat (67 degrees of reclination). Subjects were required to perform both a perceptual/motor and a classification task under varying levels of G. Results indicated that there were little differences in reaction times or accuracy between seat configurations for single task cognitive performance. There were significant differences in reaction times for seat types for dual task cognitive performance. In general, tracking performance on the upright seat was better than the reclined seat during G, while the reclined seat seemed to show substantial performance recovery post-G. The possibility that tracking results favoring the upright seat may not be a function of true perceptual/motor advantages, but rather engineering design problems inherent in the reclined seat were discussed. Author

A93-27152
EFFECTS OF ERROR-PROOFING AND CHEMICAL/BIOLOGICAL/RADIATION PROTECTIVE GLOVE USE ON TOUCH PANEL OPERATION
DENNIS B. BERINGER (New Mexico State Univ., Las Cruces) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 Santa Monica, CA Human Factors Society 1991 p. 137-140. Research supported by McDonnell Douglas Helicopter Co refs
Copyright

The effect of wearing chemical/biological/radiation (SBR) protective gloves on the accuracy of use of resistive and infrared touch panel devices was investigated. The gloves were worn over Nomex flight gloves and were not part of an inflated or positive-pressure system. It was found that little degradation of performance occurred when operators were required to wear CBR gloves during performance of a menu-selection task. The importance of constraining input as much as possible to only those areas that are currently active was underscored by results obtained in a replication. I.S.

A93-27153
A SYSTEMS ANALYSIS TO IDENTIFY HUMAN FACTORS ISSUES AND REQUIREMENTS FOR DATA LINK
VICTOR RILEY (Honeywell Systems and Research Center, Minneapolis, MN) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 Santa Monica, CA Human Factors Society 1991 p. 141-145. refs
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When developing a complex system, it is often difficult to identify the human factors issues and requirement areas associated with the system. We have developed a systematic methodology to identify human factors issues and requirement areas based on

an information flow model of the system, the form of which is determined by a taxonomy of automation. We have tested the methodology on an analysis of data link, which is a communications technology intended to replace much of the air-to-ground voice communications in commercial transport aircraft. Our analysis addresses such areas as what factors may contribute to errors and what the effects of those errors may be, Cockpit Resource Management (CRM) effects and requirements, pilot and air traffic controller situation awareness and workload, and the design of the Human-Computer-Interface (HCI). The analysis has brought to light a number of potentially critical issues that have not been addressed in the data link literature. Although the analysis does not yield quantitative system design requirements, it does lead to extensive and detailed qualitative requirement areas that may then be used to drive a System Requirements Document and guide empirical research. It is also relatively simple and inexpensive to perform. Author

A93-27154
COLOUR HEAD-UP DISPLAYS - HELP OR HINDRANCE?
HELEN J. DUDFIELD (Royal Aerospace Establishment, Farnborough, United Kingdom) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 Santa Monica, CA Human Factors Society 1991 p. 146-150. refs
Copyright

The development of color HUD technology has encouraged inquiry into the benefit of color coding conventional HUD formats. Color could be used to warn crew of danger, highlight changes in onboard systems or assist in target acquisition and combat. Specifically for this experiment color encoded the accuracy of a subject's performance, redundant color codes indicated the success with which a subject was maintaining a requested flight profile. Contemporary research has often found a subjective preference for color-coded displays, but little evidence of an objective advantage. The results of this experiment followed such a trend. Color coding failed to provide any advantage in performance terms, yet it significantly reduced subjective workload, as measured by the NASA TLX (p is less than 0.05). The initial indications are that color coding was not optimized in this task and other techniques, e.g. recovery from unusual attitudes, and applications, e.g. target information, might be more appropriate. Author

A93-27155* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
ADAPTIVE STRATEGIES OF REMOTE SYSTEMS OPERATORS EXPOSED TO PERTURBED CAMERA-VIEWING CONDITIONS
MARK A. STUART, MEERA K. MANAHAN, JOHN M. BIERSCHWALE, CARLOS E. SAMPAIO (Lockheed Engineering and Sciences Co., Houston, TX), and A. J. LEGENDRE (NASA, Johnson Space Center, Houston, TX) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 Santa Monica, CA Human Factors Society 1991 p. 151-155. refs
(Contract NAS9-17900)
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This report describes a preliminary investigation of the use of perturbed visual feedback during the performance of simulated space-based remote manipulation tasks. The primary objective of this NASA evaluation was to determine to what extent operators exhibit adaptive strategies which allow them to perform these specific types of remote manipulation tasks more efficiently while exposed to perturbed visual feedback. A secondary objective of this evaluation was to establish a set of preliminary guidelines for enhancing remote manipulation performance and reducing the adverse effects. These objectives were accomplished by studying the remote manipulator performance of test subjects exposed to various perturbed camera-viewing conditions while performing a simulated space-based remote manipulation task. Statistical analysis of performance and subjective data revealed that remote manipulation performance was adversely affected by the use of perturbed visual feedback and performance tended to improve with successive trials in most perturbed viewing conditions. Author

A93-27156* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
EVALUATING ROBOT PROCEDURES AND TASKS FOR THE FLIGHT TELEROBOTIC SERVICER
TIMOTHY A. SAUERWEIN (NASA, Goddard Space Flight Center, Greenbelt, MD) and JOHN A. MOLINO (Tech-U-Fit Corp., Alexandria, VA) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 Santa Monica, CA Human Factors Society 1991 p. 156-159. refs
Copyright

NASA is developing space telerobotic systems to construct, service and maintain complex space hardware. These systems will be controlled by an astronaut operator in space. Preliminary mission procedures have been developed and typical task elements have been selected. The present study simulates some of these procedures, tasks and devices in the laboratory in order to obtain initial operator/robot system performance data. Author

A93-27157* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
TASK-ANALYTIC EVALUATIONS OF SPACE STATION FREEDOM WORKSTATIONS
MANUEL F. DIAZ (Lockheed Engineering and Sciences Co., Houston, TX) and DEAN G. JENSEN (NASA, Johnson Space Center, Houston, TX) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 Santa Monica, CA Human Factors Society 1991 p. 160-163. (Contract NAS9-17900)
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Space Station Freedom will be a permanently manned multipurpose facility in low Earth orbit by the late 1990's. Integral to Space Station Freedom will be Data Management System workstations. These workstations will provide the human-machine interface for controlling such systems as Guidance, Navigation and Control, Propulsion, and Environmental Control and Life Support. In addition, they will be used by crewmembers in the space station's pressurized shirt-sleeve environment to control remote manipulator systems and free-flyer devices. This paper presents an overview of proposed workstations and current task-analytic evaluations being used to assess their adequacy in supporting Space Station Freedom operations. Particular emphasis is placed on the results and conclusions of the analysis. Author

A93-27160* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
DISPLAY FORMAT AND HIGHLIGHT VALIDITY EFFECTS ON SEARCH PERFORMANCE USING COMPLEX VISUAL DISPLAYS
KIMBERLY A. DONNER (Rice Univ., Houston, TX), TIM MCKAY, KEVIN M. O'BRIEN (Lockheed Engineering and Sciences Co., Houston, TX), and MARIANNE RUDISILL (NASA, Johnson Space Center, Houston, TX) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 Santa Monica, CA Human Factors Society 1991 p. 374-378. Previously announced in STAR as N92-10287 refs
(Contract NAS9-17900)
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Display format and highlight validity were shown to affect visual display search performance; however, these studies were conducted on small, artificial displays of alphanumeric stimuli. A study manipulating these variables was conducted using realistic, complex Space Shuttle information displays. A 2x2x3 within-subjects analysis of variance found that search times were faster for items in reformatted displays than for current displays. The significant format by highlight validity interaction showed that there was little difference in response time to both current and reformatted displays when the highlight validity was applied; however, under the non or invalid highlight conditions, search times

were faster with reformatted displays. Benefits of highlighting and reformatting displays to enhance search and the necessity to consider highlight validity and format characteristics in tandem for predicting search performance are discussed. Author

A93-27163
HUMAN-COMPUTER COOPERATIVE PROBLEM SOLVING IN SATELLITE GROUND CONTROL
PATRICIA M. JONES and CHRISTINE M. MITCHELL (Georgia Inst. of Technology, Atlanta) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 Santa Monica, CA Human Factors Society 1991 p. 408-412. refs
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In the supervisory control of highly automated dynamic systems, the human operator is responsible for monitoring system state and compensating for system failures. Increasingly, the human operator interacts with one or more knowledge-based (e.g., expert) systems that assume responsibility for a portion of the supervisory control task. Thus, supervisory control is shared by both human and machine agent(s). To date, however, there is little research addressing the interaction of human and knowledge-based machine agents in supervisory control. This paper describes research that explores issues in the design of the cooperative human-machine interaction in the control of a complex dynamic system. The paper presents a set of prescriptive principles that define the human-computer interaction in supervisory control systems. In addition, the paper summarizes a case study of a NASA satellite ground control system in which human operators work with an expert system. The prescriptive principles and case study results from the basis of an architecture for cooperative problem solving for real-time control of dynamic systems. Author

