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Professor Jahn is Dean Emeritus of the School of Engineering and Applied Science. He is a Fellow of the American Physical Society and of the American Institute of Aeronautics and Astronautics, and has been chairman of the AIAA Electric Propulsion Technical Committee, associate editor of the AIAA Journal, and a member of the NASA Space Science and Technology Advisory Committee. He is vice President of the Society for Scientific Exploration and Chairman of the Board of the International Consciousness Research Laboratories consortium. He has been a long-term member of the Board of Directors of Hercules, Inc. and chairman of its Technology Committee, and a member and chairman of the Board of Trustees of Associated Universities, Inc. He has received the Curtis W. McGraw Research Award of the American Society of Engineering Education and an honorary Doctor of Science degree from Andhra University.



Research Projects

Electric Propulsion and Plasma Dynamics

Investigators: R.G. Jahn and E.Y. Choueiri

Support: National Aeronautics and Space Administration, U. S. Air Force

High-power electrical discharges are used to accelerate a variety of working fluids to very high velocities. These intense discharges and the plasma streams they produce are configured into several types of magnetoplasmadynamic thrusters which offer a desirable combination of high specific impulse and high thrust density for advanced space propulsion applications. The research emphasis is on the physical processes by which the electrical input is converted to useful thrust, and on those which limit the operational lifetime of such thrusters. Most of the studies are conducted in the Electric Propulsion and Plasma Dynamics Laboratory, which features a number of space-simulating vacuum facilities, a variety of specialized diagnostic devices, and sophisticated computational equipment.

Publications

Plasma Propulsion

Physics of Electric Propulsion. McGraw-Hill Series in Missile and Space Technology, New York: McGraw-Hill Book Company (1968).

(with E.Y. Choueiri)

“Electric Propulsion.” In Encyclopedia of Physical Science and Technology, 3rd Edition. R.A. Myers, ed. San Diego: Academic Press, Vol. 5, pp. 125–141 (2002).

Engineering Anomalies Research

Investigators: R.G. Jahn and B.J. Dunne

Support: Several philanthropic organizations and individuals

The interaction of human operators with sensitive information processing devices and systems is studied by combining appropriate engineering facilities and techniques with a selection of protocols and insights drawn from modern cognitive science. In this work, premium is placed on extraordinarily precise yet robust instrumentation, tight environmental and quality control, multiply redundant on-line data collection and processing, rapid accumulation of large data bases, and sensitive analytical measures to facilitate extraction of small systematic trends from high levels of background noise, while rejecting spurious artifacts. Under these rigorous conditions, certain aspects of these human/machine interactions are found to yield anomalous effects currently inexplicable on the basis of established physical concepts and statistical theory.

Over its 25-year history, the program has produced immense databases generated under highly controlled laboratory conditions, indicating the existence of small but replicable and statistically significant correlations between operator intention and the output characteristics of a variety of random digital and analogue processors. Current experiments involve several microelectronic, mechanical, fluid dynamical, acoustical, and optical devices, and a complementary program of remote perception research, from which a number of technical, psychological, and environmental correlates have been identified. Complementary analytical studies and theoretical models have been developed to facilitate the extraction of the most salient correlations from the empirical data, and to help explicate the basic phenomena in fundamental terms.

Publications

Engineering Anomalies Research

(with B.J. Dunne)

Margins of Reality: The Role of Consciousness in the Physical World. New York-San Diego: Harcourt Brace Jovanovich (1987).

(with B.J. Dunne, *et al.*)

“Correlations of Random Binary Sequences with Pre-Stated Operator Intention: A Review of a 12-Year Program.” *Journal of Scientific Exploration*, 11(3): 345–367 (1997).

(with B.J. Dunne)

“Experiments in Remote Human/Machine Interaction.” *Journal of Scientific Exploration*, 6(4): 311–332 (1992).

(with B.J. Dunne, *et al.*)

“Series Position Effects in Random Event Generator Experiments.” *Journal of Scientific Exploration*, 8(2): 197–215 (1994).

(with R.D. Nelson, *et al.*)

“FieldREG Anomalies in Group Situations.” *Journal of Scientific Exploration*, 10(1): 111–141 (1996).

