52

Final Report--Objective E, Task 5

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AN RNG EXPERIMENT TO TEST THE EFFECTS OF SOURCE AND DISTANCE

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SRI Project 1291

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ABSTRACT

A detailed and systematic investigation to determine (1) the effects of distance between remote action (RA) subjects and random number generators (RNG), and (2) the subjects' performance utilizing RNGs based on fundamentally different sources of random noise is described. A subcontract was let to Syracuse University for this joint venture with SRI International. Because of unforeseen delays in the contracting processes, no experimental data were recorded as of September 30, 1986. However, all of the specialized hardware and software necessary to generate random numbers from a noise diode, β-decay source and a pseudorandom algorithm have been developed and debugged. In addition, the telecommunications data-link software has been written, and test data have been successfully transmitted between SRI and Syracuse.

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I INTRODUCTION

In FY 1986, SRI International awarded a subcontract to the Communication Studies Laboratory (CSL) at Syracuse University* to determine (1) the effects of distance between remote action (RA) subjects and random number generators (RNG), and (2) the subjects' performance differences in influencing RNGs based on fundamentally different sources of random noise. This subcontract is in part a "joint venture" because SRI is providing three different RNGs and a computer controlled communications link to serve as the "distant" half of the experiment. Unforeseen delays arose in the subcontracting process and, as a result, the subcontract was not in place until 24 June 1986. These delays were caused by questions regarding the use of human subjects, differences in the cost accounting procedures of SRI and Syracuse, a dispute over the publication approval process, and a change in principal investigator at Syracuse. (Professor Edward Storm has replaced Dr. Robert Morris, who moved to Edinburgh University in January of 1986.)

*This report constitutes Objective E, Task 5, detailing an RNG experiment to test the effects of source and distance.

II METHOD OF APPROACH

A. General Description

An RNG experiment consists of four basic elements:

1. A source of a random (true) or computer-based (pseudorandom) binary sequence.
2. An individual who intends to "modify" the random sequence (by mental means alone).
3. A feedback mechanism that displays the real-time statistical properties of the sequence.
4. An analysis procedure defined *a priori*.

A single trial, which encompasses these elements, might proceed as follows. An undisplayed random process is running continuously. When ready, the participant presses a button that initiates collection of a predetermined number of bits. A statistical quantity (i.e., the accumulated number of 1's to date) is displayed to the participant for feedback, and a Z-score is computed as a quantitative measure of performance.

Over 300 experiments of this type have been reported in the literature.* An initial analysis of the existing data base shows an overall combined effect of greater than 8σ. Although some of the experiments have attempted to explore the effects of distance and source of randomness, few have dealt with these issues in depth.

B. Specific Experiment

The proposed experiment consists of a pilot phase, in order to refine the protocol and to select participants; a formal phase, using the "best" seven individuals from the pilot phase; and a control phase.

Six different sources for binary random sequences and two different source/participant distances will be combined into a single trial. Thus, for a single button press on the part of

*Radin, D. I., May, E. C., and Thomson, M. J., "Psi Experiments with Random Number Generators: Meta-Analysis, Part 1," Proceedings of the Presented Papers of the 28th Annual Parapsychological Association Convention, Tufts University, Medford, Massachusetts (August 1985).

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the participant, N/6 bits will be collected from each of the three sources located at two different distances. (The total number of bits/trial, N, will be determined during the pilot phase.) Feedback will be provided to allow the participant to monitor his/her progress; however neither the participant nor the experimenter will know the source and distance being used within a given session.

C. Overall Hypothesis and Analysis

The overall hypothesis is that there is no significant difference in performance as a function of source type or distance. The independent variables in this experiment are source type and distance. The dependent variable in this experiment is the number of binary 1's observed in each of the N/6 sequences. The Analysis will be an ANOVA.