A93-27167
AIR TRAFFIC CONTROL FACILITY LIGHTING
PAUL A. KROIS, DAVID R. LENOROVITZ, PATRICK S. MCKEON, CHRISTINE A. SNYDER, WAYNE K. TOBEY (CTA, Inc., Englewood, CO), and HOWARD S. BASHINSKI *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 Santa Monica, CA Human Factors Society 1991 p. 551-555. refs
(Contract DTFA01-89-C-00057)
Copyright

In conjunction with the current upgrade of the FAA's Air Traffic Control (ATC) system, significant effort has been devoted to identifying an appropriate facility lighting design. The new ATC environment will entail more extensive and intensive use of computer displays than in the current system. Studies of facility lighting techniques were performed, validating the relative advantages of indirect lighting versus direct lighting, examining proper illumination levels, and identifying appropriate positioning of luminaires. Author

A93-27170* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
USING GOMS MODELS AND HYPERTEXT TO CREATE REPRESENTATIONS OF MEDICAL PROCEDURES FOR ONLINE DISPLAY
LEO GUGERTY (Lockheed Engineering and Sciences Co., Houston, TX), SHANNON HALGREN (Rice Univ., Houston, TX), JOHN GOSBEE (Lockheed Engineering and Sciences Co., Houston, TX), and MARIANNE RUDISILL (NASA, Johnson Space Center, Houston, TX) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 Santa Monica, CA Human Factors Society 1991 p. 713-717. refs
(Contract NAS9-17900)
Copyright

This study investigated two methods to improve organization and presentation of computer-based medical procedures. A literature review suggested that the GOMS (goals, operators, methods, and selecton rules) model can assist in rigorous task analysis, which can then help generate initial design ideas for the human-computer interface. GOMS model are hierarchical in nature, so this study also investigated the effect of hierarchical, hypertext interfaces. We used a 2 x 2 between subjects design, including the following independent variables: procedure organization - GOMS model based vs. medical-textbook based; navigation type - hierarchical vs. linear (booklike). After naive subjects studies the online procedures, measures were taken of their memory for the content and the organization of the procedures. This design was repeated for two medical procedures. For one procedure, subjects who studied GOMS-based and hierarchical procedures remembered more about the procedures than other subjects. The results for the other procedure were less clear. However, data for both procedures showed a 'GOMSification effect'. That is, when asked to do a free recall of a procedure, subjects who had studies a textbook procedure often recalled key information in a location inconsistent with the procedure they actually studied, but consistent with the GOMS-based procedure. Author

A93-27182
METHODS FOR TEST AND EVALUATION OF NIGHT VISION GOGGLE INTEGRATED HELMETS
KATHY MCCLOSKEY, ROBERT L. ESKEN, and ERIC L. SCARBOROUGH (USAF, Armstrong Lab., Wright-Patterson AFB, OH) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 2 Santa Monica, CA Human Factors Society 1991 p. 1302-1306. refs
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Three Interim Night Integrated Goggle Head Tracking Systems (I-NIGHTS) were evaluated under sustained acceleration in the Dynamic Environment Simulator (DES) centrifuge. Ten subjects underwent three different high G profiles: a +8 Gz maximum profile, a +4 Gz maximum profile with mask dangling from the left side of the helmet, and a +4 Gz maximum profile with the mask removed from the helmet. Four different helmets were tested; three (A, B, and C) were prototype I-NIGHTS helmets obtained from different manufacturers and the fourth helmet (D) was the standard HGU-55P. Author

A93-27184
SELECTING SPACE STATION FREEDOM HARDWARE
NANCY B. MITCHELL (Boeing Aerospace and Electronics, Huntsville, AL) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 2 Santa Monica, CA Human Factors Society 1991 p. 1317-1320. refs
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Four types of restraint attachment hardware were evaluated using the method of paired comparisons. From these four, one restraint attachment device was chosen and the result accepted by the organizations involved. Paired comparisons provided a way of handling subjective data that produced an outcome which was objectively verifiable while, at the same time, reducing personal bias. The method of paired comparisons, as used in this trade study, is portable, accommodates groups of participants, and allows each participant's input to have equal weight. These advantages argue for using paired comparisons as a basic trade study tool in the selecting hardware, hardware configurations, and software display designs especially for developing systems. Author

A93-27186
MULTIDIMENSIONAL SCALING ANALYSIS OF TERRAIN FEATURES RELEVANT FOR SIMULATING LOW-ALTITUDE FLIGHT
JAMES A. KLEISS (Dayton Univ., OH) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 2 Santa Monica, CA Human Factors Society 1991 p. 1372-1376. refs
Copyright

Multidimensional scaling was used to identify the features of real-world terrain that are salient to pilots during low-altitude, high-speed flight. Subjects were ten United States Air Force and Air National Guard pilots experienced in low-altitude flight. The stimuli were 17 short (five-seconds duration) videotape segments

depicting low-altitude, high-speed flight over a variety of real-world terrains. Pilots rated pairs of terrains with respect to similarity of terrain features relevant for visual low-altitude flight. Similarity ratings were submitted to a multidimensional scaling analysis using ALSCAL. A two-dimensional solution revealed dimensions corresponding to (1) the presence/absence of hills and ridges and (2) the presence/absence of large objects clustered into groups. Results suggest that designers of flight simulators should focus on representing hills and ridges, and large trees and buildings with high perceptual fidelity. Author

A93-27190* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
EXOCENTRIC JUDGEMENTS IN REAL ENVIRONMENTS AND STEREOSCOPIC DISPLAYS
STEPHEN R. ELLIS, GREGORY K. THARP, ARTHUR J. GRUNWALD, and STEPHEN SMITH (NASA, Ames Research Center, Moffett Field; California Univ., Berkeley) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 2 Santa Monica, CA Human Factors Society 1991 p. 1442-1446. refs
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Spatial direction errors during interpretation of perspective images, such as 3D map displays, may originate from misjudgment of the orientation of the viewing direction used to make the display. One source of these errors could be perceptual evidence of the display surface. Two experiments are reported in which the same judgment exocentric task was presented, but the cues to the picture surface were reduced or eliminated by presenting the task as a stereoscopic, virtual image or by a geometrically matched physical model. A theory developed to model exocentric direction errors on perspective displays has been fitted to the data from these two experiments. The parameters estimated from the fit in both experiments indicate that the subjects may be more correctly estimating the viewing direction than in ordinary perspective displays. Consequently, in some real world or stereo viewing conditions, errors in estimating the viewing direction are not likely to dominate exocentric direction errors. Author

A93-27191
EFFECTS OF DISPLAY LUMINANCE ON THE RECOGNITION OF COLOR SYMBOLS ON SIMILAR COLOR BACKGROUNDS
ROBYN L. CRAWFORD, MONA L. TOMS (Logicon Technical Services, Inc., Dayton, OH), and DENISE L. WILSON (USAF, Human Engineering Div., Wright-Patterson AFB, OH) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 2 Santa Monica, CA Human Factors Society 1991 p. 1466-1470. refs
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This study examined the effects of display luminance on the ability of human observers to recognize color symbols displayed against similar color backgrounds. The Signal Detection paradigm was utilized and subject sensitivity, as measured by d-prime, was the primary measure of interest. The symbol colors were red, green, and blue. Background colors were .01 to .07 1976 CIE/UCS units distant from the symbol color. Luminance levels ranged from 11.85 dc/sq m to 127.25 dc/sq m. The symbols were presented on a CRT under ambient lighting of two lux. Display luminance was found to affect subject sensitivity, d-prime, as a function of symbol-background color combination. The results imply that display luminance for the presentation of blue symbology on bluish backgrounds is optimal at 19 cd/sq m. For the red and green symbol-background conditions, display luminance between 56 and 93 cd/sq m yields the best performance. Author

A93-27193* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
HUMAN FACTORS ISSUES IN THE USE OF NIGHT VISION DEVICES
MARY K. KAISER and DAVID C. FOYLE (NASA, Ames Research Center, Moffett Field, CA) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 2 Santa Monica, CA Human Factors Society 1991 p. 1502-1506. refs
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An account is given of the critical human factors that arise in field data on the differences between night vision displays and unaided day vision. Attention is given to the findings of empirical studies of performance on rotorcraft-flight-relevant perceptual tasks in which depth and distance perception are critical factors. Suggestions are made for man-machine-critical component design modifications in current night vision systems. O.C.