(with Y.H. Dobyns and B.J. Dunne)

“Count Population Profiles in Engineering Anomalies Experiments.” *Journal of Scientific Exploration*, 5(2): 205–232 (1991).

(with B.J. Dunne, *et al.*)

“Mind/Machine Interaction Consortium: PortREG Replication Experiments.” *Journal of Scientific Exploration*, 14(4): 499–555 (2000).

(with B.J. Dunne)

“On the Quantum Mechanics of Consciousness, with Application to Anomalous Phenomena.” *Foundations of Physics*, 16(8): 721–772 (1986).

(with B.J. Dunne)

“A Modular Model of Mind/Matter Manifestations (M^5).” *Journal of Scientific Exploration*, 15(3): 299–329 (2001).

“ M^* : Vector Representation of the Subliminal Seed Regime of M^5 .” *Journal of Scientific Exploration*, 16(3): 341–357 (2002).

(with B.J. Dunne)

“Science of the Subjective.” *Journal of Scientific Exploration*, 11(2): 201–224 (1997).

“The Complementarity of Consciousness.” In *Cultivating Consciousness for Enhancing Human Potential, Wellness, and Healing*, K.R. Rao, ed. (Westport, CT and London: Praeger, 1993) pp. 111–121.

“20th and 21st Century Science: Reflections and Projections.” *Journal of Scientific Exploration*, 15(1): 21–31 (2001).

“The Challenge of Consciousness.” *Journal of Scientific Exploration*, 15(4): 443–457 (2001).

“Information, Consciousness, and Health.” *Alternative Therapies in Health and Medicine*, 2(3): 32–38 (1996).

(with P. Devereux and M. Ibison)

“Acoustical Resonances of Assorted Ancient Structures.” *Journal of the Acoustical Society of America*, 99(2): 649–658 (1996).

Princeton Engineering Anomalies Research

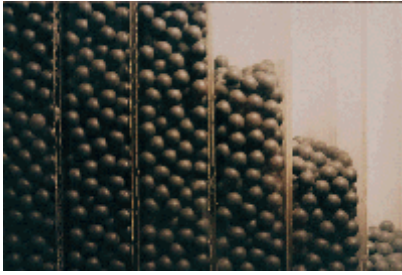
Scientific Study of Consciousness-Related Physical Phenomena

Engineering and Consciousness

The Princeton Engineering Anomalies Research (PEAR) program, which flourished for nearly three decades under the aegis of Princeton University's School of Engineering and Applied Science, has completed its experimental agenda of studying the interaction of human consciousness with sensitive physical devices, systems, and processes, and developing complementary theoretical models to enable better understanding of the role of consciousness in the establishment of physical reality. It has now incorporated its present and future operations into the broader venue of the International Consciousness Research Laboratories (ICRL), a 501(c)(3) organization chartered in the State of New Jersey. In this new locus and era, PEAR plans to expand its archiving, outreach, education, and entrepreneurial activities into broader technical and cultural context, maintaining its heritage of commitment to intellectual rigor and integrity, pragmatic and beneficial relevance of its techniques and insights, and sophistication of its spiritual implications. As described more fully on the [ICRL](#) website, PEAR also will continue to provide the scholarly pedestal from which all other ICRL activities will radiate.

I. Human/Machine Anomalies

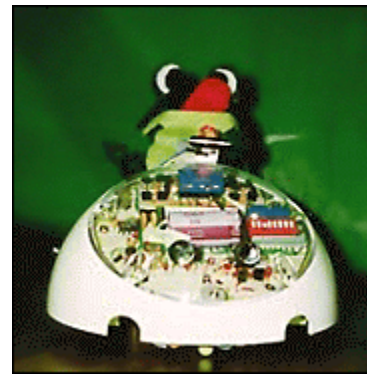
The most substantial portion of the PEAR experimental program examines anomalies arising in human/machine interactions.



Random mechanical cascade experiment.

In these studies human operators attempt to bias the output of a variety of mechanical, electronic, optical, acoustical, and fluid devices to conform to pre-stated intentions, without recourse to any known physical influences. In unattended calibrations all of these sophisticated machines produce strictly random data, yet the experimental results display increases in information content that can only be attributed to the consciousness of their human operators.