Two type of control runs will be conducted:

1. Global controls--long runs for each of the source/distance combinations to assure long-term system stability.
2. Local controls--a series of randomly initiated trials before and just after an effort session to ensure short term stability of the system. These trials will be exactly like the effort trials except no observers will be present.

Significance criteria will be developed during the pilot phase prior to the formal collection of data.

D. Communications Protocol

The current design allows on-line data collection from each of two research laboratories (SRI and CSL), such that each has reasonable confidence that the data have been generated fairly and represent a valid description of what actually transpired. For example, at the start of each run of the experimental session, the experimenter sends two control bytes to SRI. Within the first byte, Bit 0 tells whether the first four runs have 0 or 1 as target. Bit 1 tells whether Order 0 or Order 1 of RNG characteristics counterbalanced within and between runs will be used. Bit 2 declares whether or not the run is practice or will count, and so forth. The detailed description of this communications protocol may be found in the Appendix.

III RESULTS AND DISCUSSION

At this time, the hardware and communications protocols have been debugged but no experimental trials have been conducted. This delay was caused by unforeseen difficulties at both Syracuse and SRI. Work is currently underway to remedy this situation and we expect results in all areas during FY 1987. We suggest a detailed reading of the Syracuse report (see Appendix) for a more complete understanding of the procedural complexity of the experiment.

Appendix

INVESTIGATION OF PSYCHOENERGETIC DISTANCE EFFECTS OBTAINED FROM NOISE SOURCES WITH DIFFERENT CHARACTERISTICS

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I INTRODUCTION

This document constitutes the final report for services performed in connection with a services contract between SRI International and Syracuse University (Services Contract Number C-11489). This work has been performed within the Communication Studies Laboratory in the School of Computer and Information Science, Syracuse University. We refer to this Laboratory as "CSL."*

*The staff of CSL is committed to supply any additional information bearing on the execution of this contract that SRI may request. In addition, CSL will submit a supplement to this document reporting on the experimental results obtained when the experiment itself has been completed.

II EXPERIMENTAL DESIGN AND DESIGN GOALS*

There were four primary goals set for the design of the SRI–Syracuse Remote Action Project. First, it was desired that we develop a protocol that would allow comparison of remote action (RA) effectiveness for RNGs having different physical characteristics and located at varying distances from the designated RA agents. Second, the protocol, although rigorous, should allow RA agents considerable flexibility, and should be oriented, in general, toward producing strong positive RA effects. Third, the protocol should allow for on-line multiple laboratory research, such that each laboratory could have confidence in the validity of the obtained results. Fourth, the protocol should be such as to eliminate reasonable counterhypotheses. We will now consider how these goals are implemented by the design developed.

GOAL I: Comparison Of RNGs Of Differing Characteristics

The present study employs a within-subject two-factor design. Each subject completes at least one session composed of eight runs. Each run is composed of 1,536 trials, where one trial equals a single binary digit generated by one of six possible sources of randomness (RNG). RNG distance from RA agent is one factor, in that three RNGs are at CSL in Syracuse and three at SRI in California. At each site, one RNG is pseudorandom, one relies on a source of electronic noise, and one uses beta-decay as noise source. Thus, characteristic of RNG noise is the second factor in a 2 x 3 two-factor design. Within each run, all six RNGs contribute 256 consecutive trials, making up 6 x 256 or 1, 536 trials. These trials are fed back to the RA agent through a circle of lights display (to be described below) in such a way that the display behaves the same and looks the same for each of the six RNGs, including any time delays made necessary by hardware or software considerations. Thus, the RA agent is operating an equal amount of the time on all six, yet has no ordinary knowledge of which is driving the display at any given time and, if desired, need not be informed that more than one kind of RNG is involved. Although all six RNGs are involved in each run, a run lasts little more than a minute therefore, there should be minimal noise from any short or long-term environmental or psychological changes. Additionally, to eliminate

*This chapter prepared by Dr. Robert L. Morris.