A93-27451
HEAD-UP DISPLAY STANDARDIZATION AND THE UTILITY OF ANALOG VERTICAL VELOCITY INFORMATION DURING INSTRUMENT FLIGHT
LISA F. WEINSTEIN, WILLIAM R. ERCOLINE (KRUG Life Sciences; USAF, Armstrong Lab., Brooks AFB, TX), RICHARD H. EVANS, and D. F. BITTON (USAF, Instrument Flight Center, Randolph AFB, TX) International Journal of Aviation Psychology (ISSN 1050-8414) vol. 2, no. 4 1992 p. 245-260. refs
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The U.S. Air Force is attempting to create a standard symbol set for use with the head-up display (HUD) as a primary flight reference. As part of that effort, 8 HUD-experienced pilots and 12 non-HUD-experienced pilots participated in a study that examined the effects of five different vertical velocity indicators in use under instrument flight conditions in a simulator. The five configurations assessed were (1) an altimeter arc, (2) a digital readout, (3) an altimeter arc with digital readout, (4) a dial, and (5) boxed digits with tape. The results clearly indicate that the altimeter arc with digital readout and the altimeter arc alone resulted in significantly more accurate maintenance of flight parameters (i.e., vertical velocity and altitude) than did the digital readout alone, the boxed digits with tape, or the dial. Author

A93-27455* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
PILOT INTERACTION WITH COCKPIT AUTOMATION - OPERATIONAL EXPERIENCES WITH THE FLIGHT MANAGEMENT SYSTEM
NADINE B. SARTER and DAVID D. WOODS (Ohio State Univ., Columbus) International Journal of Aviation Psychology (ISSN 1050-8414) vol. 2, no. 4 1992 p. 303-321. refs
(Contract NCC2-592)
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Results are presented of two studies on the potential effect of cockpit automation on the pilot's performance, which provide data on pilots' difficulties with understanding and operating one of the core systems of cockpit automation, the Flight Management System (FMS). The results of both studies indicate that, although pilots do become proficient in standard FMS operations through ground training and subsequent flight experience, they still have difficulties tracking the FMS status and behavior in certain flight contexts and show gaps in the understanding of the functional structure of the system. The results suggest that design-related factors such as opaque interfaces contribute to these difficulties, which can affect the pilot's situation awareness. I.S.

A93-28695
A PHYSICIAN'S WORKSTATION DESIGNED FOR NASA AND EARTH-BASED APPLICATIONS
R. R. GRAMS, F. S. YU, E. IDDINGS, and R. FIORENTINO (Florida Univ., Gainesville) Journal of Medical Systems (ISSN 0148-5598) vol. 16, no. 1 Feb. 1992 p. 39-64.
Copyright

One of the prime missions for NASA is the safety and care of astronauts. In addressing this challenge, a tool has been developed which has great potential for earth-based applications. The multimedia physician's workstation is the result of 13 years of planning and technical revolution in the field of computer science. Today, we have the hardware and the software to make a major change in the office-based practice of physicians. By offering the online features of a medical library as well as a complete multimedia

medical record system, we are now in a position to introduce advance decision support technology that can be used on a daily basis for routine outpatient care. The system supports a new platform for patient education and offers the doctor an opportunity to share his expertise with his patient and their family. Although NASA will need several more years before this technology can be applied to a remote space environment, we plan to introduce this system into the doctor's office as an initial test of its feasibility. The basic design and general specifications of this multimedia workstation/office system are described and illustrated as they currently exist. A.U.T.

A93-28715* National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.
CONTROLLED ECOLOGICAL LIFE-SUPPORT SYSTEM - USE OF PLANTS FOR HUMAN LIFE-SUPPORT IN SPACE
D. CHAMBERLAND, W. M. KNOTT, J. C. SAGER, and R. WHEELER (NASA, Kennedy Space Center, Cocoa Beach, FL) Florida Medical Association, Journal (ISSN 0015-4148) vol. 79, no. 8 Aug. 1992 p. 537-544.
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Scientists and engineers within NASA are conducting research which will lead to development of advanced life-support systems that utilize higher plants in a unique approach to solving long-term life-support problems in space. This biological solution to life-support, Controlled Ecological Life-Support System (CELSS), is a complex, extensively controlled, bioengineered system that relies on plants to provide the principal elements from gas exchange and food production to potable water reclamation. Research at John F. Kennedy Space Center (KSC) is proceeding with a comprehensive investigation of the individual parts of the CELSS system at a one-person scale in an approach called the Breadboard Project. Concurrently a relatively new NASA sponsored research effort is investigating plant growth and metabolism in microgravity, innovative hydroponic nutrient delivery systems, and use of highly efficient light emitting diodes for artificial plant illumination. A.U.T.

A93-28717* National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.
BIOMEDICAL ENGINEERING - A MEANS TO ADD NEW DIMENSION TO MEDICINE AND RESEARCH
D. F. DOERR (NASA, Kennedy Space Center, Cocoa Beach, FL) Florida Medical Association, Journal (ISSN 0015-4148) vol. 79, no. 8 Aug. 1992 p. 530, 531.
Copyright

Biomedical engineering is an evolving science that seeks to insert technically oriented and trained personnel to assist medical professionals in solving technological problems in the pursuit of innovations in the delivery of health care. Consequently, engineering solutions are brought to bear on problems that previously were outside the training of physicians and beyond the understanding or appreciation of the conventionally educated electrical or mechanical engineers. This physician/scientist/engineer team has a capability to extend medicine and research far beyond the capability of a single entity operating alone. How biomedical engineering has added a new dimension to medical science at the Kennedy Space Center is described. A.U.T.

A93-29101* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
COOPERATIVE INTELLIGENT ROBOTICS IN SPACE III; PROCEEDINGS OF THE MEETING, BOSTON, MA, NOV. 16-18, 1992
JON D. ERICKSON, ED. (NASA, Johnson Space Center, Houtson, TX) Bellingham, WA Society of Photo-Optical Instrumentation Engineers (SPIE Proceedings. Vol. 1829) 1992 525 p. (SPIE-1829; ISBN 0-8194-1030-6) Copyright

The present volume on cooperative intelligent robotics in space discusses sensing and perception, Space Station Freedom robotics, cooperative human/intelligent robot teams, and intelligent space robotics. Attention is given to space robotics reasoning and control, ground-based space applications, intelligent space robotics architectures, free-flying orbital space robotics, and cooperative intelligent robotics in space exploration. Topics addressed include proportional proximity sensing for telerobots using coherent lasar radar, ground operation of the mobile servicing system on Space Station Freedom, teleprogramming a cooperative space robotic workcell for space stations, and knowledge-based task planning for the special-purpose dextrous manipulator. Also discussed are dimensions of complexity in learning from interactive instruction, an overview of the dynamic predictive architecture for robotic assistants, recent developments at the Goddard engineering testbed, and parallel fault-tolerant robot control. (For individual items see A93-29102 to A93-29146) P.D.

A93-29106
FLIGHT TELEROBOTIC SERVICER LEGACY
PAUL L. SHATTUCK and JAMES W. LOWRIE (Martin Marietta Astronautics Group, Denver, CO) *In* Cooperative intelligent robotics in space III; Proceedings of the Meeting, Boston, MA, Nov. 16-18, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 60-74.
Copyright

The technology evolution that stemmed from developing and integrating a dexterous robot into a manned system, the Space Shuttle, is traced. Emphasis is placed on the safety and reliability requirements for a man-rated system as the critical factors which drive the overall system architecture. Task requirements and operational concepts for servicing and maintenance of space platforms, origins of technology for dexterous robotic systems, issues associated with space qualification of components, and development of the industrial base to support space robotics are also discussed. The Flight Telerobotic Servicer (FTS), developed to enhance and provide a safe alternative to the human presence in space, had completed the major component development activities for the flight system at the point of termination. The FTS Technology Capture Program provides a mechanism for transfering the component technologies to the user community and could serve as a focal point for the A&R program thrust in on-orbit servicing. P.D.

A93-29107
GROUND OPERATION OF THE MOBILE SERVICING SYSTEM ON SPACE STATION FREEDOM
Z. A. WOJCIK (Canadian Space Agency, Vanier, Canada) *In* Cooperative intelligent robotics in space III; Proceedings of the Meeting, Boston, MA, Nov. 16-18, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 75-90. refs
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Ground Operated Telerobotics (GOT), the operation of the Mobile Servicing System (MSS) from the ground, is proposed as an approach to reducing the anticipated maintenance backlog, along with reducing crew workload when the MSS is executing simple or repetitive tasks. GOT would be implemented in a phased approach, both in terms of the type of activity carried out and the point of control gradually passing from on-orbit crew to ground personnel. GOT offers reduced on-orbit crew workload, greater availability of the MSS during the postpermanently-manned-capability period, and the ability to significantly reduce or even eliminate any maintenance action backlog. GOT is compared with crew operation timelines. Critical factors such as safety, space-ground communications latency, simulation, operations planning, and design considerations are reviewed. P.D.

A93-29109
TELEPROGRAMMING A COOPERATIVE SPACE ROBOTIC WORKCELL FOR SPACE STATION
D. D. HAULE, S. M. NOORHOSSEINI, and A. S. MALOWANY (McGill Univ., Montreal, Canada) *In* Cooperative intelligent robotics in space III; Proceedings of the Meeting, Boston, MA, Nov. 16-18, 1992 Bellingham, WA Society of Photo-Optical

Instrumentation Engineers 1992 p. 102-116. refs
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Robotics and automation in remote hostile enviroments such as space (planet) exploration, for which working conditions - environment model and robot operating conditions - are unknown or very partially known, are studied. Several interrelated topics for Space Station automation using a teleprogrammable space robotic workcell (SRW) are discussed. The operation rationale for SRW is to free up crew time with the ultimate goal of making on-board crew involvement in SRW tasks optional, while solving the problem of 'automation of operator or supervisory control'. The key issues of task level teleprogramming as an attribute for operating and decisional autonomy vs the concepts of classical teleoperation and telerobotics are also addressed. P.D.