Over the laboratory's 27-year history, thousands of such experiments, involving many millions of trials, have been performed by several hundred operators. The observed effects are usually quite small, of the order of a few parts in ten thousand on average, but they compound to highly significant statistical deviations from chance expectations. These results are summarized in "[Correlations of Random Binary Sequences with Pre-Stated Operator Intention](#)" and "[The PEAR Proposition](#)."



Robot experiment.



Fountain experiment.

A number of secondary correlations reveal other anomalous structural features within these human/machine databases. In many instances, the effects appear to be operator-specific in their details and the results of given operators on widely different machines frequently tend to be similar in character and scale. Pairs of operators with shared intentions are found to induce further anomalies in the experimental outputs, especially when the two individuals share an emotional bond. The data also display significant disparities between female and male operator performances, and consistent series position effects are observed in individual and collective results. These anomalies can be demonstrated with the operators located up to thousands of miles from the laboratory, exerting their efforts many hours before or after the actual operation of the devices.

The random devices also respond to group activities of larger numbers of people, even when they are unaware of the presence of the machine. Such "FieldREG" data produced in environments fostering relatively intense or profound subjective resonance show larger deviations than those generated in more pragmatic assemblies. (See "[FieldREG II: Consciousness Field Effects: Replications and Explorations.](#)") Venues that appear to be particularly conducive to such field anomalies include small intimate groups, group rituals, sacred sites, musical and theatrical performances, and other charismatic events. In contrast, data generated during most academic conferences, business meetings, or other mundane venues show less deviations than would be expected by chance.

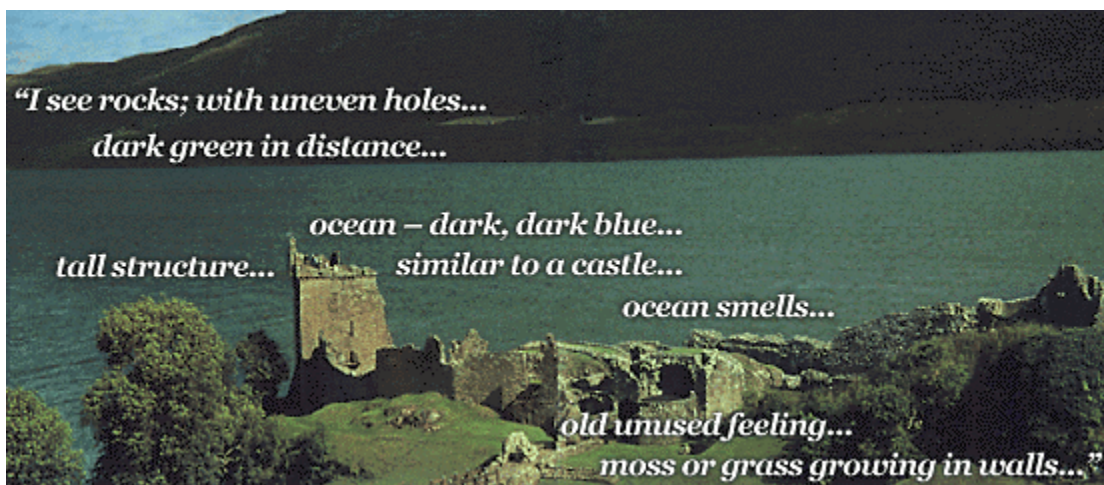


Linear pendulum experiment.

Elaborate analytical methods have been developed to extract as much understanding as possible from all of these results, and to guarantee their integrity against any experimental or data processing flaws.

II. Remote Perception

In another class of studies, the ability of human participants to acquire information about spatially and temporally remote geographical targets, otherwise inaccessible by any of the usual sensory channels, has been thoroughly demonstrated over several hundred carefully conducted experiments. The protocol requires one participant, the "agent," to be stationed at a randomly selected location at a given time, and there to observe and record impressions of the details and ambience of the scene. A second participant, the "percipient," located far from the scene and with no prior information about it, tries to sense its composition and character and to report these in a similar format to the agent's description.



Remote perception target and transcript: Ruins of Urquardt Castle, Loch Ness, Scotland.