order effects within the run and within the session, the order of the six RNGs is tightly counterbalanced within runs, within sessions, and between sessions. Half of the time the three RNGs from CSL are run first within the run and half of the time they are not. Likewise, half of the time the RNGs from a given location are run in the order: noise, pseudorandom, decay; and half of the time in the reverse order. These four possibilities are counterbalanced within each session, in one of two fixed symmetrical orders. The two orders (designated Order 0 and Order 1) are counterbalanced between sessions for the 32 sessions. A pseudorandom computer algorithm decides which one of the two counterbalancing orders will be used first, so that the experimenter and subject are blind to the sequence in a given session. The computer software in either location has been set up to recognize and implement each order when told which order is in use. Thus, any differences in RNG performance cannot be ascribed to any kind of order effect such as decline effects, terminal salience, and so on, of the sort occasionally observed in parapsychological data.

GOAL II: Allow RA Agents Adequate Procedural Flexibility and Simplicity Such as to Optimize the Likelihood of Positive Results

No more than ten RA agents are to be selected to complete a total of 32 sessions. Although each agent will thus average just over three sessions each, strong performers may be invited back for more than three, while weak performers may be invited for fewer, at the discretion of the experimenter. Thus, each person will have more than one opportunity to do well, thereby reducing the pressure often experienced by agents in single session designs. Although such a procedure potential diminishes the generalizability of the final result (a deficit to be remedied in any event only by follow-up research), such that whatever results are obtained are more likely to represent findings about real RA. Additionally, introductory sessions (not to count in the formal series of 32) will be conducted for each potential agent, to expose them to the testing environment and personnel and options (see below). They can thus familiarize themselves with the environment, decide whether they want to participate, think about the conditions under which they would like to be run, complete (or at least be familiar with) the necessary questionnaire and consent form, and so on. Those who show evidence of strong negative scoring during the introductory session may, at the discretion of the experimenter, be encouraged to do a second introductory session, or at least some additional practice runs before beginning the formal experiment.

At the introductory session, potential agents will be shown or told several things. They will receive an introductory talk about the lab and its work, with emphasis on its past success in producing results in RA studies, plus the success of similar studies in other labs throughout the world. They will be told that this study explores the range of RNGs that are amenable to RA effects, that we anticipate success on all of them, but need further descriptive data. The exact nature of this talk will vary with the agent, some of whom will already be sophisticated. After the talk, agents will be shown the SRI questionnaire and the CSL consent form, and will be encouraged to complete them both. Following this, agents will be shown the equipment room and where the experimenter will be sitting during the session. At this time, the experimenter will actually start up a demonstration display, then lead the agent to the adjoining experimental room where the display will now be running.

The experimental room itself is sizable, approximately 15 feet square. The walls are thick and covered by light brown sound absorbent drapes; only loud sounds from outside can be heard. Lighting is either by overhead fluorescent or by small floor lamp with dimmer, placed in one corner. Furnishings include a brown leather sofa, matching leather recliner, and two additional brown cushioned chairs. The display is a low, black octagonal wooden table, approximately four feet across. Protruding through holes in the top of the table are 128 small light bulbs arranged in a circle 3 feet in diameter.

At the start of a run, certain of the lights are lit; decisions of the RNG are used to shift the set of lights that are lit one position at a time, either clockwise or counterclockwise. The subject's task is to bias the shift of the lit lights consistently in whichever direction has been designated as target. The movement of the lights around the circle can be displayed in a variety of ways, e.g., as shifts in the position of a single light, a small group of lights, several small groups of lights equally spaced around the circle, or as a gap in a ring of lights. The lights can move at a rate of over a hundred steps a second or any slower speed. The RNG can be used to bias them clockwise or counterclockwise, in a random walk, or can step them in one direction only, with the decision being between taking a step or not taking a step. The latter provides feedback, but feedback that does not allow subjects to know how much better or worse than chance they are doing at a given moment. Such indirect feedback may be preferred under certain circumstances. The RNG can be omitted, such that the lights simply circle evenly in one direction, to produce visual effects or to provide a focus of concentration. Any display mode can be maintained for any length of time, and displays of different modes can be strung together in sequence.