A93-29110
KNOWLEDGE-BASED TASK PLANNING FOR THE SPECIAL PURPOSE DEXTROUS MANIPULATOR
PATRICK FEIGHAN, ALDO DAGNINO, KEITH CHRYSTALL, and PIOTR WOJCIK (Alberta Research Council, Advanced Computing and Engineering Dept., Calgary, Canada) *In* Cooperative intelligent robotics in space III; Proceedings of the Meeting, Boston, MA, Nov. 16-18, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 117-127. Research supported by International Submarine Engineering, Ltd. and Thomson-CSF Systems Canada refs
Copyright

This paper presents the design of a knowledge-based task planning system for the Special Purpose Dextrous Manipulator (SPDM). The SPDM is a component of Canada's contribution to the International Space Station Project, the Mobile Servicing System (MSS), which will assist in assembling, servicing and maintaining the Space Station Freedom through the use of advanced robot systems. A general description of a supervisory control system for the SPDM is presented. The supervisory control system includes space based and ground control systems. Knowledge-based task planning is performed within the ground control system. The ground control system includes a world model, a task decomposition sub-system and an operator interface. The functionality and interconnections of these sub-systems are explained in detail in the paper. Author

A93-29111* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
DIMENSIONS OF COMPLEXITY IN LEARNING FROM INTERACTIVE INSTRUCTION
SCOTT B. HUFFMAN and JOHN E. LAIRD (Michigan Univ., Ann Arbor) *In* Cooperative intelligent robotics in space III; Proceedings of the Meeting, Boston, MA, Nov. 16-18, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 130-141. Research sponsored by Univ. of Michigan and U.S. Navy refs
(Contract NCC2-517)
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Robot systems deployed in space must exhibit flexibility. In particular, an intelligent robotic agent should not have to be reprogrammed for each of the various tasks it may face during the course of its lifetime. However, pre-programming knowledge for all of the possible tasks that may be needed is extremely difficult. Therefore, a powerful notion is that of an instructible agent, one which is able to receive task-level instructions and advice from a human advisor. An agent must do more than simply memorize the instructions it is given (this would amount to programming). Rather, after mapping instructions into task constructs that it can reason with, it must determine each instruction's proper scope of applicability. In this paper, we will examine the characteristics of instruction, and the characteristics of agents, that affect learning from instruction. We find that in addition to a myriad of linguistic concerns, both the situatedness of the instructions (their placement within the ongoing execution of tasks) and the prior domain knowledge of the agent have an impact on what can be learned. Author

A93-29112
AN OVERVIEW OF THE DYNAMIC PREDICTIVE ARCHITECTURE FOR ROBOTIC ASSISTANTS
CHARLES E. MARTIN and R. J. FIRBY (Chicago Univ., IL) *In* Cooperative intelligent robotics in space III; Proceedings of the Meeting, Boston, MA, Nov. 16-18, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 142-148. Research supported by DARPA refs
(Contract AF-AFOSR-91-0112; F30602-91-C-0028)
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An overview of the dynamic predictive memory architecture for robotic assistants for extravehicular activity in space is presented. This architecture is an extension of the direct memory access parsing model of language understanding, in which the data structures and algorithms associated with the reactive action package execution system are represented in the uniform memory format of the system. This allows natural language reference to take place coincident with the reactive execution of plans. The result is a reactive system which human users can interact with in natural language. The target robotic platform, low-level reactive plannng, an embedded low-level system, and the high-level agent are also discussed. P.D.

A93-29113* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
PERSON-LIKE INTELLIGENT SYSTEMS ARCHITECTURES FOR ROBOTIC SHARED CONTROL AND AUTOMATED OPERATIONS
JON D. ERICKSON (NASA, Johnson Space Center, Houston, TX), PASCHAL J. AUCOIN, JR. (Lockheed Engineering & Sciences Co., Houston, TX), and PETER G. OSSORIO (Ellery Systems, Inc., Boulder, CO) *In* Cooperative intelligent robotics in space III; Proceedings of the Meeting, Boston, MA, Nov. 16-18, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 149-160. refs
Copyright

An approach to rendering robotic systems as 'personlike' as possible to achieve needed capabilities is outlined. Human characteristics such as knowledge, motivation, know-how, performance, achievement and individual differences corresponding to propensities and abilities can be supplied, within limits, with computing software and hardware to robotic systems provided with sufficiently rich sensory configurations. Pushing these limits is the developmental path for more and more personlike robotic systems. The portions of the Person Concept that appear to be most directly relevant to this effort are described in the following topics: reality concepts (the state-of-affairs system and descriptive formats, behavior as intentional action, individual persons (person characteristics), social patterns of behavior (social practices), and boundary conditions (status maxims). Personlike robotic themes and considerations for a technical development plan are also discussed. P.D.

A93-29114* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
TELEROBOTIC SYSTEM PERFORMANCE MEASUREMENT - MOTIVATION AND METHODS
GEORGE V. KONDRASKE and GEORGE J. KHOURY (Texas Univ., Arlington) *In* Cooperative intelligent robotics in space III; Proceedings of the Meeting, Boston, MA, Nov. 16-18, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 161-172. Research supported by NASA and Texas Advanced Technology Grant Program refs
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A systems performance-based strategy for modeling and conducting experiments relevant to the design and performance characterization of telerobotic systems is described. A developmental testbed consisting of a distributed telerobotics network and initial efforts to implement the strategy described is presented. Consideration is given to the general systems performance theory (GSPT) to tackle human performance problems as a basis for: measurement of overall telerobotic system (TRS) performance; task decomposition; development of a generic TRS

model; and the characterization of performance of subsystems comprising the generic model. GSPT employs a resource construct to model performance and resource economic principles to govern the interface of systems to tasks. It provides a comprehensive modeling/measurement strategy applicable to complex systems including both human and artificial components. Application is presented within the framework of a distributed telerobotics network as a testbed. Insight into the design of test protocols which elicit application-independent data is described. P.D.

A93-29115* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
RECENT DEVELOPMENTS AT THE GODDARD ENGINEERING TEST BED
STEPHEN LEAKE (NASA, Goddard Space Flight Center, Greenbelt, MD) and EDWARD CHEUNG (Jackson & Tull, Greenbelt, MD) *In* Cooperative intelligent robotics in space III; Proceedings of the Meeting, Boston, MA, Nov. 16-18, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 174-183. refs
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Work on the Flight Telerobotic Service (FTS) since that reported in Leake (1991) is examined, and initial work on a Hubble servicing mission is outlined. A state-of-the-art force reflecting teleoperation system that uses torque control at the joints of the slave manipulator has been implemented. The master rate/slave damper mode proposed by Langley has proved to be a very efficient operational mode, allowing force reflection ratios up to one to one. A software architecture for real-time Ada robotics systems has been proposed, and implementation has been launched. This architecture builds on the lessons learned from NASA Standard Reference Model Architecture and the prototype FTS effort. The Capaciflector sensor has been integrated into the system, and it has been used to perform a basic berthing task autonomously. P.D.

A93-29116* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
THE SERVICING AID TOOL
JOHN L. PULLEN, WILLIAM O. KEKSZ, THOMAS J. MANSON (Fairchild Space Washington Technical Services Center, Greenbelt, MD), DAVID MARTIN, and RUSSEL WERNETH (NASA, Goddard Space Flight Center, Greenbelt, MD) *In* Cooperative intelligent robotics in space III; Proceedings of the Meeting, Boston, MA, Nov. 16-18, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 184-195.
Copyright

The Servicing Aid Tool (SAT) is a teleoperated manipulation system designed for use on the NSTS Orbiter. The system will assist EVA servicing of spacecraft such as the Hubble Space Telescope and Explorer platform. SAT components are spaceflight adaptations of existing ground-based designs from Robotics Research and Schilling Development. Fairchild Space is providing the control electronics, safety system, and flight integration. The manipulator consists of a 6-DOF Slave Arm mounted on a 1-DOF Positioning Link in the Payload Bay. The Slave Arm is controlled via a highly similar, 6-DOF, force-reflecting Master Arm. Each slave arm joint receives position commands from the corresponding master arm joint; torque commands are reflected to each master joint based on the current state of the slave joint and the master/slave relationship. Scaled and indexed control will be accommodated, as will various features to ensure safe operation. The paper will focus on the development of the safety system, and operations for the demonstration and servicing missions. Author

