MASTER

QUARTERLY TECHNICAL PROGRESS REPORT

July, August, September 1970

DEPARTMENT OF COMPUTER SCIENCE
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN · URBANA, ILLINOIS

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1. CIRCUIT RESEARCH

(Supported in part by the Office of Naval Research under Contract
N000 14-67-A-0305-0007, W. J. Poppelbaum, Principal Investigator.)

Summary

The Bundle Processing report this quarter has new contributions from Trevor Mudge, who is finishing up the SABUMA project (Section 1.1.3), and Bernard Tse, whose report is appended to that of Dr. Afuso on the Bundle Signal Restorer. The APE report by Yiu Wo describes the stochastic implementation of multiply and divide for the Autonomous Processing Element. Finally, S. Hadjistavros has a description of the present status of the Colormatrix liquid crystal display.

M. Faïman

1.1 Bundle Processing (Project No. 21)

1.1.1 System Design of the Bundle Signal Restorer

To realize the bundle signal restorer proposed in the last quarterly report, a further study has been done.

The overall system is shown in Figure 1. The binary-to-ternary level shifting may be included in the main switching network in practice.

Consider the main switching network. Assume that each bundle has N wires at both input and output. Since there are two input bundles, there are $2N$ wires in total at the input. The output has two identical bundles and, as far as the switching network is concerned, they are considered as one bundle, namely N wires. Therefore, in designing the switching network, a reduction in the number of wires from $2N$ to N must also be considered.

The required function for the switching network is to assign one active wire (wire with "+" or "-") to each output wire. There are practically infinitely many ways of achieving this. Three representative ways are considered below.

Method 1: For each output wire, n input wires are tried. In order for each output wire to be assigned to only one input wire, an assignment priority has to be included. For example, by numbering n wires, if the first wire is active, the output wire is assigned to the first wire and the remaining $n-1$ wires are discarded. If the first wire is not active (namely its ternary level is "0"), but the second wire is active, then the second wire is assigned to the output. In this way the n^{th} wire is to be assigned to the output wire only when the first $n-1$ wires are not active. Also every input wire is to be tried equally frequently so that "+"s and "-"s on the input wires are mapped onto the output wires with uniform weighting. A typical arrangement for this procedure is shown in Figure 2. At the input, wires from two bundles are interlaced.

—○— DENOTES A BUNDLE

$$n_1' = N \frac{n_1}{n_1 + n_2}$$

$$n_2' = N \frac{n_2}{n_1 + n_2}$$

$$n_1' = N - n_2'$$

$$\text{OR } n_2' = N - n_1'$$

Figure 1. Bundle Signal Restorer

p_1 — : WIRE FROM BUNDLE #1 WITH PROBABILITY OF BEING ACTIVE p_1 .

p_2 — : WIRE FROM BUNDLE # 2 WITH PROBABILITY OF BEING ACTIVE p_2 .

Figure 2. Wire Searching Scheme for Method 1

The signal level of wire #1 of the output is determined by the first n input wires. This is shown by a half-bracket encompassing n wires. The priority of assignment is indicated by numbers along the bracket. To match $2N$ input wires with N output wires, the grouping bracket is shifted by 2 wires for the adjacent output wire.

Referring to Figure 1, let

$$\begin{aligned} n_1 &= \text{number of wires with "1"s in bundle \#1,} \\ n_2 &= \text{number of wires with "1"s in bundle \#2.} \end{aligned}$$

The the probability p_1 that a wire in bundle #1 is active is given by $p_1 = n_1/N$, and similarly for bundle #2, $p_2 = n_2/N$. After two input bundles are combined, there are $n_1 + n_2$ active wires among the total of $2N$ wires, and hence the probability that a wire is active is obtained from

$$\frac{n_1 + n_2}{2N} = \frac{p_1 + p_2}{2} \quad (1)$$

The probability of success in this restoring operation is equal to the probability P_n , of finding at least one active wire among n input wires. If n wires are tried in the way described above, P_n is obtained in the following way:

$$\begin{aligned} P_n &= \text{Prob. \{the 1}^{\text{st}} \text{ wire is active\}} \\ &\quad + \text{Prob. \{the 1}^{\text{st}} \text{ wire is not active, but the 2}^{\text{nd}} \text{ wire} \\ &\quad \quad \text{is active\}} \\ &\quad + \text{Prob. \{the 1}^{\text{st}} \text{ and the 2}^{\text{nd}} \text{ wires are not active, but} \\ &\quad \quad \text{the 3}^{\text{rd}} \text{ wire is active\}} \\ &\quad + \dots \\ &\quad + \text{Prob. \{the first } n-1 \text{ wires are not active but the} \\ &\quad \quad \text{ } n^{\text{th}} \text{ wire is active\}} \\ &= \frac{p_1 + p_2}{2} + \left(1 - \frac{p_1 + p_2}{2}\right) \cdot \frac{p_1 + p_2}{2} + \left(1 - \frac{p_1 + p_2}{2}\right)^2 \cdot \\ &\quad \frac{p_1 + p_2}{2} + \dots + \left(1 - \frac{p_1 + p_2}{2}\right)^{n-1} \cdot \frac{p_1 + p_2}{2} \\ &= 1 - \left(1 - \frac{p_1 + p_2}{2}\right)^n \quad (2) \end{aligned}$$

Consider an example where $p_1 = p_2 = 0.1$ which seems the worst case in a realistic situation. Suppose that this restoring operation is required to be 99% successful, i.e. $p_n = 0.99$. Then the number of wires which have to be tried, n , can be calculated by the above relation. Substitution of these numbers into Equation (2) yields,

$$0.99 = 1 - 0.9^n$$

Solving for n ,

$$n = 43.5$$

This means that 44 wires have to be tried in order for the restoring operation to be successful with probability of 99%.

Method 2: A switching network that tries 44 wires would seem quite complicated. Instead of searching an active wire in this way at one step, trying fewer wires at one time and repeating such a process would be another approach. For example, consider a case where only two wires are tried at one stage and this simpler operation is repeated many times. A typical wire searching arrangement is shown in Figure 3. A 2:1 reduction in the number of wires takes place at the first stage. The assignment priority is again indicated by numbers along the brackets. At the first stage this is done with care so that wires of the two bundles are equally weighted. Beyond the second stage there are always two active wires side-by-side at the output for one active at the input. The local crowding of active wires due to this reduces the effectiveness of the following restoring operation. To avoid this, a random interchange of wires between stages seems useful. Although three such switching stages are shown, it is clear that it can be repeated as many times as desired.

p_1 ——— : WIRE FROM BUNDLE #1 WITH PROBABILITY OF BEING ACTIVE p_1 .

p_2 ——— : WIRE FROM BUNDLE #2 WITH PROBABILITY OF BEING ACTIVE p_2 .

Figure 3. Wire Searching Scheme for Method 2

At the output of the first stage, the probability $P^{(1)}$ that a wire is active is given by

$$\begin{aligned} P^{(1)} &= P_1 + (1 - P_1)P_2 \\ &= P_1 + P_2 - P_1P_2 \end{aligned} \quad (3)$$

The corresponding probability following the second stage $P^{(2)}$ is given by

$$P^{(2)} = 2P^{(1)} - [P^{(1)}]^2$$

In general the probability $P^{(m)}$ that a wire is active at the m^{th} stage is calculated by a recurrence formula:

$$P^{(m)} = 2P^{(m-1)} - [P^{(m-1)}]^2, \quad m = 2, 3, \dots \quad (4)$$

For a given $(P_1 + P_2)/2$, $P_1 = P_2$ yields the minimum of $P^{(1)}$; this is the worst case. For example, for $P_1 = P_2 = 0.1$, if 99% success is desired, $m = 6$, i.e. 6 stages are needed.

Method 3: There are practically infinitely many ways which fall in between the above two methods namely, more than two wires can be tried at each stage and such an operation can be repeated as many times as required. Because of the required 2:1 reduction in the number of wires, an odd number of trials at the first stage is to be avoided, since this could result in an unequal weighting of wires in the two bundles.

Consider a case where the first stage is the same as that in Method 2, and after this stage 3 wires are tried at each stage. Again the effectiveness of the operation is expressed by the probability of finding at least one active wire at each stage. $P^{(1)}$ is the same as before. For the stages beyond the first one, a recurrence formula applies:

$$P^{(m)} = P^{(m-1)} \cdot [1 + \{1 - P^{(m-1)}\} + \{1 - P^{(m-1)}\}^2], \quad m = 2, 3, \dots \quad (5)$$

For example, for $P_1 = P_2 = 0.1$, 4 stages ($m = 4$) are needed to obtain $P^{(m)} = 0.99$.

In order to compare these three cases, let us assume that cost of the total switching network is proportional to both the number of wires tried at one stage and the number of stages. Then the relative measures of cost for the three cases under the conditions of $P_1 = P_2 = 0.1$ and 99% success are:

$$C_1 = 44 \times 1 = 44 \text{ for Method 1,}$$

$$C_2 = 2 \times 6 = 12 \text{ for Method 2,}$$

$$C_3 = 2 \times 1 + 3 \times 3 = 11 \text{ for Method 3.}$$

To see some more about these characteristics, a case where two wires are tried at the first stage and four wires are tried at each stage after the first was considered. Calculations show that $C_4 = 14$.

According to this criterion, Method 3 seems the best, and Method 2 seems nearly as good. For the simplicity of its switching network, Method 2 is to be studied hereafter.