On the basis of pretesting with a variety of potential agents, we have selected five kinds of displays, representing various combinations of initial light patterns. Four of the five involve binary choices of advance clockwise versus no advance; the fifth is a random walk. Agents are shown each of the five and given an opportunity to explore them. At the start of each experimental session, the agent will be asked to select one of the five, which will then be used throughout that session. The agent's task for each display is to facilitate its smooth and rapid movement in a clockwise direction. Agents are encouraged to use any metaphor or image that they find helpful, as long as they all share the concept that the display is functioning best when it is proceeding clockwise, to keep the task consistent and straightforward for all participants. That consistency enables them to become absorbed in the task without needing to keep track of which direction the target is or without being concerning that half of the time the target is in their preferred direction and half of the time not. In pretesting, clockwise was almost unanimously preferred as target direction.

Because target direction is not varied, we need to build in controls against short term first order bias in the RNGs. This is done in two ways. First, at periodic intervals throughout the experiment, control data will be collected by duplicating the conditions of a session save for the absence of a designated RA agent. Such sessions will be assigned a session number above 100, to indicate that they are controls (see below). Second, within each run, two separate programs will be run. One program designates 0 as clockwise, i.e., as target; the second designates 1 as clockwise. Within each session, either the first four or the last four runs uses 0 as target, with the remaining four using 1 as target. To avoid order effects, half of the sessions employ 0 as target for the first four runs. Which session uses which as target first has been prearranged at the start of the study, in counterbalanced order. The counterbalancing pattern is deep, and thus would not match any gradual shift in RNG bias. Agents are not told which bit is target for a given run; the experimenter does know, and thus this study allows, directly, for experimenter RA effects (difficult if not impossible to eliminate in RA studies under any circumstance).

Agents are given considerable freedom in the environmental conditions of each session. They can fix their own level of lighting. A focusing object may or may not be placed in the center of the table. They may hear music of their choice, encouragement from the experimenter, or silence through loudspeakers placed in two corners of the room. Body position can be varied within the session, e.g., standing, sitting, lying down, or moving around in some way. Agents are free to verbalize, as long as the noise level is not too high. (Because there is no need to keep the target secret, agent and experimenter can interact quite freely and naturally.) At the end of each run, the agents can register any short commentary that they wish, regarding what they tried, other special aspects, and so on. Following this they can be given feedback of results, if requested.

Toward the end of the introductory session, the above points are summarized and the prospective agent is requested to consider what specific conditions they might prefer for their formal sessions. If the agent seems uncertain, the experimenter can also summarize some of the mental strategies that others have tried with some success in the past, and can make some suggestions on how to prepare mentally in advance for the formal sessions (e.g., advance imagery of successful outcomes, and so on). Agents will be reminded that they have access to practice runs at the start of each session and even, if needed, in the middle of a session. Any run intended as a practice run is declared as such at the start by both agent and experimenter, and designated as such to the computer system controlling the data generation, such that the resultant data will not be stored. These practice runs can then be available to the agent for exploration of mental strategy or changes in environment.

A final aspect of the experimental design aimed at optimizing results concerns the initiation of each run. The timing of each run onset is influenced by both agent and experimenter, thus allowing ample opportunity for psychic functioning under the Intuitive Data Sorting (IDS) model.

GOAL III: On-line Multiple Laboratory Research with Mutual Confidence in Result Validity

The current design allows formal experimental sessions that allow on-line data collection from each of two research laboratories, such that each has reasonable confidence that the data have been generated fairly and represent a valid description of what actually transpired. The mechanics of this are evident in the procedure used in the formal experimental sessions, to be run by number in that order. Each session has been assigned in advance to one of two counterbalanced RN characteristic orders (Order 0 or Order 1, see above). Each session has also been assigned in advance to one of two conditions, target is 0 for first four runs or target is 1 for first four (see above). There are four combinations of these two pairs of variables; these four combinations have been counterbalanced through the 32 sessions to control for any order effects. The experimenter has access to a sheet listing each of these conditions for each of the sessions.