A93-29118 National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
HUMAN-LIKE AGENTS WITH POSTURE PLANNING ABILITY
MOON R. JUNG and NORMAN BADLER (Pennsylvania Univ., Philadelphia) *In* Cooperative intelligent robotics in space III; Proceedings of the Meeting, Boston, MA, Nov. 16-18, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 207-218. Research supported by Lockheed Engineering and Management Services, NASA, Moco, Inc., et al. refs
(Contract NSF CDA-88-22719; DAAL03-89-C-0031)
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Human body models are geometric structures which may be ultimately controlled by kinematically manipulating their joints, but for animation, it is desirable to control them in terms of task-level goals. We address a fundamental problem in achieving task-level postural goals: controlling massively redundant degrees of freedom. We reduce the degrees of freedom by introducing significant control points and vectors, e.g., pelvis forward vector, palm up vector, and torso up vector, etc. This reduced set of parameters are used to enumerate primitive motions and motion dependencies among them, and thus to select from a small set of alternative postures (e.g., bend vs. squat to lower shoulder height). A plan for a given goal is found by incrementally constructing a goal/constraint set based on the given goal, motion dependencies, collision avoidance requirements, and discovered failures. Global postures satisfying a given goal/constraint set are determined with the help of incremental mental simulation which uses a robust inverse kinematics algorithm. The contributions of the present work are: (1) There is no need to specify beforehand the final goal configuration, which is unrealistic for the human body, and (2) the degrees of freedom problem becomes easier by representing body configurations in terms of 'lumped' control parameters, that is, control points and vectors. Author

A93-29121* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
SAFETY ISSUES OF MANIPULATOR SYSTEMS UNDER COMPUTER CONTROL
JAMES F. ANDARY, RUTH C. CARTER, KAREN HALTERMAN, PETER D. SPIDALIERE, MICHAEL TASEVOLI (NASA, Goddard Space Flight Center, Greenbelt, MD), and ADRIAN L. RAD (Hernandez Engineering, Inc., Greenbelt, MD) *In* Cooperative intelligent robotics in space III; Proceedings of the Meeting, Boston, MA, Nov. 16-18, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 242-250. refs
Copyright

An overview of the development test flight (DTF-1) mission is presented, and the system design, safety requirements, and safety features are described. The lessons that were learned during the design and early development stages are also presented. The DTF-1 mission objectives are to evaluate: the overall man-machine performance in zero G, Flight Telerobotic Service manipulator design, and workstation design, including handcontrollers and displays. The payload bay and aft flight deck elements, and computer control of the DTF-1 are described. Recommendations for developing and implementing a safety system are presented, and some design alternatives for the next space-qualified telerobotic system are suggested. P.D.

A93-29132 National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
A DISTRIBUTED TELEROBOTICS SYSTEM FOR SPACE OPERATIONS
JAMES D. WISE, LAWRENCE A. CISCON (Rice Univ., Houston, TX), and SEAN GRAVES (Texas A & M Univ., College Station) *In* Cooperative intelligent robotics in space III; Proceedings of the Meeting, Boston, MA, Nov. 16-18, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 359-370. Research supported by Texas Advanced Technology Program and Mitre Corp. refs
(Contract NAG9-461; NCC2-517; NGT-50379)
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Robotic systems for space operations will require a combination of teleoperation, closely supervised autonomy, and loosely supervised autonomy. They may involve multiple robots, multiple controlling sites, and long communication delays. We have constructed a distributed telerobotics system as a framework for studying these problems. Our system is based on a modular interconnection scheme which allows the components of either

manual or autonomous control systems to communicate and share information. It uses a wide area network to connect robots and operators at several different sites. This presentation will describe the structure of our system, the components used in our configurations, and results of some of our teleoperation experiments. Author

A93-29135* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
TESTBED FOR REMOTE TELEPRESENCE RESEARCH
SARMAD ADNAN and JOHN B. CHEATHAM (Rice Univ., Houston, TX) *In* Cooperative intelligent robotics in space III; Proceedings of the Meeting, Boston, MA, Nov. 16-18, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 393-400. refs
(Contract NAG9-372; NAG9-443)
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The paper describes the design and implementation of a telepresence system, as well as its control hardware and software. The mobile omnidirectional robot has three independent degrees of freedom that permit independent control of translation and rotation, thereby simulating a free-flying robot in a plane. The kinematically redundant robot arm has eight degrees of freedom that assist in obstacle and singularity avoidance. The on-board control computers permit control of the robot from the dual hand controllers via a radio modem system. A head-mounted display system provides the user with a stereo view from a pair of cameras attached to the mobile robotics system. The head tracking camera system moves stereo cameras mounted on a three-DOF platform to coordinate with the operator's head movements. This telepresence system provides a framework for research in remote telepresence, and teleoperations for space. P.D.

A93-29136
INTELLIGENT VIRTUAL INTERFACES FOR TELEROBOTICS
GEORGES G. GRINSTEIN, MARK T. MAYBURY, and RICHARD B. MITCHELL (Mitre Corp., Bedford, MA) *In* Cooperative intelligent robotics in space III; Proceedings of the Meeting, Boston, MA, Nov. 16-18, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 401-408. refs
Copyright

Research in two key areas of intelligent interfaces to support teleoperation - intelligent virtual interfaces and plan-based communication - is described. The former promises a visual, auditory, and tactile experience, and the latter promises more natural and effective communications. Ways in which these capabilities might fit into a virtual reality interface for teleoperation are shown. A device integrator couples physical (e.g., dataglobe and eye-tracker) and linguistic input, which is then interpreted by a plan recognizer which would interpret both the communicative action as well as physical action intended by the operator. Once an action was performed by the remote physical or simulated (for training) robot, the results would be communicated to the user via a variety of modes, including visual, auditory, and tactile. These components need to be integrated and then evaluated. P.D.

A93-29137* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
AN EXPERIMENT IN VISION BASED AUTONOMOUS GRASPING WITHIN A REDUCED GRAVITY ENVIRONMENT
K. A. GRIMM, J. D. ERICKSON (NASA, Johnson Space Center, Houston, TX), G. ANDERSON, C. H. CHIEN, L. HEWGILL, M. LITTLEFIELD, and R. NORSWORTHY (Lockheed Engineering & Sciences Co., Houston, TX) *In* Cooperative intelligent robotics in space III; Proceedings of the Meeting, Boston, MA, Nov. 16-18, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 410-420. refs
Copyright

The National Aeronautics and Space Administration's Reduced Gravity Program (RGP) offers opportunities for experimentation in gravities of less than one-g. The Extravehicular Activity Helper/Retriever (EVAHR) robot project of the Automation and Robotics Division at the Lyndon B. Johnson Space Center in Houston, Texas, is undertaking a task that will culminate in a series of tests in simulated zero-g using this facility. A subset of the final robot hardware consisting of a three-dimensional laser mapper, a Robotics Research 807 arm, a Jameson JH-5 hand, and the appropriate interconnect hardware/software will be used. This equipment will be flown on the RGP's KC-135 aircraft. This aircraft will fly a series of parabolas creating the effect of zero-g. During the periods of zero-g, a number of objects will be released in front of the fixed base robot hardware in both static and dynamic configurations. The system will then inspect the object, determine the objects pose, plan a grasp strategy, and execute the grasp. This must all be accomplished in the approximately 27 seconds of zero-g. Author

A93-29141
ROBOT FREE-FLYERS IN SPACE EXTRAVEHICULAR ACTIVITY
HARALD WEIGL and HAROLD L. ALEXANDER (MIT, Cambridge, MA) *In* Cooperative intelligent robotics in space III; Proceedings of the Meeting, Boston, MA, Nov. 16-18, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 458-469. refs
Copyright

Attention is given to the development of a remote robot with maneuverability and dexterity comparable to that of a space-suited astronaut with a manned maneuvering unit capable of handling many of the tasks currently planned for astronauts during EVA. A real-time vision-based navigation and control system for an underwater space robot simulator, the Submersible for Telerobotic and Astronautical Research (STAR) is examined. The system, implemented with standard, inexpensive computer hardware, exhibits excellent performance and robustness characteristics for a variety of applications, including automatic station-keeping and large controlled maneuvers. Experimental results are presented which indicate the precision, accuracy, and robustness to disturbances of the vision-based control system. The study proves the feasibility of using vision-based control and navigation for remote robots and provides a foundation for developing a system for general space robot tasks. P.D.

A93-29696
ESTIMATION OF THE NUMBER OF OPERATORS AND THEIR EFFICIENCY IN FLIGHT VEHICLE CONTROL [OTSENKA KOLICHESTVA I EFFEKTIVNOSTI DEIATEL'NOSTI OPERATOROV PRI UPRAVLENII LA]
G. M. ANTONOVA *In* Algorithms and automated techniques for the design of control systems for moving objects Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 40-49. In Russian. refs
Copyright

A simulation model is proposed which makes it possible to estimate the number of operators required for the processing of information in the form of a series of problems with specified discrete initial times of execution. Two methods for evaluating the efficiency of operators are examined whereby the operator efficiency is characterized by the individual rate of execution of a certain type of tasks and by the scatter of this characteristic. The model proposed here makes it possible to characterize the operator performance for various kinds of tasks. V.L.