Even casual comparison of the agent and percipient narratives produced in this body of experiments reveals striking correspondences in both their general and specific aspects, indicative of some anomalous channel of information acquisition, well beyond any chance expectation. Incisive analytical techniques have been developed and applied to these data to establish more precisely the quantity and quality of objective and subjective information acquired and to guide the design of more effective experiments. Beyond confirming the validity of this anomalous mode of information acquisition, these analyses demonstrate that this capacity of human consciousness is also largely independent of the distance between the percipient and the target, and similarly independent of the time between the specification of the target and the perception effort.

Over its long history, PEAR has accumulated over 650 remote perception trials, performed over several phases of investigation. Numerous scoring methods have involved various arrays of descriptor queries that have been addressed to both the physical targets and the percipients' subjective descriptions thereof, the responses to which have provided the basis for numerical evaluation and statistical assessment of the degree of anomalous information acquired under a variety of experimental protocols. Twenty-four such recipes have been employed, with queries posed in binary, ternary, quaternary, and ten-level distributive formats. Thus treated, the composite database yields a probability against chance of approximately three parts in ten billion.

The overall results are not noticeably affected by any of the secondary protocol parameters tested, or by variations in descriptor effectiveness, possible participant response biases, target distances from the percipients, or time intervals between perception efforts and target visitations by the agents. However, over the evolution of the analysis programs there has been a striking diminution of the anomalous yield that appears to be associated with the participants' growing attention to, and dependence upon, the progressively more detailed descriptor formats. An intrinsic complementarity is thereby suggested between the analytical and intuitive aspects of the remote perception process that appears to limit the extent to which such anomalous effects can be simultaneously produced and evaluated ([Information and Uncertainty in Remote Perception Research](#)).

III. Theoretical Models

Nearly three decades of intense experimentation leave little doubt that the anomalous physical phenomena appearing in the PEAR studies are valid, and are significantly correlated with such subjective variables as intention, meaning, resonance, and uncertainty. The stark inconsistencies of these results with established physical and psychological presumptions place extraordinary demands on the development of competent new theoretical models for

constructive dialogue with the empirical data. But since the contemporary scientific approach leaves little room for such subjective correlates in its mechanistic representations of reality, it follows that science as we know it either must exclude itself from study of such phenomena, even when they precipitate objectively observable physical effects, or broaden its methodology and conceptual vocabulary to embrace subjective experience in some systematic way.

The primary importance of operator intention and emotional resonance with the task at hand, along with the operator-specific structure evident in the data, the absence of traditional learning patterns, and the lack of explicit space and time dependence clearly predicate that no direct application or minor alteration of existing physical or psychological frameworks will suffice. Rather, nothing less than a generously expanded scientific model of reality, one that allows consciousness a proactive role in the establishment of its experience of the physical world, will be required. The challenges and caveats of such a "[Science of the Subjective](#)" are explored in detail in several of our publications.

One such model has been proposed and developed in "[On the Quantum Mechanics of Consciousness, With Application to Anomalous Phenomena](#)," under the major premise that the basic processes by which consciousness exchanges information with its environment, orders that information, and interprets it, also enable it to bias probabilistic systems and thereby to avail itself of some control over its reality. This model regards the concepts that underlie all physical models of reality, particularly those of observational quantum mechanics such as the principles of uncertainty, complementarity, exclusion, indistinguishability, and wave mechanical resonance, as fundamental characteristics of consciousness rather than as intrinsic features of an objective physical environment. In this view, the "anomalous" phenomena observed in the PEAR experiments become quite normal expectations of bonded human/machine and human/human systems, and the door is opened for all manner of creative consciousness/environment interactions.

In a complementary approach, a modular conceptual framework has been articulated, wherein direct attention of the conscious mind to observable physical processes is bypassed altogether. Instead, an alternative route is proposed, whereby the inherently probabilistic nature of unconscious mind and intangible physical mechanisms are invoked to achieve anomalous acquisition of information about, or anomalous influence upon, otherwise inaccessible material processes. ([A Modular Model of Mind/Matter Manifestations \(M5\)](#).) Theoretical requisites for its pursuit include better understanding of the dialogue between the conscious and unconscious aspects of the mind; more pragmatic formulations of the relations between tangible and intangible physical processes; and most importantly, cogent representation of the merging of mental and material dimensions into indistinguishability at their deepest levels.