At the start of each run of the experimental session, the experimenter sends two control bytes to SRI. Within the first byte, Bit 0 tells whether the first four runs have 0 or 1 as target. This target assignment is registered at both ends in advance of any RNG data generation. Bit 1 tells whether Order 0 or Order 1 of RNG characteristics counterbalanced within and between runs will be used. Thus both SRI and CSL computers know which order of RNGs to sample in the production of data, given the run number. Bit 2 declares whether or not the run is practice or will count. Thus the designation of whether or not the data are to count has been registered at both ends in advance of any data generation. Bits 3-5 declare which run number, 0-7, is to be generated. this information plus Bit 1 tells the computer in what exact order the six available RNGs are to be sampled. Bit 6 is sent as a 1, telling the SRI computer that it is to send bits from the three SRI RNGs to CSL. The second byte gives the session number. Since control runs are always designated as part of sessions numbered above 100, the designation of a run as experimental versus control has been registered at both ends before any data are generated.

Once the SRI computer receives these two bytes, the actual run takes place. bits from each of the six RNGs are collected and displayed to the agent in the proper order. As of this moment in time, the SRI computer has all the information that it needs to score the data generated by its own RNGs and it has that raw data. The CSL computer has the scoring information plus all the raw data from all six RNGs. The experimenter then completes the transaction for that run by sending the CSL RNG data for the run back to SRI. This is accomplished by sending the same two bytes back to SRI, but with one change: Bit 6 is changed from a 1 (SRI send data) to a 0 (SRI receive data). The computer then transmits the CSL data back to the SRI computer, thus completing the transaction and guaranteeing that each laboratory has a complete record of each run before the next run is begun.

Each run is accomplished in the above manner until all eight for the session have been completed. It is understood that the agent cannot terminate a run once it is underway, and the experimenter cannot exclude a run once it is completed. Any equipment malfunction which obviously damages data will lead to the discarding of those data. If a session must be interrupted before it is completed, then the session can be resumed at a later date. The rule of thumb is, any data designated as counting in advance and which is successfully transmitted must count. If good data exists in the CSL computer but is not successfully transmitted immediately to the SRI computer it should be stored and transmitted later. It is possible that decisions will come up that are not covered above, and we will learn from them. When in doubt, keep the data. This minimized criticism that decisions are biased by the experimenter's knowledge of whether or not the data look favorable. It is also recommended that at the end of each session hard copy of the data and control bytes be printed out, and that the stored data be backed up periodically.

GOAL IV: Elimination Of Reasonable Counterhypotheses

If the above procedure is carried out as stated, any successful results would not appear to be interpretable in terms of flaws in experimental design. Experimenter fraud is still possible, but it would have to be quite sophisticated and willfully sustained over a substantial portion of the experiment. Any significant difference among RNG characteristics would be likely caused by RA agent effects rather than experimental artifacts. Statistical evaluation of data will treat the mean scores for each RNG by session as the unit of analysis of a two-way analysis of variance. Primary effects will be examined, as will all interactions. An overall Z-score for all sessions will be used to assess whether this study produced significant evidence for an RA agent effect.

III HARDWARE DESIGN AND CONSTRUCTION

The hardware configuration has four units: an LSI-11 computer system, and APPLE-II computer system, the computer system at SRI, and the table of lights. Communications between the APPLE-II and the SRI computer are provided by authorized access through TYMNET.