C. Afuso

1.1.2 Fail Safe Bundle Signal Repeater

One of the methods of realizing the bundle signal repeater is to collect the N wires of a bundle into N/b sub-bundles of b wires each, b being a factor of N for convenience. If a wire in a sub-bundle is broken or grounded, it is assigned the value of the adjacent wire; and if the latter happens to be disturbed too, both these wires are then assigned the value of the wire adjacent to the second wire.

Then, if the probability of disturbance between the sending end of the bundle and the first signal repeater is p_1 , the probability of failure of compensation for the sub-bundle is p_1^b .

Moreover, if the probability of disturbance between the first and the second repeater is p_2 , and if the assignment of wires to the N/b sub-bundles of the second signal repeater is random, then the probability of failure of the two-repeater system to compensate is:

$$(p_1^b \cdot p_2)^b = p_1^{2b} \cdot p_2^b$$

For an n -repeater system, the probability of failure is:

$$p_1^{nb} \cdot p_2^{(n-1)b} \cdot p_3^{(n-2)b} \cdot \dots \cdot p_n^b$$

Work has been done on the design of the switching network of the repeater for $b = 2$. Two different mapping schemes have been investigated. The first scheme is to use $+V$ and 0 volts as the signal levels and $-V$ as the disturbance level; while in the second scheme $+V$ and $-V$ are the signal levels and 0 volt the disturbance level. The relative merits of the two mapping methods are being investigated.

Bernard Tse

1.1.3 SABUMA

[SABUMA - Safe BUNDLE Machine. The design of SABUMA formed the M.S. thesis project for Dan Coombes, who has since left. The thesis is being issued as D.C.S. Report No. 412, "SABUMA - SAFE BUNDLE MACHINE". Trevor Mudge has undertaken to complete the physical construction of SABUMA. -- Ed.]

All the major printed circuits cards have been made and wired up. They have also been tested as individual units.

A cabinet was purchased and the racks to take the printed circuit cards were installed. The back wiring has been partially accomplished, ready for testing the cards insitu.

Trevor Mudge

1.2 APE (Project No. 25)

[APE = Autonomous Processing Element. This project involves the design of multi-function, reconfigurable, stochastic computing elements, which communicate with each other and a control unit by radio waves. They also receive their operating power by radio, eliminating the need for any sort of hard wiring. -- Ed.]

1.2.1 Operation of Multiplication and Division

It has been mentioned previously that the mapping between the variable value x_i and its machine number value x_{im} is given by

$$x_i = 1 - 2x_{im} \quad (0 < x_{im} < 1)$$

The machine number value x_{im} can be either in duty cycle representation, denoted by x_{imD} or in SRPS representation, denoted by x_{imS} . Under such a mapping, the operations of multiplication and division take the following forms.

$$\begin{aligned} x_3 &= x_1 \cdot x_2 & \xrightarrow{\text{mapping}} & x_{3m} = x_{1m} + x_{2m} - 2x_{1m}x_{2m} \\ x_3 &= \frac{x_1}{x_2} & \xrightarrow{\text{mapping}} & x_{3m} = \frac{x_{1m} - x_{2m}}{1 - 2x_{2m}} \end{aligned}$$

To do multiplication, machine numbers X_{1m} and X_{2m} are put into SRPS representation denoted by X_{1mS} and X_{2mS} . They are then fed into the inputs of a two-input exclusive-or gate, to perform multiplication. The output X_{3mS} is the product of the two inputs in SRPS representation, as shown in Figure 1.

For the division operation, somewhat more circuitry is involved. Since X_{3m} is necessarily non-negative,

$$X_{3m} = \frac{X_{1m} - X_{2m}}{1 - 2X_{2m}} = \frac{|X_{1m} - X_{2m}|}{|1 - 2X_{2m}|}$$

Figure 1. The Multiplication Operation

Figure 2. The Division Operation

In the form of absolute value, the numerator and the denominator of the last expression can be computed readily with simple circuitry, as shown in Figure 2. The magnitude of the numerator is stored in binary form in counter #1, whereas the magnitude of the denominator is stored in the combination of counter #2 and the True-and-Complement gates. At the beginning of a computing cycle, counter #3 is set to zero and starts to count the output of the SRPS counter. It can be shown that the time it takes for the content of the counter #3 to reach that of the counter #1 is equal to X_{3m} . Therefore the output from the comparator is equal to X_{3mD} , the machine value of the result in duty cycle modulation representation.

Yiu Wo

1.3 Colormatrix (Project No. 27)

1.3.1 Summary

This project uses heat sensitive liquid crystals as the elements of a color display: the color of the light reflected by such elements depends on their temperature. [See previous reports.]

The present scheme calls for a display of eight characters, each character being in the conventional 5 x 7 element format. Thus, each character requires 35 liquid crystal elements, whose temperatures are selectively controlled by a matrix of miniature resistors. The appropriate resistor currents are provided by a set of drivers, seven of which are common to the corresponding rows of all eight characters and the remaining forty for the columns. In operation, the forty columns of the display are driven (pulsed) cyclically.

1.3.2 System Design

A straightforward system has been designed, and is currently being assembled, to demonstrate this technique. Eight characters are entered from a keyboard and stored in a small IC memory, with six bits

for each character. The memory is sequentially addressed by timing circuitry, and the character read out drives a six wire input to an MOS decoder/encoder. The latter has an additional five wire input, one for each column of the 5 x 7 character, to determine the bit pattern on its seven wire (row) output. This output is fed direct to the row drivers of the display, while the column drivers are sequenced in synchronism with the five wire input to the decoder/encoder. A more detailed description will follow in the next report.

S. Hadjistavros

2. HARDWARE SYSTEMS RESEARCH

(Supported in part by the Atomic Energy Commission under Contract US AEC AT(11-1) 1469, W. J. Poppelbaum, Principal Investigator.)

Summary

M. Cooper's LASCOT (Large Screen Color TV) project is now under AEC sponsorship and his reports will henceforth appear in this section. The present one deals with compensation for changes of display intensity in the horizontal direction caused by non-uniform motion of the deflecting mirrors. The OLFIT report by Doug Sand discusses the design of a transition temperature Pockels tube. The ORBIT (On-Line Reduced Bandwidth Information Transmission) project is nearing completion, awaiting only its final few circuit cards. Don Hanson describes a scheme for inputting outlines to the Tricolor Cartograph from a TV camera to supplement the existing manual mode. The Transformatrix report of Larry Ryan's deals with circuitry to implement coordinate transformations, as well as a sample and hold circuit. BLAST (Binocular Lenticular Automatic Stereo Television) is awaiting delivery of its new CRT. Art Simons has some comments on the hardware design of Eidolyzer (Scene Analyzer). Dick Blandford writes about the design of photocell amplifiers and other circuits for LINDA (Line Drawing Analyzer), a pattern recognition project in which symbols displayed on a CRT are expanded to allow their boundaries to intersect detectors at the edge of the tube face. RASER (Random-to-Serial Converter) is a new project being undertaken by Tak Katoh. It is an interface processor and memory which accepts random points (x,y) output from a computer for display and stores them in such a way that they can readily modulate a raster scanned CRT. Some other features of the unit are also described in his report. The Stereomatrix report is mostly by Chuck Pirnat, on an infrared scheme for detecting the observer's position, and Steve Whiteside, on the E-O modulator driver for the display. Finally, there is a preliminary report by Dick Partridge on the proposed design of an analog pattern generator - PAGAN - for regular three dimensional figures. In the first instance, PAGAN will be tailored to suit the input requirements of Stereomatrix.

M. Faiman, editor

2.1 LASCOT (Project No. 09)

2.1.1 Intensity Compensation

The sinusoidal deflection of the horizontal deflection mirror causes the beam to sweep past the middle of the picture at a much faster rate than at the ends. This causes the sides of the picture to be much brighter than the middle portion. To counteract this effect a variable-gain amplifier has been inserted just before the power amplifier (which drives the modulator). The gain of the amplifier is controlled by a signal which tends to equalize the above mentioned intensity variation.

The variable-gain amplifier is a minor modification of the Analog Multiplier used in Stereomatrix (see QTPR Jan., Feb., March 1970, page 34). The printed circuit layout is readily available, and a single card conveniently holds three such circuits -- one for each of the primary colors used in the display.

The variable-gain amplifier will also serve to eliminate the "venetian blind" effect caused by the decay time of the phosphor of the color TV monitor.

Preliminary calculations have been made regarding the intensity of the light source and the components have been ordered.

M. N. Cooper

2.2 OLFT (Project No. 12)

2.2.1 Transition Temperature Pockels Tube

Chinlon Lin has completed his M.S. thesis, entitled "Design Factors for a Transition Temperature Pockels Tube," which will be released as the Department of Computer Science Report #413. In this report many details concerning transition temperature operation are considered, including an analysis of the temperature distribution in the cooled crystal and substrate. However, additional problems remain, including the selection of a suitable electron gun, the design of the crystal assembly incorporating

the thermoelectric cooling elements and the type of secondary electron collection grid to be used. Further, some uncertainty exists concerning the physical and electronic behavior of the proposed cooled crystal assembly, as discussed in the following section.