N93-21113# York Univ. (Ontario). Inst. for Space and Terrestrial Science.
AIMED ARM MOVEMENTS UNDER CHANGED GRAVITY
Abstract Only
O. BOCK, I. HOWARD, K. MONEY, and K. ARNOLD *In* Canadian Space Agency, Spacebound 1991 p 228 1991
Avail: Canadian Space Agency, P.O. Box 7275, Ottawa, ON, Canada K1L 8E3 HC

The accuracy of aimed arm movements under normal gravity and during the hyper- and micro-gravity episodes of KC-135 parabolic flight were analyzed. Five human subjects pointed at the reflected images of visual targets in a frontal plane 33 cm ahead, while vision of their arm was prevented. The final position

of the pointing finger was recorded on impact with a digitizing pad. Compared with the normal gravity baseline, subjects pointed about 44 mm higher in microgravity and about 25 mm higher in hypergravity. The results were the same if subjects viewed the targets only during the normal gravity episode and pointed at the memorized target position during the changed gravity episode. This result implies that pointing performance under changed gravity is not due to visual mislocalization but rather to problems of motor control. The microgravity results are explained by assuming that the movements are preprogrammed and that programs appropriate on earth will yield upward deviations in microgravity. In hypergravity, it is postulated that the motor system reinterprets increased gravity as an additional weight acting on the arm under normal gravity. The resultant muscle forces will compensate properly for the increased gravity but overcompensate the arm's inertia.
Author (CISTI)

N93-21161# Technical Research Centre of Finland, Espoo. Fire Technology Lab.
CORRELATION OF RESULTS OF RADIANT HEAT TEST AND CONVECTIVE HEAT TEST FOR THREE LAYERED PROTECTIVE CLOTHING
BRITA-LISA IRJALA, DJEBAR BAROUDI, and TANJA RISIKKO *In its* Textiles and Composites 1992 p 297-302 1992
Copyright Avail: CASI HC A02/MF A03

Research concerning the heat and flame protection of 120 three layered assemblies is reported. Three flame resistant fabrics were used as the upper layer, four materials were used as the inner layer, and the underclothing consisted of ten knitted mens underwear fabrics. The correlations between results of the radiant heat test in accordance with prEN 366 and convective heat tests in accordance with prEN 367 were calculated based on the fact that both methods are determining protection time units. The evaluation with a calculating program gave the equations S(sub 1) = a + bS(sub 2) for the correlations. The results show that there is a strong correlation between the results of the methods measuring the protection against radiant heat with 20 kW/sq m and convective heat assemblies where the uppermost layer is a non-melting fabric. ESA

N93-21215# Research Triangle Inst., Research Triangle Park, NC.
SURVEY OF PROTOCOLS FOR CONDUCTING INDOOR AIR QUALITY INVESTIGATIONS IN LARGE BUILDINGS
ROY C. FORTMANN Jun. 1992 25 p Presented at the ASHRAE IAQ 1992 Conference on Environment for People, San Francisco, CA, 18-21 Oct. 1992; sponsored by EPA
(Contract EPA-68-02-4544)
(PB93-119865; EPA/600/A-92/226) Avail: CASI HC A03/MF A01

Numerous investigations are conducted in large buildings each year to evaluate health and comfort complaints that building occupants perceive to be related to poor indoor air quality. Some guidelines have been developed for conducting indoor air quality investigations, but standardized building diagnostics protocols have not been developed. The purpose of the work was to compile information that might be used to develop standardized protocols. A computerized literature search and a mail-out survey were conducted. A number of reports describing indoor air quality investigation guidelines and protocols were identified. The recently-published EPA/NIOSH Building Air Quality document contained the most comprehensive guidance. A survey of other documents identified many common elements, particularly for the collection of information during the initial walk-through investigation phases. GRA

N93-21269# Army Natick Research and Development Command, MA.
EVALUATION OF TWO MICROCLIMATE COOLING AIR VESTS ON A HEATED MANNEQUIN Final Report, Jun. - Aug. 1992
ROGER MASADI and BRAD LAPRISE Dec. 1992 17 p
(AD-A259410; NATICK/TR-93/009) Avail: CASI HC A03/MF A01

This study compared the newly developed Microclimate Cooling Air Vest (MCAV) to the Combat Vehicle Crewman (CVC) Air Vest on a heated mannequin using a sweating skin. At flow rates of 12 and 15 cubic feet per minute, both vests were found to remove an equivalent amount of heat. In addition, the effect of each vest's resistance to air flow (pressure drop) is noted. GRA

N93-21370*# National Aeronautics and Space Administration, Washington, DC.
SPACE HUMAN FACTORS DISCIPLINE SCIENCE PLAN
1991 18 p
(NASA-TM-108023; NAS 1.15:108023) Avail: CASI HC A03/MF A01

The purpose of this Discipline Science Plan is to provide a conceptual strategy for NASA's Life Sciences Division research and development activities in the comprehensive areas of behavior, performance, and human factors. This document summarizes the current status of the program, outlines available knowledge, establishes goals and objectives, defines critical questions in the subdiscipline areas, and identifies technological priorities. It covers the significant research areas critical to NASA's programmatic requirements for the Extended Duration Orbiter, Space Station Freedom, and Exploration mission science activities. These science activities include ground-based and flight; basic, applied and operational; and animal and human research and development. This document contains a general plan that will be used by both NASA Headquarters program offices and the field centers to review and plan basic, applied, and operational research and development activities, both intramural and extramural, in this area. Author

N93-21436*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
OPERATOR-ASSISTED PLANNING AND EXECUTION OF PROXIMITY OPERATIONS SUBJECT TO OPERATIONAL CONSTRAINTS Abstract Only
ARTHUR J. GRUNWALD and STEPHEN R. ELLIS *In* NASA, Washington, NASA Automated Rendezvous and Capture Review. Executive Summary p 28 1991
Avail: CASI HC A01/MF A01

Future multi-vehicle operations will involve multiple scenarios that will require a planning tool for the rapid, interactive creation of fuel-efficient trajectories. The planning process must deal with higher-order, non-linear processes involving dynamics that are often counter-intuitive. The optimization of resulting trajectories can be difficult to envision. An interaction proximity operations planning system is being developed to provide the operator with easily interpreted visual feedback of trajectories and constraints. This system is hosted on an IRIS 4D graphics platform and utilizes the Clohessy-Wiltshire equations. An inverse dynamics algorithm is used to remove non-linearities while the trajectory maneuvers are decoupled and separated in a geometric spreadsheet. The operator has direct control of the position and time of trajectory waypoints to achieve the desired end conditions. Graphics provide the operator with visualization of satisfying operational constraints such as structural clearance, plume impingement, approach velocity limits, and arrival or departure corridors. Primer vector theory is combined with graphical presentation to improve operator understanding of suggested automated system solutions and to allow the operator to review, edit, or provide corrective action to the trajectory plan. Author

N93-21537# National Highway Traffic Safety Administration, East Liberty, OH. Vehicle Research and Test Center.
UPPER INTERIOR HEAD PROTECTION. VOLUME 1. THE DEVELOPMENT OF A RESEARCH TEST PROCEDURE Final Report
DONALD T. WILLKE Nov. 1991 83 p
(PB93-113769; DOT-HS-807-865; VRTC-89-0140-VOL-1) Avail: CASI HC A05/MF A01

About 4000 fatalities and 9300 serious injuries result each year from occupants' heads striking various upper interior structures. The magnitude of the problem has prompted both the Government and industry to address the issue of reducing head

injuries due to contact with these structures. Over the last several years, the Research and Development arm of the National Highway Traffic Safety Administration has conducted extensive research on the subject. The report, which is divided into two volumes, contains the results and findings from much of the work. A research test procedure for use in evaluating the potential for head injury due to impacts with vehicle upper interior structures is presented in Volume 1. This includes a discussion of the selection of a free-motion headform, as well as the results and analysis of testing done in the development of the component test procedure. Presented in Volume 2 are the results of tests conducted to estimate the potential for head injury in the current U.S. passenger vehicle fleet. The results of tests to evaluate the effectiveness of padding as a countermeasure are also included. All these tests were conducted following the research test procedure described in Volume 1. GRA

N93-21753# Vector Research, Inc., Arlington, VA.
REQUIREMENTS FOR AN AUTOMATED HUMAN FACTORS, MANPOWER, PERSONNEL, AND TRAINING (HMPT) PLANNING TOOL Final Report, 1 Aug. 1991 - 31 Jan. 1992
SUSAN M. EVANS and NICOLE A. RITCHIE May 1992 85 p
(Contract F33657-91-C-2211)
(AD-A258531; VRI-AFHEL-1-FR-92-1; ASD-TR-92-5010) Avail: CASI HC A05/MF A01

This Phase 1 Small Business Innovative Research (SBIR) project investigated the impact of system design decisions on human operator performance during concept development. The research established the functional and information requirements for an effective automated design analysis and crew performance assessment methodology for use in Premilestone 1 planning. The information structure included process, task, dynamic crew performance, operator graphic and human factors parameters, and training requirements. Existing automated tools such as the IDEF sub 0 structured analysis methodology, the SAINT task network simulation model and various operator graphic and human factors models were evaluated, along with other proven methodologies such as IDEAL and the Air Force's Instructional Systems Development (ISD) process. Insights from designers and other potential users identified special functional, information, and hardware requirements which were included in the methodology. The requirements will direct the implementation of an automated Human Factors, Manpower, Personnel, and Training System in Phase 2. The resulting system will make a significant contribution to the complex problems of considering HMPT issues early in system planning. It has potential application by elements in DoD program offices and organizations, and would also be of use in the private sector by those who are involved with the early concept phases in the design of complex human-operated systems.... Manpower, Personnel and training, Human performance, Process modeling, IDEF, Simulation modeling, Concept exploration, System planning. GRA