The table of lights is a low, black octagonal table having 128 small light bulbs arranged in a circle 3 feet in diameter. A detailed specification of the capabilities of this unit is given elsewhere in this report. The LSI-11 computer system has been programmed to control the action of the table of lights, using control bits that are transmitted through a serial board attached to the LSI-11. The LSI-11 also maintains a record of all data used to control the table of lights. The hardware and software used to implement communication between the LSI-11 and the table of lights is in place and functional.

The APPLE-II computer system contains two boards, which hold the RNGs and deliver the data bits. One board contains an avalanche diode random noise generator. The second board contains an atomic radioactive decay source; it was designed and constructed by TWS Associates, Inc. Details for both boards are found later in this chapter. The APPLE-II also contains an implementation of the pseudorandom number generator algorithm that has been supplied by SRI. It is the function of the APPLE-II to access random bits as needed, record them, and send them to SRI, or to retrieve random data from SRI, and dispatch the appropriate control bits to the LSI-11 for table of lights control. The experimental design specifies the exact order in which random bits from SRI or from the APPLE-II source are to be dispatched to the LSI-11.

The atomic radioactive generator acts continually. Each time an alpha particle is emitted from the atomic source, the timing of the emission is used to generate a random number between 0 and 255. We refer to this 8-bit number as the RNG1 output data word. Each time this generation occurs, the RNG1 status bit is set to 0. When the APPLE-II accesses the RNG1 output data word, the RNG1 status bit is set to 1. The APPLE-II can access the data word several times, but the program should check that the status bit is 0 in order to be sure of having new (previously unread) data. In principle, the RNG1 output data word contains 8 random bits.

The APPLE-II peripheral card I/O space consists of 8 "slots," each having 16 bytes consecutive in memory. The base address for each of these slots is given as $C0a0, where a is 8, 9, A, B, C, D, E, or F. The peripheral card may be inserted in any slot so long as the addressing scheme knows where to find the data. Individual bytes within a slot are addressed by $C0ab, where b is between 0 and F (hexadecimal). Word 1 of the slot contains the random number generated, a number between 0 and 255. The status bit is found in word 7, where all bits except for the status bit have been set to 1. Thus, if the status word has the value 253, the status bit is low; if that value is 255, the status value is high. For example, if the first slot is used, then its base address is $C080, the output data word is found in $C081, and the byte containing 253 (status low) or 255 (status high) is found in $C087.

The status bit is low (0) if the RNG1 output data word contains data that have been refreshed and have not yet been read. Otherwise it contains 1. Note that the status bits will be valid within a few machine cycles after power-up. And note that an inadvertent write to the RNG1 output data location or to the word containing the status bit will have no effect on either the output buffer contents or the status word output buffer contents.

The avalanche diode random number generator uses the random noise output of a reversed-biased silicon avalanche diode as the basis for generating a random number data stream. The random avalanche waveform amplitudes and times of transition are transformed from analog signals into a digital bit stream by a zero-crossing detector (or comparator). This data stream is fed into a binary divider, to counter the effects of any uneven 1 to 0 content (first-order error) in the digitized bit stream. As a precaution against corruption of the low-level analog signals at the input of the zero-crossing detector by digital interference pickup, the analog data sampling process is suspended by internal lockout circuitry during periods of computer digital activity.

As a further precaution against first-order errors, the outputs of two independent avalanche RNGs are combined in an exclusive-nor circuit. The output of this circuit, which is still a bit stream in time, is fed into a serial-in parallel-out shift register. The parallel output of the shift register, in the form of an 8-bit byte, is transferred out of the RNG upon a computer read command. Because output bytes are refreshed regularly in time, no status handshaking of data availability is necessary; only a minimum inter-read dwell time need be observed in executing the computer program.