A rudimentary attempt to represent this latter “subliminal seed space” has been attempted in the format of an array of complex vectors whose components embody the pre-objective and pre-subjective aspects of their interactions ([M*: Vector Representation of the Subliminal Seed Regime of M5](#)). Elementary algebraic arguments predict that the degree of anomalous correlation between the emergent conscious experiences and the corresponding tangible events depends only on the alignment of these interacting vectors, *i.e.*, on the correspondence of the ratios of their individual “hard” and “soft” coordinates. This in turn suggests a subconscious alignment strategy based on need, desire, shared purpose, or personal resonance that is consistent with our empirical experience.

In another closely related approach, entitled "[Sensors, Filters, and the Source of Reality](#)," we speak of the need to elevate the subjective capacities of consciousness to complementary status with the more objective physical senses, along with recognition of the bi-directional capabilities of both, thereby allowing establishment of resonant channels of communication between the mind and its ultimate source that can exceed conventional information processing. The key elements in tuning these channels to amplify such information creation are the physiological and psychological filters imposed upon them, some of which can be enhanced or altered by conscious or unconscious attention.

Although the concepts and mechanics presented in this array of specific models may seem somewhat disparate, their larger value may lie in the identification of certain common-denominator issues that arise in one form or another in all of them. Taken together, they can provide a comprehensive conceptual framework for an overarching "science of the subjective" that may one day support a yet more fundamental representation of the full panorama of human experience.

Implications and Applications

From its inception, PEAR's scholarly agenda has been motivated by three overarching goals that relate to the practical, the intellectual, and the spiritual dimensions of the human search for knowledge:

The Practical: Pragmatic Applications

Despite the small scale of the observed consciousness-related anomalies, they could be functionally devastating to many types of contemporary information processing systems, especially those relying on random reference signals. Such concern could apply to aircraft cockpits and ICBM silos; to surgical facilities and trauma response equipment; to environmental and disaster control technology; or to any other technical scenarios where the emotions, attitudes, or purposes of human operators may intensify and deepen their interactions with the controlling

devices and processes. Indeed, the extraordinarily sophisticated equipment that generates much of the fundamental data on which modern science and information technology is based cannot be excluded from this potential vulnerability. As cutting-edge nanotechnology and quantum computing move into even more delicately poised information processors, protection against such consciousness-related interference could become increasingly relevant, even essential, to the design and operation of these and many other engineering systems of the future.

On a more positive note, since these same research results provide important technical evidence of, and bear strong similarities to, the precious processes of human creativity, they offer the promising possibility of a new genre of human/machine systems that can enhance creative performance in all domains of human activity, from analytics to aesthetics, communication to commerce, medicine to management, sports to science, among countless other compass points of creative inspiration. The understanding and technology that have emerged from the foregoing basic research have prompted a number of practical initiatives. Indeed, interest has been growing among a visionary group of industrial entrepreneurs and venture capitalists regarding the development and marketing of a variety of pragmatic devices. For example, one emerging company, [Psyleron, Inc.](#), is producing a new line of state-of-the-art equipment for both research and personal applications.

The Intellectual: Enhancement of Basic Science

The historical evolution of scientific instrumentation that has extended our observational faculties into the domains of increasingly large, or increasingly small, natural phenomena has often forced reformulations of the prevailing representations of reality. Usually these theoretical revisions have been driven by the discovery of empirical anomalies -- unexpected observations that were inconsistent with the established models of that era. The advent of the "Information Age" over the past several decades has brought its own class of such anomalies, typically those associated with meaning, context, and other subjective discriminators. PEAR's contribution to this expansion of the scientific worldview has been its accumulation of huge bodies of consciousness-correlated empirical evidence that the subjective/objective dichotomy of Cartesian philosophy is no longer entirely viable.

More comprehensive accommodation of these anomalies within a functional scientific framework will require the explicit inclusion of consciousness as an active agent in the establishment of physical reality, a generalization of the scientific paradigm demanding more courageous theoretical structures than are employed at present, guided by more extensive empirical data than are now available, acquired via more cooperative interdisciplinary collaborations than are currently practiced. It is our hope that by its proposition of a few possible

conceptual models PEAR has established productive precedents for such representation of this formidable, but crucial, topical domain.