N93-21795# National Highway Traffic Safety Administration, East Liberty, OH. Vehicle Research and Test Center.
UPPER INTERIOR HEAD PROTECTION. VOLUME 2: FLEET CHARACTERIZATION AND COUNTERMEASURE EVALUATION Final Report
DONALD T. WILLKE Nov. 1991 50 p
(PB93-113777; DOT/HS-807-866; VRTC-89-0140-VOL-2) Avail: CASI HC A03/MF A01

About 4000 fatalities and 9300 serious injuries result each year from occupants' heads striking various upper interior structures. The magnitude of the problem has prompted both the Government and industry to address the issue of reducing head injuries due to contact with these structures. Over the last several years, the Research and Development arm of the National Highway Traffic Safety Administration has conducted extensive research on the subject. The report, which is divided into two volumes, contains the results and findings from much of the work. A research test procedure for use in evaluating the potential for head injury due to impacts with vehicle upper interior structures is presented in Volume 1. This includes a discussion of the selection of a free-motion headform, as well as the results and analysis of testing done in the development of the component test procedure. Presented in Volume 2 are the results of tests conducted to estimate the potential for head injury in the current U.S. passenger vehicle fleet. The results of tests to evaluate the effectiveness of padding as a countermeasure are also included. All these tests were conducted following the research test procedure described in Volume 1. GRA

N93-22002*# McDonnell-Douglas Space Systems Co., Huntsville, AL.
SPACE STATION ECLSS INTEGRATION ANALYSIS Final Report
Jan. 1993 14 p
(Contract NAS8-36407)
(NASA-CR-192470; NAS 1.26:192470; MDC-93W5044) Avail: CASI HC A03/MF A01

The Space Station Environmental Control and Life Support System (ECLSS) contract with NASA MSFC covered the time frame from 9 May 1985 to 31 Dec. 1992. The contract roughly covered the period of Space Station Freedom (SSF) development from early Phase B through Phase C/D Critical Design Review (CDR). During this time, McDonnell Douglas Aerospace-Huntsville (formerly McDonnell Douglas Space Systems Company) performed an analytical support role to MSFC for the development of analytical math models and engineering trade studies related to the design of the ECLSS for the SSF. Author (revised)

N93-22167*# Jasper (Louis J., Jr), Fulton, MD.
VARIABLE-VOLUME FLUSHING (V-VF) DEVICE FOR WATER CONSERVATION IN TOILETS
LOUIS J. JASPER, JR. *In* NASA, Washington, Technology 2002: The Third National Technology Transfer Conference and Exposition, Volume 2 p 175-179 Feb. 1993
Avail: CASI HC A01/MF A04

Thirty five percent of residential indoor water used is flushed down the toilet. Five out of six flushes are for liquid waste only, which requires only a fraction of the water needed for solid waste. Designers of current low-flush toilets (3.5-gal. flush) and ultra-low-flush toilets (1.5-gal. flush) did not consider the vastly reduced amount of water needed to flush liquid waste versus solid waste. Consequently, these toilets are less practical than desired and can be improved upon for water conservation. This paper describes a variable-volume flushing (V-VF) device that is more reliable than the currently used flushing devices (it will not leak), is simple, more economical, and more water conserving (allowing one to choose the amount of water to use for flushing solid and liquid waste). Author

N93-22190*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
DESIGN OF A PORTABLE POWERED SEAT LIFT
BRUCE WEDDENDORF *In* NASA, Washington, Technology 2002: The Third National Technology Transfer Conference and Exposition, Volume 2 p 390-396 Feb. 1993
Avail: CASI HC A02/MF A04

People suffering from degenerative hip or knee joints find sitting and rising from a seated position very difficult. These people can rely on large stationary chairs at home, but must ask others for assistance when rising from any other chair. An orthopedic surgeon identified to the MSFC Technology Utilization Office the need for development of a portable device that could perform a similar function to the stationary lift chairs. The MSFC Structural Development Branch answered the Technology Utilization Office's request for design of a portable powered seat lift. The device is a seat cushion that opens under power, lifting the user to near-standing positions. The largest challenge was developing a mechanism to provide a stable lift over the large range of motion needed, and fold flat enough to be comfortable to sit on. CAD 3-D modeling was used to generate complete drawings for the prototype, and a full-scale working model of the Seat lift was made based on the drawings. The working model is of low strength,

but proves the function of the mechanism and the concept.
Author

N93-22191*# General Engineering and Systems Analysis Co., Inc., Kearneysville, WV.
MICROCOMPUTER BASED SOFTWARE FOR BIODYNAMIC SIMULATION
N. RANGARAJAN and T. SHAMS *In* NASA, Washington, Technology 2002: The Third National Technology Transfer Conference and Exposition, Volume 2 p 397-405 Feb. 1993
Avail: CASI HC A02/MF A04

This paper presents a description of a microcomputer based software package, called DYNAMAN, which has been developed to allow an analyst to simulate the dynamics of a system consisting of a number of mass segments linked by joints. One primary application is in predicting the motion of a human occupant in a vehicle under the influence of a variety of external forces, specially those generated during a crash event. Extensive use of a graphical user interface has been made to aid the user in setting up the input data for the simulation and in viewing the results from the simulation. Among its many applications, it has been successfully used in the prototype design of a moving seat that aids in occupant protection during a crash, by aircraft designers in evaluating occupant injury in airplane crashes, and by users in accident reconstruction for reconstructing the motion of the occupant and correlating the impacts with observed injuries. Author

N93-22195*# Naval Command, Control and Ocean Surveillance Center, San Diego, CA. Research, Development, Test and Evaluation Div.
OPERATOR PERFORMANCE SUPPORT SYSTEM (OPSS)
MARLEN Z. CONKLIN (Nova Univ., Dania, FL.) *In* NASA, Washington, Technology 2002: The Third National Technology Transfer Conference and Exposition, Volume 2 p 439-444 Feb. 1993
Avail: CASI HC A02/MF A04

In the complex and fast reaction world of military operations, present technologies, combined with tactical situations, have flooded the operator with assorted information that he is expected to process instantly. As technologies progress, this flow of data and information have both guided and overwhelmed the operator. However, the technologies that have confounded many operators today can be used to assist him -- thus the Operator Performance Support Team. In this paper we propose an operator support station that incorporates the elements of Video and Image Databases, productivity Software, Interactive Computer Based Training, Hypertext/Hypermedia Databases, Expert Programs, and Human Factors Engineering. The Operator Performance Support System will provide the operator with an integrating on-line information/knowledge system that will guide expert or novice to correct systems operations. Although the OPSS is being developed for the Navy, the performance of the workforce in today's competitive industry is of major concern. The concepts presented in this paper which address ASW systems software design issues are also directly applicable to industry. the OPSS will propose practical applications in how to more closely align the relationships between technical knowledge and equipment operator performance. Author

N93-22268*# Department of the Air Force, Kirtland AFB, NM.
TALON AND CRADLE: SYSTEMS FOR THE RESCUE OF TUMBLING SPACECRAFT AND ASTRONAUTS Abstract Only
DUNNING IDLE, V *In* NASA, Washington, NASA Automated Rendezvous and Capture Review. A Compilation of the Abstracts 1 p 1991
Avail: CASI HC A01/MF A03

Advanced pressure suit and tool designs are beginning to allow extravehicular astronauts to repair space vehicles and so increase mission life and system reliability. A common spacecraft failure that is a severe challenge to the rescue mission planner is loss of attitude control resulting in tumbling motion. If an extravehicular astronaut flying the Manned Maneuvering Unit (MMU) 'falls' into a tumble, the result could be loss of life. TALON (Tumble Arresting Large Oscillation Nullifier) is a device capable of capturing a target in an uncontrolled three-axis tumble. CRADLE (Concentric Rotating Astronaut Detumble Lifesaving Equipment) is a similar device sized to rescue a suited astronaut. The two rescue vehicles work on the same basic principle. They are structural shells with articulated limbs which can surround a tumbling target and thus align both the chaser and target centers of mass (CM). Author (revised)

N93-22389# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany). UB Flugzeuge, Cockpitsysteme und Ergonomie.
USER AREAS IN AIRCRAFT COCKPIT, USING METHODS OF RAPID PROTOTYPE DEVELOPMENT [BENUTZEROBERFLAECHEN IM FLUGZEUGCOCKPIT MIT METHODEN DER SCHNELLEN PROTOTYPENENTWICKLUNG]
ALEXANDER RUMPF and BURKHARD BALSER Sep. 1990 13 p In GERMAN Presented at 33rd DGLR Fachausschusssitzung, Hamburg, Germany, 25-26 Sep. 1990 Submitted for publication
(MBB-FE-315-S-PUB-0493; ETN-93-93435) Avail: CASI HC A03/MF A01

A study which shows that System Prototyping Rig (SPR) is a development implement which meets perfectly with the present requirements of a modern system implement is presented. SPR allows compliance with the most important tasks in the development phases of the new system. The application of such an implement leads to a minimization of development risks, used time, and costs. The software package Virtual Avionics Prototyping System (VAPS) is described as a tool for the generation of virtual, interactive man machine interface. A permanent further development and a continuous adaptation of new technologies are necessary to obtain the efficiency of the tool. ESA

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SPACE BIOLOGY

Includes exobiology; planetary biology; and extraterrestrial life.