The atomic event (radioactive) random number generator uses the random time-of-arrival of atomic disintegration particles as the basis for generating a data stream of random numbers in the range from 0 to 255. A solid-state radiation detector and fast preamplifier generate a series of trigger pulses, which are used to "capture" the instantaneous values of a fast clock, thus generating an output data byte (8-bit data word) stream. In addition, a time history of the trigger pulse arrivals is employed algorithmically to vary slightly the frequency of the fast clock (in a manner that will not introduce first-order errors into the output data). This is done to ensure that unwanted synchronistic correlations will not appear between any regularly periodic data sampling rate and the clock frequency. Because the frequency dithering is driven by atomic disintegration events, the output of the RNG is still conceptually entirely dependent on atomic events.

In addition, the generation of a new data word also causes a status bit to be reset (i.e., set to 0 if not already 0). The act of reading the RNG data location in the computer causes the status bit to be set to 1 (if not already set). Because there can be a wide range of time intervals between atomic disintegrations, the use of the status bit allows a maximum data throughput rate, and ensures against old data being repetitively (and inappropriately) re-read.

IV SOFTWARE DOCUMENTATION

The APPLE-II computer at CSL has 65,536 bytes of memory and one one-and-one-half-inch disk drive. The basic cycle time of the APPLE-II is one MHz, and the video cycle "steals" from the basic operation of the computer. In addition, although the computer allows for up to 8 peripheral I/O boards, there is no interrupt facility available in the system. Data which is received at a peripheral board, if not seized when available may be over-written by subsequent data transmissions. For these reasons, initial plans to implement the software in a higher level language were abandoned. The software has been developed in the assembly language for the APPLE-II.

It is possible that at some future time it will be found desirable to implement an experimental protocol similar to that described in this report, by taking streams of random bits from many distinct sources. Anticipating this possibility, the basic software control package has been designed to facilitate such expansion. At the present time, this control program processes input asynchronously from the keyboard, from a parallel board associated with the LSI-11, and from a serial board associated with an external line to be connected through TYMNET with the SRI computer system. The basic plan has been to have the program interrogate (in order) the status of each of these three possible inputs, and when an input is found to have available data, the program determines exactly what action to take by consulting a state variable. For example, the program may determine by examining status bits that there are data at the serial board, and the state variable may then instruct the program to forward those data to the LSI-11 and to a disk file. An initializing program establishes contact with the SRI computer, using the APPLE-II as a terminal. Note that the boards that provide random data need not be included as asynchronously monitored inputs--the atomic disintegration source provides a status bit which ensures the relevance of the data, and no status signal is needed for the electronic noise source.

In the control program lines 1-69 contain identifiers and minimal commenting. Lines 70-94 contain the asynchronous control for the three inputs mentioned above. Lines 95-109 contain code for handling data from the keyboard. Lines 110-153 process data to the serial board (communication with the SRI computer). Lines 157-162 initialize the serial board for input. Lines 175–195 calculate the addresses needed to access the serial board, depending on the slot to which it is assigned. Lines 210–219 allocate buffer and other storage to the boards. Each buffer space is 128 bytes long.

Additional documentation will be provided with the report of the results of the experimental sessions.

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V ACKNOWLEDGEMENTS

This Services Contract was initiated at CSL by Dr. Robert L. Morris, Arthur M. Koestler Professor of Parapsychology at the University of Edinburgh. The conception of the project originated in conversations with the staff at SRI International, and the design and analysis was done by Dr. Morris. The experimental design report which Dr. Morris prepared is reproduced as Section II of this report.

Mr. Robert Chevako has contributed the design, construction, and delivery of the hardware facilities required to complete the work. His work has been carried out through NWS Associates, Inc., in New Woodstock, New York. The software to control the table of lights from the LSI-11 was prepared by Mr. Kevin Mack. All the special software for this project was designed, implemented, and tested by Mr. Richard Havourd. Ms. Nancy Morrell has been responsible for a variety of administrative and procedural matters, has recruited the subjects for the experiments, and will act as experimenter. Professor Edward F. Storm has acted formally as principal investigator, and has administered the contract with assistance from Mr. Richard E. Ward, Assistant Dean of the School of Computer and Information Science.