2.2.2 KD*P Parameter Measurements

In discussions with crystal suppliers it was learned that KD*P crystals now available are of very high purity and deuteration level and, consequently, that the transition temperature characteristics of these new crystals differ considerably from the data available in the literature.^[1,2] In particular, the previous value of the transition temperature, T_0 , was taken to be about 222°K as a practical upper limit, whereas large crystals with $T_0 \approx 230^\circ\text{K}$ are now readily available. Since the value of T_0 and the temperature dependence of other parameters such as the dielectric constant and resistivity are of great importance in the design of the transition temperature Pockels tube, it was proposed that several crystal assemblies used in the room-temperature Pockels tube be analyzed for the desired information.

Since the crystal assemblies are z-cut platelets with one face coated with a conducting layer and glued to a substrate, it will be fairly easy to measure the z-axis parameters ϵ_c and ρ_c . With a special electrode configuration emphasizing field fringing at the edges, it may also be possible to measure the transverse parameters ϵ_a and ρ_a . To this end, a small cold chamber is being constructed which will use dry ice and ethyl alcohol as a coolant. In addition, several temperature sensors (thermistors and p-n junctions) have been calibrated against a master thermocouple junction with an ice-bath reference. These devices, which do not require a temperature reference, will be used for temperature measurement and control in this experiment and later for the same purposes in the Pockels tube.

Doug Sand

- (1) G. M. Loiacono, Mat. Res. Bull. 5, 775 (1970).
- (2) I. P. Kaminow, Phys. Rev. 138, A1539 (1965).

2.3 ORBIT (Project No. 15)

2.3.1 Project Completion

At present ORBIT is in a state of finalization. Except for the addition of the sync circuitry developed by Ed Carr, the design of the system is complete. Several cards which were in a prototype state are being built by the shop. These include a video-to-logic converter and a sync insertion circuit. Complete system drawings are being made and will be completed by the drafting facilities. The only remaining work to be done on ORBIT is the documentation in the form of a thesis.

Peter Oberbeck

2.4 Tricolor Cartograph (Project No. 16)

2.4.1 Video to Binary Converter for Outline Input

The parabolic corrector as described in the last report proved to be inadequate for varying light conditions. Also, the operator would have to be constantly adjusting the circuitry for each different scene surveyed because "whiter" scenes have a different correction parabola than "darker" scenes. This comes about due to the automatic gain control in the camera's circuitry.

We have decided to employ a scheme often used for "Vertical Aperture Correction" in commercial broadcast television. This involves the use of an ultrasonic delay line. For the vertical portions of the outline information it is necessary to delay the video information 150 nanoseconds or so and subtract this delayed signal from the real time video signal. This differentiates the video in the horizontal direction, leaving only vertical outline information. The same thing must be done in the vertical direction to obtain the horizontal outline information. But, in the latter case, two adjacent lines in video (interlaced) occur one field, or more than 16ms, apart. A delay line with a delay time this long would be very expensive if any reasonable bandwidth and S/N ratio were to be upheld. Hence, rather than subtracting directly adjacent lines we have decided to

subtract adjacent lines in the real time sense. Using this technique, we will output two television lines of information for every horizontal boundary instead of just one. To form the composite outline of the subject information, the results of the vertical differentiation are simply added to the results of the horizontal differentiation. This composite outline will be shifted to the right by about 150 nanoseconds and down by two lines. This is compatible with the Tricolor Cartograph because it has suitable adjustments. Another advantage of this new outline input system is that an outline (of some sort) can be derived from a very complex picture or scene input. An outline can even be derived on a near real time basis from a moving picture and a picture where there are rapid light variations. We are assuming that the parabolic curve is not changing appreciably from one real time to the next, and hence will simply be eliminated by the subtraction process. We are in the process of ordering an ultrasonic delay line.

2.4.2 Physical Wiring

The Demodulators have been wired into place and are now a part of the rack. The sync box has been mounted along with all associated rewiring and cable mounting for cables running to the television camera.

Don Hanson

2.5 Transformatrix (Project No. 17)

2.5.1 Project Status

The remaining analog circuits required by Transformatrix were designed during the past quarter. Two of these circuits are described below.

Completion of the Coefficient Processor and output circuitry is expected during the next quarter. Left to be done are several digital control circuits and the assembling and wiring of the operator control panel.

2.5.2 Coordinate Transform

The Coordinate Transform subsection of Transformatrix implements the following transformation of coordinates on the input picture,

$$u = \frac{1}{m}[U \cos\theta - V \sin\theta] - a$$

$$v = \frac{1}{n}[U \sin\theta + V \cos\theta] - b$$

where (u,v) and (U,V) are the coordinates of points in the input and output picture respectively, m and n are the amounts of horizontal and vertical magnification, a and b refer to horizontal and vertical translation and θ is the angle of rotation.

The transformation circuitry for the horizontal input picture coordinate, u, is shown in Figure 1. The voltages, $5 \cos\theta$ and $5 \sin\theta$, are generated by a sine-cosine potentiometer. To produce u point b is shorted to point c. To obtain v the b-c connection is opened, point b is shorted to point a, the resistor from point c to ground is changed to 3.3k, and the sine-cosine inputs are interchanged. A range of magnification of 1/4 to 4 is obtained by varying the input to the VTL2C3 LED controlled resistor from 0V to +5V. The diodes in the feedback loop of the final op amp stage prevent amplifier saturation.

2.5.3 Sample and Hold

Three sample and hold circuits are used in Transformatrix. They perform the following functions:

- 1) Store a voltage corresponding to the average light intensity of the input picture for an entire frame (33ms).
- 2) As an intermediate step in the (Fourier Transform) generation of $|F(K,L)|$, a sample and hold stores $|\text{Re}[F(K,L)]|$ for one cycle (32.5 μ s).
- 3) Store the final CRT z-axis drive signal for approximately 30 μ s.

The configuration of the sample and hold is illustrated in Figure 2. The first LM302 voltage follower buffers the input signal. Upon application of a +3V sample pulse the 2N5638 FET is switched into its low

NOTE:
ALL RESISTORS ARE CARBON, 1/4W, 5%
UNLESS OTHERWISE SPECIFIED
EXCEPT 10K - DALE, MFF, 1/4W, 1%, T-0

Figure 1. Coordinate Transform Circuitry

ALL RESISTORS ARE CARBON, 1/4W, 5% UNLESS OTHERWISE SPECIFIED

Figure 2. Sample and Hold Circuit Diagram

R_{DS} region and the .001 μ f capacitor is charged (discharged) to the input voltage. The 100 Ω resistor from pin 5 of the input LM302 to -15V provides the LM302 with extra drive capability for large input changes. The acquisition time is 2.5 μ s maximum for a 10V input change. When the sample pulse returns to 0V, the FET is switched off with a maximum leakage of 1nA. The second LM302 acts as a high input impedance isolator for the output voltage. The 30k input resistors of both LM302's prevent the LM302's from oscillating when driven with fast ($> 10V/\mu s$) rise and fall time signals. The 30k in parallel with the 3pf input capacitance of the LM302 slows down the input signal enough so the 10V/ μ s output slew rate of the LM302 is not exceeded at the input.

The accuracy of the circuit is 1% full scale for both an abruptly changing input with a 32.5 μ s hold time and a slowly changing input with a 33ms hold time.

Larry Ryan

2.6 BLAST (Project No. 19)

2.6.1 Special Cathode Ray Tube

The new BLAST tube was ordered in August and delivery is expected in late October or early November. Meanwhile, work has proceeded on an inductive coupling scheme for recovering the signal from the screen. This method appears to be more satisfactory than the capacitive coupling technique tried previously. However, it will not be known how well this will work until it is tried with the new BLAST tube.

Larry Wallman

2.7 Eidolyzer (Project No. 23)

2.7.1 Hardware Design

A frame has been designed, built, and installed in the cabinet which will hold all the standard size printed circuit boards. Almost all of these boards have been fabricated and checked out individually. As soon as the wiring of the racks is completed, a full scale test of the entire digital information-handling section will be conducted.

At this time I am awaiting shipment of the power supplies, a few remaining integrated circuits, the photocells with the Wratten filters punched and placed inside the photocell can, and a variety of discrete components.

During the next quarter work will begin on building the photocell matrix and the circuitry which immediately follows it - that is, the Row Analyzer (see QTPR, October, November, December, 1969). This circuitry will be fabricated in the printed circuit facility on 16 boards, each approximately 8" square.

A. Simons

2.8 LINDA (Project No. 28)

2.8.1 Photocell Amplifiers

Amplifiers have been designed and constructed to provide a five volt signal when an expanding pattern edge passes a photocell. The amplifiers are adjustable to allow for differences in individual photocells.

2.8.2 Registers and Decoding

Information from each photocell will be clocked into 4-bit registers. Clocking of the registers begins when a pattern edge passes one or more photocells. The clock continues for four pulses and stops when one or more registers have a logical one in the last place. The registers, clock, and necessary logic have been designed and built and are presently being

tested. Decoders for the register information are now in the design stage. Decoding will be done in such a manner that a given pattern may be recognized regardless of orientation. Simple closed patterns which produce a single logical one in each register are of primary interest at this time.

Future work will be directed at building the decoder and the flying spot scanner. The scanner will be used to put any line drawing on the oscilloscope.

Dick Blandford

2.9 RASER (Project No. 29)

2.9.1 Introduction

In the computer graphic display field the raster format display (of which standard television is a particular type) has certain advantages over a random format type display in some applications. These advantages exist for the following reasons:

- 1) The efficiency of this format when the scanning mechanism does not have a high frequency response, such as for large screen displays using lasers or large screen C.R.T.'s, is greater than for a random format display.
- 2) There is no overflow problem when the amount of information to be displayed is large and the duration of the display time is limited (typically 1/30 of a second).
- 3) Because of the high state of development and the high volume of production of raster type T.V. equipment, costs are generally lower for the display.