A93-27561
THERMAL EVOLUTION OF COMETARY NUCLEI BY RADIOACTIVE HEATING AND POSSIBLE FORMATION OF ORGANIC CHEMICALS
S. YABUSHITA (Kyoto Univ., Japan) Royal Astronomical Society, Monthly Notices (ISSN 0035-8711) vol. 260, no. 4 Feb. 15, 1993 p. 819-825. refs
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Thermal evolution of large cometary nuclei (radii are not less than 40 km) due to heating by decay of U-238, U-235, K-40, and Th-232 is investigated by adopting chemical models based on observations of P/Halley and mineral compositions of C1 chondrites. If the thermal diffusivity of crystallized ice is sufficiently small (not greater than 0.0015 cm/s), the central temperature may reach the melting point of H2O in large nuclei (radii = 200 km), while if the diffusivity is 0.003 or greater, the central temperature will not reach the melting point. The high temperature attained within cometary nuclei allows molecules such as HCN and NH3 to form various organic compounds such as amino acids through oligomerization, and such compounds might be delivered to the earth through disintegrations of the large nuclei, which subsequently impact the earth. The extraterrestrial amino acids found in the K/T boundary layer and in the dust of P/Halley might have been processed in cometary interiors. Author

A93-27887* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
THE POSSIBILITY OF LIFE ON MARS DURING A WATER-RICH PAST
C. P. MCKAY, R. L. MANCINELLI, C. R. STOKER (NASA, Ames Research Center, Moffett Field, CA), and R. A. WHARTON, JR.

(Nevada Univ., Reno) *In* Mars Tucson, AZ University of Arizona Press 1992 p. 1234-1245.
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Geomorphological evidence for past liquid water on Mars implies an early, warmer, epoch. In this review we compare this early warm environment to the first Gyr of Earth's history, the time within which we know life originated. We consider the key question about early Mars from the biological standpoint. How long was liquid water present? The range of answers encompasses the time interval for the origin of life on Earth. We use studies of early life on Earth as a guide, albeit a limited one, to the possible forms of evidence for past life on Mars. Presumptive evidence for microbial life on early Earth are stromatolites, layered deposits produced by microorganisms binding and trapping sediment. A search for fossils might be fruitful at sites on Mars that contained standing bodies of water over long periods of time. The ice-covered lakes of the dry valleys of Antarctica may provide analogs to the ultimate lakes on Mars as the surface pressure fell with a concomitant decrease in surface temperatures. Author

A93-28376 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
HABITABLE ZONES AROUND MAIN SEQUENCE STARS
JAMES F. KASTING (Pennsylvania State Univ., University Park), DANIEL P. WHITMIRE (Southwestern Louisiana Univ., Lafayette, LA), and RAY T. REYNOLDS (NASA, Ames Research Center, Moffett Field, CA) Icarus (ISSN 0019-1035) vol. 101, no. 1 Jan. 1993 p. 108-128. Research supported by Louisiana Educational Quality Support Fund refs
(Contract NAGW-1911)
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A mechanism for stabilizing climate on the earth and other earthlike planets is described, and the physical processes that define the inner and outer boundaries of the habitable zone (HZ) around the sun and main sequence stars are discussed. Physical constraints on the HZ obtained from Venus and Mars are taken into account. A 1D climate model is used to estimate the width of the HZ and the continuously habitable zone around the sun, and the analysis is extended to other main sequence stars. Whether other stars have planets and where such planets might be located with respect to the HZ is addressed. The implications of the findings for NASA's SETI project are considered. C.D.

A93-28377 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
PRESERVATION OF BIOLOGICAL INFORMATION IN THERMAL SPRING DEPOSITS - DEVELOPING A STRATEGY FOR THE SEARCH FOR FOSSIL LIFE ON MARS
M. R. WALTER (Macquarie Univ., North Ryde, Australia) and DAVID J. DES MARAIS (NASA, Ames Research Center, Moffett Field, CA) Icarus (ISSN 0019-1035) vol. 101, no. 1 Jan. 1993 p. 129-143. Research supported by NASA refs
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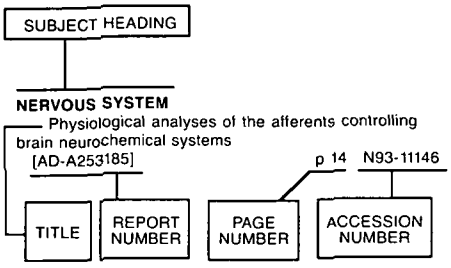
Paleobiological experience on earth is used here to develop a search strategy for fossil life on Mars. In particular, the exploration of thermal spring deposits is proposed as a way to maximize the chance of finding fossil life on Mars. As a basis for this suggestion, the characteristics of thermal springs are discussed in some detail. C.D.

Typical Subject Index Listing



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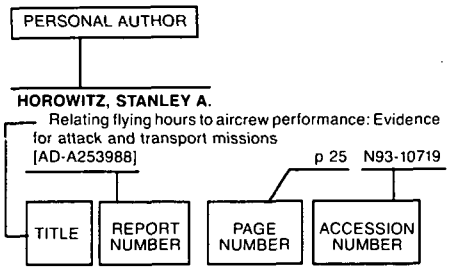

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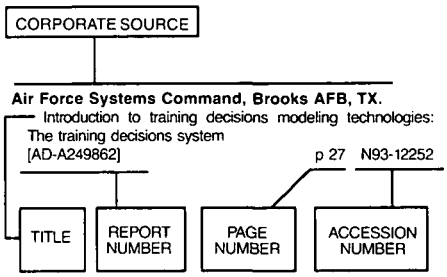

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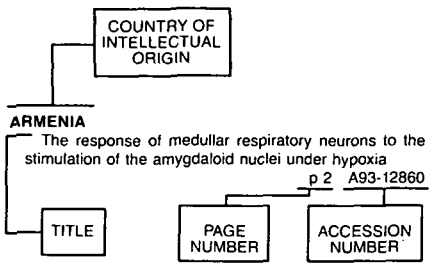

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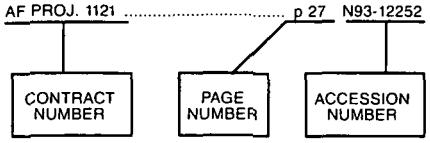

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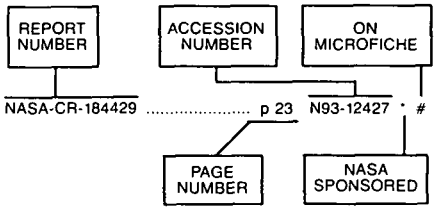

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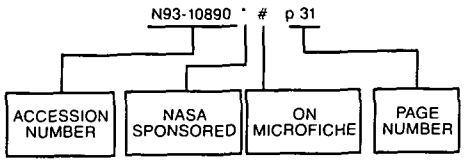

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ILLINOIS STATE LIBRARY
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INDIANA

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Govt. Documents & Map Library
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UNIV. OF MARYLAND
Hornbake Library
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UNIV. OF MINNESOTA
Wilson Library
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106 Old Gym Bldg.
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Reno, NV 89557
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NEW MEXICO STATE LIBRARY
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Santa Fe, NM 87503
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NEW YORK

NEW YORK STATE LIBRARY
Documents/Gift & Exchange Section
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Cultural Education Center
Albany, NY 12230
(518) 474-5563 FAX: (518) 474-5786

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UNIV. OF NORTH CAROLINA - CHAPEL HILL
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FAX: (405) 525-7804

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Edmon Low Library
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Millar Library
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Portland, OR 97207
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Cooper Library
Public Documents Unit
Clemson, SC 29634-3001
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In cooperation with Univ. of South Carolina, Thomas Cooper Library, Columbia

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(901) 678-2586 FAX: (901) 678-2511

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TEXAS STATE LIBRARY
United States Documents
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Austin, TX 78711
(512) 463-5455 FAX: (512) 463-5436

TEXAS TECH. UNIV. LIBRARY
Documents Dept.
Lubbock, TX 79409
(806) 742-2268 FAX: (806) 742-1920

UTAH

UTAH STATE UNIV.
Merrill Library & Learning Resources Center, UMC-3000
Documents Dept.
Logan, UT 84322-3000
(801) 750-2684 FAX: (801) 750-2677

VIRGINIA

UNIV. OF VIRGINIA
Alderman Library
Govt. Documents
Charlottesville, VA 22903-2498
(804) 924-3133 FAX: (804) 924-4337

WASHINGTON

WASHINGTON STATE LIBRARY
Document Section
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Olympia, WA 98504-0111
(206) 753-4027 FAX: (206) 753-3546

WEST VIRGINIA

WEST VIRGINIA UNIV. LIBRARY
Govt. Documents Section
P.O. Box 6069
Morgantown, WV 26506
(304) 293-3640

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