The Spiritual: Cultural Implications

Beyond its revolutionary technological applications and scientific impact, the evidence of an active role of consciousness in the establishment of physical reality holds profound implications for our view of ourselves, our relationships to others, and to the cosmos in which we exist. These, in turn, must inevitably impact our values, our priorities, our sense of responsibility, and our style of life. Our ability to acquire, or to generate tangible, measureable information independent of distance or time challenges the foundation of any reductionistic brain-based model of consciousness that may be invoked. The lack of notable correlations in the data with standard learning curves or other recognizable cognitive patterns, combined with the repeatable and distinct gender-related differences, suggest that these abilities may stem from a more fundamental source than heretofore suspected. Certainly, there is little doubt that integration of these changes in our understanding of ourselves can lead to a substantially superior human ethic, wherein the long-estranged siblings of science and spirit, of analysis and aesthetics, of intellect and intuition, and of many other subjective and objective aspects of human experience can be productively reunited.

Future

PEAR has now concluded its experimental operations at Princeton University. After nearly three decades of systematic empirical study of consciousness related physical phenomena, it is our sense that many of the salient correlates of these intriguing anomalies have now been identified. There are many important questions still to be addressed, but these will require an even broader interdisciplinary approach to the topic. Therefore, we will be shifting our base of operations to the [International Consciousness Research Laboratories](#) (ICRL), a 501(c)(3) non-profit organization, whose three-fold mission focuses on: 1) quality research, 2) educational initiatives, and 3) practical applications.

Our plans comprise: 1) Supporting collaborative research projects that strengthen the empirical databases on consciousness related physical phenomena, and developing effective theoretical models;

2) Encouraging and nurturing the intellectual and pragmatic endeavors of a network of younger scholars, many of whom have participated in our program over the years as volunteers and interns;

3) Advising corporate efforts dedicated to the realization of beneficial applications in various sectors of society. In this context, we hope to involve cogent

entrepreneurs and visionary venture capitalists, for whom the ultimate market deployments could be huge, in mutually profitable collaborations. One such enterprise has been initiated with [Psyleron, Inc](#)

Extended Activities

International Consciousness Research Laboratories

From PEAR's well-established program of empirical and theoretical research has emerged a 501(c)(3) not-for-profit organization called International Consciousness Research Laboratories ([ICRL](#)). ICRL was established several years ago as a multi-disciplinary consortium of scholars with a shared commitment to collaborative exploration of the role of consciousness in physical reality. This community now comprises some seventy colleagues from a wide range of nations and disciplines who have been closely associated with PEAR over the past quarter century. ICRL will extend the reach of PEAR's research and educational interests into many other scholarly venues, and will serve as a vehicle to carry forward its mission.

Society for Scientific Exploration

Over the years, several members of the PEAR staff have served as officers or councilors of the Society for Scientific Exploration ([SSE](#)), a unique international and interdisciplinary professional organization. SSE is devoted to open but critical discussion and publication of research in many areas of frontier science not adequately covered by more conventional scientific organizations. It holds annual international meetings in the U.S., bi-annual meetings in Europe, and occasional topical symposia. It also publishes the archival peer-reviewed *Journal of Scientific Exploration*, a reservoir of documentation for much of the current scholarly research on consciousness-related anomalies, along with other areas of controversial contemporary study. The society has also created a [Young Investigators Program](#) in response to the growing interest of younger scholars in the topics addressed by SSE.

<http://www.princeton.edu/~pear/pdfs/IEEE.pdf>

http://www.princeton.edu/~pear/pdfs/jse_papers/1EA%20i0892-3310-001-01-0021.pdf

<http://www.princeton.edu/~pear/pdfs/Complementarity.pdf>

<http://www.princeton.edu/~pear/pdfs/finalcap.pdf>

http://www.princeton.edu/~pear/pdfs/jse_papers/PEARproposition.pdf

<http://www.princeton.edu/~pear/pdfs/ZiF.pdf>

<http://www.princeton.edu/~pear/pdfs/CMBarticle.pdf>

For more papers and publications on this fascinating research, go to:

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