The proposed system is named RASER (RANdom to SERial Converter) since the raster format is SERIAL while the data from the computer is RANDOM. The purpose of RASER is to bridge the gap between the random output of a computer and the serial input requirements of a raster display.

The fundamental idea of RASER is depicted in Figure 1. Coordinate pairs (x,y) corresponding to random locations in an xy plane -- with nine bits for each coordinate -- come into the converter at a fixed frequency (e.g. a pair every 1 μ s). The y-coordinate determines the address in a 512 word (512 bit/word) memory with a 1 μ s cycle time. The x-part is converted into a "one out of 512" code that is, a "one" in a string of zeros giving the position in (quantized) analog fashion. By sequentially displaying one word after the other bit by bit, we obviously obtain a raster scan or serial version of the stored information. Note that no grey scale is provided, since this would considerably increase the cost.

2.9.2 Description

The prototype display will be half the size in both horizontal and vertical dimensions, of that just described, to allow it to fit inside a 4096 word by 16 bit core memory having a 1.1 μ s read-modify-write cycle. Thus, eight bits are required from the computer for each x or y coordinate, and the storage of such a pair consumes one memory cycle. This will allow a maximum average data rate from the computer of one (x,y) pair every 1.3 μ s, which can be demonstrated as follows.

We assume a display frame rate of 1/30 sec. In this time 256 lines must be scanned, giving, therefore, about 130 μ s per line. Subtracting about 6 μ s for retrace time leaves 124 μ s, in which period 256 bits, or 16 core words, must be read out for display. Thus, the core memory must furnish the display with one 16 bit word every $124/16 = 7.75$ μ s. This figure is almost exactly seven core cycle times, so that six of these may be used for loading the memory from the computer. If the input data are buffered, as shown in Figure 2, the average rate can therefore be as high as one (x,y) pair every $7.75/6 = 1.3$ μ s.

RASER can also rotate the display 90° by feeding the x part of the (x,y) pairs into the y part of the RASER input and the complement of the y part of the (x,y) pairs into the x part of the input. By exchanging the x part and the y part of the incoming coordinate pairs (without inversion) the display would be flipped around one of the diagonal axes of the display screen.

Figure 1. Fundamental Idea of RASER

DATA PROPAGATE ASYNCHRONOUSLY AND ARE
STORED TILL OUTPUT CLOCK SIGNAL IS RECEIVED

Figure 2. Block Diagram of the Buffer Memory and Relations Among Input Clock Signal of RASER, Read Signal and Write Signal of the Core Memory

The other feature of RASER is its ability to expand the display by 2 or 4 times or shrink it by $1/2$ or $1/4$. Shrinking by $1/2$ or $1/4$ is not difficult since the x and y part of input data are binary and can just be shifted one or two bits with the underflowing bits being deleted. Constants may be added to the x and/or y parts in order to place the displayed information in the proper position. Expanding the display is more difficult since after expansion the space in between the points must be filled. To accomplish this an assumption must be made which contradicts the original assumption of the randomness of the input data. The additional assumption to be made is that the input data is random with respect to the raster scan, but that the input data are successive points on a line or a curve. Thus, when the display is expanded, we can interpolate between two points with first or second order interpolation.

There are several solutions to the interpolation problem:

- 1) Provide a 10 bit x and y coordinate for input instead of an 8 bit coordinate which is the normal input for RASER.
- 2) Convert the input data into an analog signal, expand and interpolate in analog form and then convert the analog signal into digital form for the core memory.
- 3) Similarly, use the same process as in 2 above but operate throughout in digital form.

Method 1 requires a fourfold increase in frequency of operation for the memory and this would be expensive. Method 2 requires a high speed A/D and D/A converter and at $1.3 \mu s$ for processing 8 bits the hardware would be reasonably expensive. However this has the advantage that the expansion would be continuous. Method 3 would require a fourfold increase in the speed of operation of the memory if the data were to be interpolated by an "ordinary" method and then computed.

However, by modification of the method by which the data are written into the memory this problem can be overcome. Although the 16 bit word has thus far been considered to be part of a 256 bit string, it is

equally possible that the 16 bit word be considered to be a 4 by 4 square. Note that when the display is expanded by 4, each input corresponds to a square region whose size is 4 x 4 points. Similarly, a 64 by 64 point plane corresponds to a plane whose size is 64 by 64 squares, i.e. 256 points by 256 points. By examining two or three successive input points 4 points in a square can be quantized simultaneously (i.e. four ones are written into the word in one read-modify-write cycle). Therefore, the frequency is maintained at 1.3 μ s for each input point.

2.9.3 Conclusion

The design and implementation of RASER will entail the following:

- 1) Design and construction of all interface hardware associated with the 4k by 16 bit memory.
- 2) Design and construction of hardware to place the shrunken picture in the proper place on the display screen.
- 3) Design and construction of hardware to pick the proper portion of the display picture which is to be expanded.
- 4) Development of an algorithm for the expansion of the display picture and design and construction of hardware for this algorithm.
- 5) Design and construction of hardware to control the operation modes, i.e. the expansion, rotation, etc.
- 6) Operation of RASER using simulated or actual input and display of the resulting output on a television monitor.

Tak Katoh

2.10 Stereomatrix (Project No. 30)

2.10.1 Summary

A new method for measuring the observer's position has been suggested and some preliminary studies for the feasibility of the method have been carried out. Engineering design of the Transformer has been done and some cards are wired and tested. A driver for the electro-optic modulator of the laser display system has been constructed and tested. Coefficient Generator cards are being laid out and wired.

2.10.2 Observer Position Detector

The phase detection system as described in the last quarterly report had to be abandoned due to the inherent problems of measuring phase in the near field of an antenna.

Several experiments with digital circuits proved to be inadequate to solve the position detection problem.

After careful consideration of past problems, it was decided to try a different approach using a relatively simple optic system in the infra-red. The system presently being evaluated comprises a portable light source at the observer and two rotating infra-red detectors, one located at each side of the screen. The two detectors measure the angle between the observer and the plane of the display at the edges of the screen. The observer's coordinates with respect to the display are then computed from the angular information.

An experiment was performed to determine the feasibility of this system. The equipment for the experiment included a constant speed motor with a polished reflector on the shaft, a phototransistor with power supply, a flashlight with an infra-red filter, and an oscilloscope. Light was easily detected at greater distances than those expected in actual operation.

During the next quarter, a wide angle portable light source will be obtained and a sensitive, selective detector will be developed along with the circuitry necessary to produce the observer's coordinates for input to the transformer.

Chuck Pirnat

2.10.3 Stereomatrix Transformer

Cards are being laid out for the various circuits of the Transformer. D/A converter cards are wired and tested. Most of the components needed for the Transformer are ordered. Rack design and wiring of the system is being considered now.

Shiv Verma

2.10.4 Display

The electro-optic modulator driver has been partially constructed and tested. The 500V power supply for the driver circuit has yet to be built, so the circuit has been tested with a peak doubler circuit (300V). Pulse widths on the order of 300 ns with a peak amplitude of about 290 volts have been obtained with the circuit shown in Figure 1. Turn-off time of the transistors is slow and takes about 250 ns. Storage time of the 2N2219A is 225 ns, so a PNP 2N2905A with a storage time of 80 ns will soon be substituted in a modified circuit. Also a pull-up circuit may be added to hasten the turn-off.

The ultrasonic deflectors are still not completed due to the lack of large, stable lead molybdate crystals. Two or three small crystals stacked end-to-end to form a single large element may be tried as a substitute.

Steve Whiteside

2.11 PAGAN (Project No. 32)

2.11.1 Pattern Generation of a Class of Regular Three Dimensional Figures

As an aid in the testing of three dimensional displays, it is desirable to have a three dimensional test pattern generator. To be useful as a test pattern, the figures displayed should be symmetric and regular. For this project, the class of figures chosen are those with a regular polygon as cross-section. A "stacking" of identically sized and oriented cross-sections will produce cylinders and prisms (e.g. cube). By linearly decreasing the size of the cross-section with height, cones and pyramids (e.g. tetrahedron) are formed. A sphere is created by varying the radius of a cylinder, not linearly, but sinusoidally with height.

Figure 1. Electro-optic Modulator Driver

2.11.2 Representation of Figures

Any display unit will have a limitation in regard to the maximum number of points presentable flicker free. Thus, the three dimensional figures must be portrayed effectively by a small set of points. The loci of points analogous to lines of longitude and latitude will adequately define the shapes of solids. The sets of points corresponding to lines of latitude are the regular cross sections outlined at uniform intervals along the height. To visualize the generation of lines of longitude, imagine that one unique point is displayed on each and every cross section. When the cross sections are "stacked", the locus of the points, one per cross section, is a line of longitude. Thus, by outlining the entire cross section at regular intervals and by displaying only a small number of points on the intervening cross sections, we create a net of lines of latitude and longitude. By restricting the number and location of such lines, we can display the chosen class of polyhedral figures by their edges.

2.11.3 Generation of the Figures

Patterns will be generated with analog circuitry. Synchronization between component sub-assemblies will be digital. A $\sin(\theta)$ and $\cos(\theta)$ waveform will be used to give a circular cross section. If the radius of the circular cross section is varied with the angle θ , the circle can be shaped into a regular polygon. Also, as the cross sections are "stacked", the radius can be decreased to give pyramidal structures. The fraction of points gated to the output determines the extent and number of the lines displayed. The gating is digitally synchronized with the cross section generation. The outputs are three analog voltages corresponding to deflections along the three coordinate axes. An optional analog to digital conversion can transform the output into digital coordinates.

Richard Partridge

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3. COMPUTER SYSTEMS RESEARCH

This work was supported in part by the Department of Computer Science, University of Illinois at Urbana-Champaign, and by the Atomic Energy Commission under contract US AEC AT(11-1)1469.

Reports and Files Written

Levin, Harold LOCAL INFORMATION RETRIEVAL FOR THE SIMULATION AND MODELING SYSTEM, Department of Computer Science Report No. 409, August 1970. Submitted in partial fulfillment of the requirements of the Graduate College for the degree of Master of Science in Computer Science, August 1970.

C. W. Gear
Principal Investigator

3.1 Ordinary Differential Equations (K. Ratliff)

A new subroutine has been written (COMPIL) to correspond to an altered version of the Sparse Matrix Inverter. The subroutine is called by SPARSE to compile code for two other subroutines, MATMUL and MATINV which premultiply a vector by an inverted matrix and invert the matrix before multiplying, respectively. These two subroutines are in turn called by the Differential Equation Solver program.

COMPIL is called with the following parameters:

- I an integer between -1 and 19 which is a code indicating that the initial subroutine instructions should be compiled (I=0), the final instructions should be compiled (I=-1), or the instruction corresponding to the code should be generated ($1 \leq I \leq 19$).
- J an address which is the location of the second operand in an RX instruction ($1 \leq I \leq 5$, $10 \leq I \leq 19$), or the address of the array where data is stored (I=0).
- K an integer which indicates whether single or double precision instructions are to be used (single=0, double=1), or indicates the compiled subroutine to which this call refers.

Possible subroutine instructions are stored in two tables. The first operand is included in the table (in register-register instructions, both operands are included). Where necessary base register and displacement for the second operand are combined with the op code and first operand to form a complete instruction. The instruction is then stored in the code for MATMUL or MATINV. These two routines are provided with the address of the data arrays as a parameter so that the arrays can be relocated after the subroutines have been compiled.

A flowchart for COMPIL follows.

3.2 Simulation and Modeling (SAM) System

3.2.1 Compiler (A. Whaley)

Compiler I--The first compiler converts the output of the Elimination phase into executable code. The form of the equation trees that are output by Elimination have already been discussed elsewhere. The manner in which they are handed to Compiler I is shown in Figure 1.

The first word of "COMPIN" gives the length of the main storage area to be freed when COMPIN is discarded. The address of each of the three equation strings is given. The address of the string is the address of the first equation tree in the string. Each equation contains in the first four bytes a pointer to the next tree. The last tree in the string contains a zero in this position. The trees begin immediately after these four byte pointers.

The output is contained in COMPOUT (Figure 2). Of interest to the user are the entry point addresses of the three subroutines (corresponding to the three input equation strings).

Figure 3 shows the subroutine initialization program used for all three subroutines. SPARMS through SPL is an exact description of the input parameter list for each call.

3.2.2 Global I and II (S. Wilkins)

Two major revisions have been made in network and element definitions which have affected Phase II of Global Analysis.

1. To allow equation specification in network definitions. This allows the user to write equations referencing variables on any node in a network definition. Previously, the only terminal variables which could be used were those as nodes which were also terminals for the element definition equivalent to the network. These equations will be handled in Global II by the same routine that outputs equations for the elements.

2. To allow both positional and keyword parameters on element definitions. To use keyword parameters the user would specify parameters for an element as $P_1 = \text{exp}_{10}$, $P_2 = \text{exp}_{20}$, The specified algebraic expressions would be stored with the element definition as default options. When an element is used, none, any, or all of the parameters may be respecified as $P_i = \text{exp}_{i1}$. If a parameter is not respecified the default option is used. The parameter specifications must always appear as keywords ($P_i =$).

Positional parameters do not have default options. During element definition parameters are specified as $P_1, P_2, \dots$. When the element is used values for parameters may be specified as either $P_1 = \text{exp}_1, P_2 = \text{exp}_2, \dots$ or $\text{exp}_1, \text{exp}_2, \dots$. Every parameter must be assigned a value.

The two methods of parameter specification cannot be mixed on any one element definition.

During Phase II of Global Analysis parameter equations are passed to the equation output routines just like other equations. In the case of expression values for parameters the proper parameter name and an = are added to the lefthand side first. To facilitate later use of the equations, parameter values that are constant or a single variable name are substituted whenever that parameter is used rather than outputting an equation.

3.2.3 Diagnostic I/O (J. Koch)

Full diagnostic I/O involves the trapping of errors in variables during the analysis process, tracing the variable(s) in error through all the internally generated name tables back to the name specified initially by the user, and reporting the errors to the user. Implementation will be started later in the next quarter.

At present, the smaller problem of modifying a copy of the FORTRAN I/O monitor is being attacked. FORTRAN compiled programs will be able to use standard FORTRAN READ/WRITE and FORMAT statements to communicate with the PDP-8.

COMPIN	
0	Length
4	Equation 1
8	Equation 2
12	Equation 3
16	N1
20	N2
24	N3
28	N4
32	3 Equation Strings

Figure 1

COMPOUT	
0	Length
4	Entry Point 1
8	Entry Point 2
12	Entry Point 3
16	Subroutines

Figure 2

```

*
*
*
*
*
SUBROUTINE INITIALIZATION CODE.
*
*
        USING *,R15
        SBGN      STM   R14,R12,12(R13)
                  BAL   R12,SBGN1
                  DS     XL72
                  SCONS  DS     A
                  SPARMS DS     OC
                  TIMEVARS EQU  *-SPARMS
                  DS     A
                  PARAMS EQU  *-SPARMS
                  DS     A
                  OUTPUT EQU  *-SPARMS
                  DS     A
                  MVARs  EQU  *-SPARMS
                  DS     A
                  LVARs  EQU  *-SPARMS
                  DS     A
                  DS     A
                  DS     A
                  SPL    EQU  *-SPARMS
                  SBGN1  DS     OH
                  ST     R12,8(R13)
                  ST     R13,4(R12)
                  LR     R13,R12
                  LR     R12,R15
                  MVC     SPARMS(SPL),0(R1)
                  L       R11,SCONS
                  DROP    R15

```

SAVE AREA.
 ADDR OF CONSTANTS.
 COPY OF CALLING PARAMETERS.
 TIME.
 ADDR OF SPECIAL PARAMETERS ARRAY.
 ADDR OF OUTPUT ARRAY.
 ADDR OF M ARRAY.. INPUT ARRAY. 7XN.
 ADDR OF L ARRAY. N.
 ADDR OF VALUE: 1/H.

Figure 3

3.3 Graphical Remote Access Simulation and Support (GRASS) System

3.3.1 Disk Monitor System (R. Haskin, C. Hyde)

No basic changes were necessary for the current Disk Monitor System this quarter, since the system has proved highly reliable. Several members of the group have been editing, assembling, listing, and running very large multi-bank programs (listings of 100-150 pages!) without problems.

Three hardware-related problems did occur, however. Occasionally, a marginal track would become so bad that a swap could not be accomplished. This was corrected in each instance by changing to a new group of tracks (c.f. section 3.4). Sometimes, though rarely, a track select error is made during exit. Exiting to two tapes has prevented this from being more than just an inconvenience. An elusive hardware bug in the PDP-8 causes the assembler to blow while in pass 3 (listing). The assembler is believed to be the only program sensitive to the problem since it is the only program to spend a considerable amount of CPU cycles in JMP.-1 loops. A patch was made to the assembler to facilitate restarting without data loss for these occurrences (c.f. section 3.4).

Some limited programming was done on the new Disk Monitor System, but "production" usage is waiting until further reliability testing is completed (c.f. section 3.3.4).

3.3.2 Display Terminals (R. Haskin)

A program has been developed for the PDP-8/I to maintain the storage tube terminals (currently: the single computek) that are attached to it. Basically display files are read out of the PDP-8, buffered in the PDP-8/I, and then fed to the terminal. In the other direction, joy stick (X,Y) and text lines input by a user at a terminal are sent to the PDP-8. A chained buffering scheme with storage allocation/deallocation is used, so that all attached terminals can be sent display data simultaneously. In addition, the line that a user types is refresh displayed in write-through (non-storing) mode, enabling typed corrections to appear immediately and in place. Moreover, since the line is not stored in this "line buffer" area, the display need not be erased and regenerated for the user to type his next line in the buffer.

Communication between the two CPU's is accomplished with two software flag words in the PDP-8, one for Input (terminal to PDP-8) and one for Output (PDP-8 to terminal).

- Input:
1. zero means no input yet.
 2. set to nonzero by PDP-8/I means input ready to be processed by PDP-8.
 3. set to zero by PDP-8 means processing of input now completed; ready for more; go to state 1).

- Output:
1. zero means no output yet.
 2. set to nonzero by PDP-8 means output ready to be processed by PDP-8/I.
 3. set to zero by PDP-8/I means processing of output now completed; ready for more; go to state 1).

Flag Designations

- A. Input:
- bit 0 (input ready when on)
 - bit 1-8 (interrupt character)
 - 0 = carriage return (text line)
 - 1-6 = joy stick hit (X,Y)
 - 7-255 = function option (currently unspecified)
 - bit 9-11 (console number)

The input flag is the first location in a 100 word buffer. The remaining words are set as follows:

	<u>text</u>	<u>(X,Y)</u>
word 2	number of characters (max currently allowed = 110 ₈)	Y
word 3	(unused)	X
word 4-77 ₈	six bit packed ascii characters with last set to a 'blank' if count is odd	(unused)

B. Output: word 1 (flag) bit 0-5 (function)

- 0 = enable console
- 1 = disable console
- 2 = input text line to console's
text line display buffer
- 3 = process display file for
console (e.g. display)
- 4-63 = (unspecified)

word 2 data addr (for functions 2, 3)

word 3 character count (for function 2 only)

Display File

The display file input by the PDP-8/I is in the DEC 338 file format, except for the use of the "spare" mode 7. This mode is used to provide special display instructions to the PDP-8/I. Each bit (of bits 3-11) represents an option and the bits are "executed" right to left, so "microprogramming" of options is possible. (option is 'on' if bit is a '1').

bit 11 - disable output of console to PDP-8

bit 10 - erase screen

bit 9 - add frame lines to display

bit 8 - enable output of console to PDP-8

bit 7 - end of display file segment (e.g. another file will be output soon for this console; do not release buffers)

bit 6 - end of display file segment and is last segment (e.g. release buffers for this console; no more display data can be passed to PDP-8/I for this console until current file is completely displayed). Bits 6 and 7 are mutually exclusive.

bit 3,4,5 currently unspecified

Cursor

The hardware inverted 'U' type cursor on the Computek has proved to be only barely adequate. Hence, a software generated "cross hairs" cursor is being investigated. A problem, of course, is how many terminals can be supported in real time by the PDP-8/I when a text line buffer or a large cursor must be continuously refreshed on every terminal.

3.3.3 Information Retrieval Package (M. Michel)

Initial interfacing of this package to the PDP-8 monitor has begun. DSKGET (for swapping program segments) has been checked-out and used extensively.

A slight change in the directory entries is being investigated. The proposed alteration would allow room for a 12 bit type word, a 12 bit user-ID word, and 10 bits for protection.

3.3.4 Disk Interface (C. Hyde)

The new disk interface was completed and final tests were run. Several wiring errors were corrected, and parity error checking was revised slightly. Although other demands on the use of the PDP-8 have prevented extensive testing, the tests run so far indicate an extremely low error rate.

To facilitate the testing of the interface, a new version of the disk monitor system was debugged and tested. Both the interface and the new monitor system proved to be extremely reliable (i.e. no nonrecoverable data errors in a four hour test period). Total conversion to the new interface has been delayed, however, pending further reliability tests.

Programs for diagnostic purposes are being written and should be available during the next quarter.

Programming the New Disk Interface

The disk interface instructions are:

```
6571 : clear disk flags
6601 : load the memory address register from the AC,
      and clear the AC
6602 : load the low order 12 bits of the disk address
      from the AC, and clear the AC
6604 : load the extension word from the AC,
      and clear the AC
6614 : load the word count register from the
      AC, clear the AC, and start the transfer.
6611 : skip on disk done
6621 : skip on disk error
```

The bit assignments for the extension word are:

AC0 : transfer direction (1=Read, 0=Write)
AC1 : interrupt enable (1=Enable, 0=Disable)
AC2 : word count extension bit (high order)
AC3-4 : memory address extension bits
AC5-11 : disk address extension bits

It should be noted that the value used as the word count by the interface is one greater than that supplied by the user. Thus, if 200₈ words must be transferred, the word count specified should be 177₈. It should also be noted that the interface instructions 6601 and 6602 should be issued only before the 6604 instruction to insure proper operation. A sample of a typical disk program follows.

DISKIO,	0	/ENTRY POINT
DKCF		/6571: CLEAR FLAGS
TAD	MA	/MEMORY ADDRESS
DKMA		/6601: TO DISK
TAD	DA	/DISK ADDRESS
DKDA		/6602: TO DISK
TAD	EX	/EXTENSION WORD
DKEK		/6604: TO DISK
TAD	WC	/WORD COUNT-1
DKWC		/6614: TO DISK AND START
DKSF		/6611: WAIT FOR FLAG
JMP.-1		/LOOP
DKSE		/6621: SKIP IF ERROR
JMP I DISKIO		/DONE, RETURN
		/TAKE ERROR EXIT

Further information may be obtained from File No. 861, "PDP-8 Disk Interface," November 1970.

3.3.5 Monitors (M. Michel)

GLASP (PDP-8 Local Monitor)

The overall flow of control and linkage philosophy of GLASP as described previously has been retained, but the code was almost entirely re-implemented this past quarter. The resulting package is much more efficient and "bomb" resistant. Overhead was notably reduced in several routines, including the interrupt handler, the request scheduler, and the input queuer, and in parameter set up procedures. In addition, rearrangement

of page 0 and the console vectors has enabled much more space to be available for program segment usage, (c.f. Figures 1 and 2). Many new "convenience" routines were also added, including routines for loading and storing data in the console vectors, picture control blocks, and parameter areas, as well as routines to aid in picture regeneration (see below). The monitor is 95% debugged and is considered fully operational for the current hardware configuration. A simplified view of the system control and work areas is presented in Figure 3.

GLASP Service Routines

Services that can be requested by program segments running under GLASP currently include data structure management (DSMN), information retrieval (IR), transmission to the 360, transmission from the 360, display processing unit output (DPU), printing on the local Inktronic printer, and printing on the operator's (local) TTY printer.

DSMN, formerly FLOG, has been rewritten from scratch to provide adequately for multi-terminal data handling and to take advantage of the new disk controller as well as the new DPU (e.g. PDP-8/I with storage tube displays). While the console vector is maintained by GLASP and by program segments for controlling console input and services, DSMN uses a picture control block (PCB) for dealing with blocks of data needed by a program segment in communicating with the user at his console. The PCB contains an entry for each data block used, giving the block's size, location, and status (in/not-in core, initialized/not-initialized, fixed/not-fixed, etc.). Room is also provided in a PCB for two scratch areas, one for DSMN and one for the executing program segment (c.f. Figure 4). All data blocks reside in core bank 2 of the PDP-8, which has been divided into 32 pages of 128 words each. The entire bank is under control of an allocator/deallocator/reallocation which assigns or frees core areas and stores or deletes core image copies within the IR system in response to load/store commands. Data blocks fall into two categories: those that contain information for standard display regeneration and those that contain nonstandard data. Provision has been made in the PCB for five standard and five nonstandard

blocks. During an automatic picture regeneration, the standard blocks are used to re-display subpicture instances and their nodes, local lines, and local text. If the program segment wanted to display data in a non-standard block (perhaps a list of names or equations, etc.) separate calls to DSMN and DPU would be used to add this to the display (c.f. Figures 5-8). DSMN is actually composed of about 40 (currently) functional subroutines used to manipulate the data blocks. When called by a program segment, these routines can load, store, initialize, delete, and variously alter the specified blocks and their contents. The program segment never knows exact core locations for data in these blocks; accessing is done by manipulating three special pointers (c.f. Figure 9). DSMN can also construct a special block, a "mnemonic storage block" with essential components to enable a picture to be referenced in another picture as an instance (c.f. Figure 10). When a block must be stored temporarily on the local disk, DSMN calls IR internally with a name generated from the console number plus a type code indicating the nature of the block (c.f. Figure 11). For pictures stored or fetched from the 360, the first 60 words of the PCB are used as a "File Control Block" (FCB) giving the name, user status, and lengths of the component ten data blocks. The complete description of a picture, then, consists of its FCB plus ten data blocks plus mnemonic storage block.

DSMN is currently 80% coded; interfacing to IR is in progress. Flow of control between program segments, DSMN routines, and GLASP as well as all parameter and pointer transferring has been debugged. Enough DSMN routines have been debugged to support all block manipulations as long as the allocator does not run out of core.

IR, described in Report No. 409, August 1970, is being interfaced to GLASP and DSMN. The filing system for the 360 is being specified and implemented to interact with IR as well as requests generated in the 360.

Transmission services to/from the 360 have been 95% coded, but debugging has not been started yet. Calls can be generated internally (by DSMN or IR, etc.) or by program segments. Special automatic functions can be initiated by use of system transmission records (e.g. monitor to monitor commands, etc.)

DPU output facilities are 95% coded and 95% debugged. This service consists of about 20 (currently) functional subroutines for building display files from DSMN blocks (direct program segment calls, etc.) and communicating with the DPU (c.f. section 3.3.2). The service is considered fully operational for the current status of the system.

Inktronic and TTY printer services have been completely coded, but not debugged. A program segment can send a packed line of trimmed ascii characters to either printer with these routines. In addition, the Inktronic routine can be "enqueued" so that a program segment can print many consecutive lines without being pre-empted by some other program segment.

GLASP Program Segments

Several program segments are being implemented and/or debugged. All assume (and use) the partitioning of the display screen described in Figure 12. 'CALLER' has been rewritten to perform both user log-on and program choosing functions. A program segment loaded via 'CALLER' can return it for choosing a new segment. In either case, CALLER first does some maintenance to insure all core and disk areas used by the returning segment have been returned to the system. A generalized drawing segment, GENDRW, has also been implemented. Common functions involving the five standard display blocks will be included in this and perhaps one or two other segments that GENDRW will be able to call. Finally, GSAMV1 the system's first applications program segment, is being implemented. It manipulates two of the nonstandard blocks to obtain data for the simulation and modeling (SAM) system. Whenever functions such as drawing, text editing, instance insertion, deletion, communication, etc., are needed, GSAMV1 can call on GENDRW to do the dirty work. GSAMV1's only main worry is the two blocks peculiar to itself, as it should be.

GLASP Status

Complete hardware/software linkage from the PDP-8 through to the user at a terminal is operational. All control and data flows between GLASP, program segments, service routines, and DPU have been debugged as well

as portions of CALLER and GENDRW. Usable capabilities are beginning to emerge at the user's end, although log-on, line drawing, and test entry are the only functions in operation at present. Barring any disasters, the coming quarter will see sizable gains in this area.

2701 Data Link

Several users exercised the 2701 for brief bursts of short records this quarter. Under these conditions, hardware and software performed perfectly. Personnel was not available to conduct extensive tests. However, testing (or at least usage by users) should increase next quarter.

GRASP (360 Remote Monitor)

No work was done on GRASP this quarter except for discussions concerning its interfacing to the 360 filing system and to console subtasks within the OS/360 HASP environment.

<u>addr</u>	<u>function</u>
0	common temporary storage word
1	} debug/error halts
:	
7	
10	program segment restart stack addr
11	} program segment auto index registers
:	
14	
15	} system auto index registers
:	
17	
20	current console addr
21	} common routine addrs
:	
47	
50	} DPU output flags
:	
52	
53	} Disk flags
:	
57	
60	} Common constants
:	
137	
140	} service parameters (saved/restored upon entry/return from service routines)
:	
147	
150	} program segment scratch area (saved/ restored upon demand only)
:	
177	

Figure 1. GLASP Page 0 Allocation

<u>addr</u>	<u>contents</u>	<u>function</u>	<u>initially</u>
+0	CIF CDF	} service request return data	0
+1	ADDR		0
+2	Request No. (0=free(No Request), >0=Service Requested -1=Service Being Processed)		0
+3	Console Status (0=inactive, 4000=offline, 2000=active, >2000=console input pending)		0
	Input flags: 010 000 00A BCD (A-D=timer, DPU, operator, 2701, respectively)		
+4	Prog ID (0-31)		0
+5	} 'PSNONAMEABCD'		-
...			...
+12			...
+13			-
	USER ID	(8 bits-Acct No, 4 bits- User No.)	-
+14	Interval Duration	} Timer Queue Element	-
+15	Interrupt Address or 0		0
+16	Interval Count		-
+17	Interval Duration Reset		-
+20	2701	} Console Input Prog Entry	-
+21	Operator		-
+22	DPU		-
+23	Timer		-
+24	Screen Seg #1	} Joystick Input Filing	-
...			...
+35	Screen Seg #10		-
+36	SPARE		-
+37	SPARE		-
+40	SVPRM1	} Service Parameter Save	-
...			...
+47	SVPRM8		-
			-
+50		} Page 0 Workspace Save	-
...			...
+77			-
			-

Figure 2. Console Vector Detail

Figure 3. Allocation of System Control and Work Areas

<u>addr</u>	<u>contents</u>	<u>function</u>
+0	Current	
...	<u>File Control Block</u>	Data Block Control
+57		
+60(10)	SPARE	
...		
+64(11)	Mnemonic Availability	Special System Functions
...		
+70(12)	Examine mode	
...		
+74(13)	SPARE	
+100	BLKNUM BLKORG ENTORG POINTER SHDERG SHDPTR	DSMN Exclude Area (copied to page 0 while DSMN executing, then restored)
...		
+117		
+120	MNMOD (0)	
+121	MNCNT (0)	
+122	MNCNTA (0)	
+123	MNRSLS (7777)	
+124	YH	Communications area
+125	XH	(set by program segment, read by DSMN)
+126	YC	
+127	XC	
+130	YSCEN (714)	
+131	XSCEN (1074)	
+132	SPARE	
+133	SPARE	
+134	PCWORK	Program Segment Scratch Area (44 words=72 characters)
...		
+177		

Figure 4. Picture Control Block

<u>addr</u>	<u>contents</u>	
+0	Six character name plus two spare characters	
+4	Total file length in allocated blocks	
+5	PDP-8 load addr (0)	
+6	10-bit protection word	
+7	User ID	
+10(0)	Local lines	
+14(1)	Comment text	} System standard data block control entries
+20(2)	Subpicture instances	
+24(3)	(Reserved)	
+30(4)	Node Connections and Terminals	
+34(5)	User 1	} User defined data block control entries
⋮		
+54(9)	User 5	

Figure 4a. File Control Block

Word 1

CIO 000 ONN NNN

C=0(incore) or 1(not)
I=0(initialized) or 1(not)
NNNNN=**number** blocks allocated or 0

Word 2

FUA AAA AOO 000

F=0(not fixed) or 1(fixed)
U=(reserved)
AAAAA=block addr in DSBANK

Words 3 and 4

(Reserved)

Figure 4b. Data Block Control Entry Detail

Figure 7. Subpicture Instance Block

$$I = \begin{cases} 40 & \text{(subpicture/internal)} \\ 41 & \text{(subpicture/external)} \\ 42 & \text{(local/internal)} \\ 43 & \text{(local/external)} \end{cases}$$

NNN = NOD SEQ # in characters

FO = 'linefeed 0'

Hence node appears as: b003₀

Figure 8. Node Connections and Terminal Block

PCB control contents:

BLKNUM=j (block under consideration)
 BLKORG=A (starting addr)
 ENTORG=B (entry in block under consideration)
 POINTR=C (data in entry under consideration)

block j control entry:

allocated blocks (NNNNN)=LL

core addr (AAAAA)=A

control

data

DS BANK data block:

Figure 9. PCB Control and Data Structure Relationships

Figure 10. Mnemonic Storage Block

bits 0-5

00	= User defined entry
40	= System defined entry

bits 6-11

for user defined entry: arbitrary

for system defined entry:

00	= FCB
01-05	= Standard data blocks
06-12	= Nonstandard data blocks
13-17	= System control
20-37	= (Reserved)
40-47	= Mnemonic storage block
50-77	= (Reserved)

Figure 11. IR Directory Entry Type-Word Detail

Figure 12.. Display Screen Composition Detail

3.4 Computer Maintenance and Construction (C. Carter, I. Cunningham, M. El-Sonni, C. Hyde, T. Kerkering, H. Lopeman, R. Miller, J. Nickolls)

3.4.1 Comutek Computer Graphics Terminal

The purchase order for a graphics terminal was sent to Comutek, Inc., 143 Abany Street, Cambridge, Massachusetts, in July. The order was for:

1. Basic model 400/15
2. Maintenance training
3. Interface, general parallel
4. Joystick and interface
5. Glass Filter
6. Write-through mode

The unit arrived in August and was connected in parallel to the accumulator of the PDP-8/I.

When it arrived the 611 portion would not store and the character generator had a fault in it. Comutek responded quickly by getting a Tektronix field man here for the storage tube and a Comutek man here for the character generator. The difficulties in this unit as we see them now are:

1. The 611 storage tube is not uniform across the writing surface. (This will be common to all suppliers.)
2. Comutek has made no distinction between their letter "O" and their number "0".
3. When using the joy stick cursor with write-through there is no intensity difference, so by the time you can see write-through the cursor is storing. (They promise to cure this.)

It is our plan to buy another unit from Comutek if we get the money soon. Even though it is not perfect it is a useful device for our purposes.

We have ordered a replacement keyboard and another storage tube as spares for the unit that is now in operation. Bob Miller or Harold Lopeman plan to get some maintenance training in Massachusetts this Fall. At the same time we hope to produce most of our cards in-house as repair spares for most of the logic.

3.4.2 PDP-8/630 Hardware

The PDP-7/630 hardware has been dedicated to 360 service for over a year now and has served the timesharing line handling function very well. It operates continuously with five different types of line interfaces. They are:

110 baud	Data set (TTY)	8 ports,
110 baud	Direct connect (TTY)	16 ports,
135 baud	(2741) (2741)	2 ports,
Touch-Tone	(403) Data sets	3 ports,
Fast (100 ch/sec.)	Direct connect	3 ports.

Some investigation is being done to upgrade the communications scanner portion (630) from its discrete logic to integrated circuit packages.

3.4.3 Touch-Tone Receivers

The addition of 403 Data Sets to our PDP-7/630 timesharing hardware has proved to be very useful for 360 users. It allows them, through the use of touch-tone phones, to make direct inquiries as to progress of their job and receive an answer immediately.

There are three such sets operating in this "Jobs-Out Inquiry" mode now.

3.4.4 Small, Fast Read/Write Memory

A small (128 words 12 bits) memory was constructed and tested using Fairchild's 9301 (MSI one of ten decoder) for chip selection and Intel Corporation's 3101 (Bipolar LSI memory--16 x 4) memory cells. This fast memory was interfaced to the PDP-8/I and checked out. With clock pulses up to ten mc. the memory operated within specifications.

3.4.5 Equipment Maintenance Log Summary

Errors Corrected

PDP-8/I

- Several indicator lights on the control panel have been failing. New bulbs have been used to replace the old and a capacitor has been installed on the power supply for the indicators.

Disc (Data Disk)

- Disc track amplifiers have been rearranged to produce as many good tracks as possible. Bad amplifiers were returned to Data Disk for repair and testing.

338

- a. a failure gave a no skip on external stop flag. The fix was to change the address accepted gate termination.
- b. the display address register was counting when not in use. The fix was to replace a bad board in the multiplexor.
- c. the display hung-up on a stop flag. The fix was to replace the board containing the decoder input flip-flop.
- d. many errors had been reported when using the push button box. The fix was to replace the cable connecting it to the 338.

Inktronic

- a. the paper feed clutch had frozen and failed to turn. A complete rework of the clutch fixed the problem.
- b. typical (occasional) errors will be the failure to print in a particular column. Use of the Freon cleaner fixes this problem easily and quickly.

Errors Not Corrected

PDP-8

- Many errors have occurred in the PDP-8 during the last three months. Lack of information and failure to respond to diagnostic testing makes it difficult to pin-point any particular area of the machine. The list below was taken directly from the log.

- A - Machine sometimes halts at Loc 53 during disk swap.
- B - Machine sometimes halts at Loc 50 during disk swap.
- C - Pal sometimes stops at about Loc 5726 (IF1) while printing listing.
It does not stop at the same place each time.
- D - Code blew up in memory bank 1, page 0 or 1.
- E - Memory bank 3 locations 6037, 6040, 6047 indicate errors.
- F - JMP to Loc 0046 (residing at Loc 0047) resulted in a jump to Loc 0006.

PC=000050	ACC=0	LOC 46=6561
MA=000006	L=1	LOC 47=5046
MB= 7772		LOC 50=7200
		LOC 0006=7772

Dectape - Top tape unit is slow (occasionally) to spin tape.

Tablet - The tablet pen switch requires an excessive pressure to bring in the "Z" axis.

As an aid to diagnostic testing, as many check-out programs as possible are being collected and revised for inclusion on a single Dectape. These programs will run continuously (e.g. an error results in a diagnostic message rather than a program "halt") and will read and start the next program on the tape. This will make extensive testing possible during off-shift hours.

3.4.6 Stereomatrix--PDP-8/I Interface (I. Cunningham)

Stereomatrix (Project No. 30) is a graphic system which displays three dimensional wire figures using laser beams. The PDP-8/I will be interfaced to this display in order to supply it with (X,Y,Z) coordinates.

Loading a new set of coordinates for each point is not sufficiently fast to generate a flicker-free picture. Instead, the initial point will be established by loading X,Y,Z registers and the direct memory access facility will obtain X,Y,Z increments (2 increments, 12 bit words). The line will be terminated by a non-incrementing data byte. This permits

a maximum data rate of .75 μ sec./point. Each coordinate uses 10 bits. The remaining 2 bits of the word may contain intensity data which may be loaded simultaneously with any of the coordinate values. A three dimensional cursor is incorporated into the display system and 3 IOT's will be used to read its coordinates.

At present exact IOT formats and hardware are being designed to be compatible with existing PDP-8/I interface hardware.

U. S. ATOMIC ENERGY COMMISSION
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2. TITLE

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3. TYPE OF DOCUMENT (Check one):

- ☐ a. Scientific and technical report
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4. ILLINOIS PATTERN RECOGNITION COMPUTER: ILLIAC III
(Supported in part by Contract AT(11-1)-1018 with
the U.S. Atomic Energy Commission)

4.1 HARDWARE DEVELOPMENTS

4.1.1 Taxicrinic Processors

The design of the control logic for the Taxicrinic Processor control sequence logic has continued. The major emphasis has been toward completing the logic drawings for the control sequences which make up the "core machine". At the present time the basic Memory Sequence control logic has been completed (10 drawings) as well as approximately half of the Operand Stack basic sequences (5 drawings).

The TP portion of the Illiac III Programming Manual has been updated to reflect the latest design changes, especially the section concerning the Supervisor and Operating System. This manual is currently awaiting final typing and printing.

B. J. Nordmann

4.1.2 Fast Core Storage Units

Both core memory units are still operating reliably. One of these core memories (Section 51) has been attached to Local Exchange 0, Unit Post 0- position of the Illiac III Exchange Network. In this position the core memory has been operating reliably and has all of the required attributes of an Illiac III "Unit". (See Section 4.1.6 below).

P. Krabbe

4.1.3 Arithmetic Units

The period under consideration was spent in becoming familiar with the various algorithms to be used in the control of arithmetic unit functions. (Original design of these algorithms was the work of Dr. Dan Atkins, now graduated). The simulation manual

(report #290 DCS) describing the various algorithms was edited and corrections made. In addition, the processing hardware drawings were checked for any logical and drafting errors.

L. N. Goyal

4.1.4 Pattern Articulation Unit

4.1.4.1 Transfer Memory

Power distribution to Sections 2 and 4 has been completed and checkout of the following operations is finished:

- 1) Test Control Panel
- 2) Test Counter
- 3) Control
- 4) Long Word Address Decoder
- 5) Short Word Address Decoder
- 6) Short Word Buffer

Work has begun on the checkout of the short word read magnetics.

About 75% of the TM drawings are in final form.

4.1.4.2 Iterative Array

Power distribution to Section 3 is complete and the IA noise tests were conducted. The results were sufficient to warrant replacing the driver wiring with twisted pairs. Complete details of the tests may be found in File No. 844, "Iterative Array Driver Noise", R. P. Harms, September 3, 1970.

Driver and receiver integrated circuits were specified for use in the driver tree from the control.

4.1.4.3 Display System

The display system drawings were completed and signed off. All local control cards (1018-285) have been checked and final checkout of the system awaits the installation of some cable connectors.

4.1.4.4 Control

The PAU control has been completely defined. It has been divided into 10 phases. Phase 0 consists of the Exchange Net interfaces, the gate registers, the border registers, the gate clocks, the ROM, and the special processors. Phase 0 has been completely flowcharted, about 50% of the logic is designed, and wiring lists for about 20 integrated circuit boards have been completed.

Phase 1 of the control consists of a set of instructions (TOPOLOGY, SETORG, CLEARP, SETP, TESTP, REPLICATE, TALLY, TALLYHO, AREA, ERASEP, COPY, COPYC, PLAND, PLOR, PLNAND, PLNOR, CONNECT, and GATEIA) which exercise all IA gate functions. This phase has been completely flowcharted.

Phase 0 and 1 are sufficient to begin checkout of the IA.

Documentation of the control is proceeding in parallel with the design.

R. Borovec

4.1.5 Interrupt Unit

There have been no new developments in this area because of time spent in other areas having higher priority.

P. Krabbe

4.1.6 Exchange Net

Checkout of the Illiac III Exchange Network has progressed such that error free data transfers are possible between Processor Post 0 and Unit Post 0 of Local Exchange 0. A processor simulator called SPEU (described in the first quarterly report of 1968 in section 4.7.6) is attached to Processor Post 0 and a Fabri-Tek core memory is attached to Unit Post of Local Exchange 0. In this configuration the following sequence occurs: 1) the Processor accesses the Unit via the Exchange Net, 2) the Processor transmits data with parity bits to the unit, 3) the Unit accesses the processor via the Exchange Net, 4) the Unit transmits data with parity lists and status information back to the Processor, 5) the Processor compares

data sent with data received (including parity lists) and halts if an error occurred, 6) if no error occurred the Processor generates new data and repeats the sequence. Two timing measurements were taken as follows:

$T(IBA)$ = the time required for a Processor to secure
a path to a unit via the Exchange Net, i.e.
InBus Access

$T(OBA)$ = the time required for a Unit to secure a path
to a Processor via the Exchange Net, i.e.
OutBus Access

$T(IBA)$ = 315ns measured at Processor Post 0

$T(OBA)$ = 150ns measured at Unit Post 0 of Local Exchange 0

These access times may be reduced later. Currently the Exchange Net timing has been slowed down to facilitate checkout.

P. Krabbe

4.1.7 I/O Processors

A description of the I/O Processors including registers, command repertoire and communication with the individual channels has been completed for the programming manual for the Illiac III computer. Detailed flow charts for the mode of communication between the I/O Processor and the Channel Interface Unit (CIU), covering data transfer on an individual channel, were completed in final form and are now consistent with the recently completed control design for the CIU.

B. H. McCormick

4.1.8 Channel Interface Units

During this quarter, all flow charts were completed and final versions were prepared.

With the exception of the control-to, control-from, control-in and control-out registers, logic design is complete and all logic drawings have been submitted to drafting.

Back plane wiring lists for DTL logic section (with above exceptions) are complete and back plane wiring, for these sections, have been completed for two units.

All mechanical modification of card drawers, for two units, is completed. Logic design, chip-layout, and detailed drawings is over 75% of the integrated circuit cards, are complete. Of these completed items, 60% of the IC card wire lists are finished.

Yet to be completed are the following:

1. Design and drawings of control register logic
2. Design, layout, and wiring lists for remainder of the IC cards.
3. Signal listing and routing.
4. Position of IC cards.
5. Back plane wire listing and wiring of IC card area.

J. Wenta

4.1.9 Device Controller

Work resumed on this function at the end of the quarter. The interface to the Channel Interface Unit (CIU) is fully defined; however, it is yet necessary to define a low-level set of signals by which the various Illiac III devices can talk to the Device Controller (DC). A tentative set has been defined, but it is still necessary to review the DC sequences and the device sequences to validate the completeness of the set.

Val G. Tareski

4.1.10 Scanner-Monitor-Video Controller

The S-M-V controller and its attached 46 mm film scanner and monitor were used this quarter to prepare data for image-processing studies. The pictures were transmitted to the 360 via the PDP-8 and processed using the PAX II language. The S-M-V system was also used in the development of S-M-V software, e.g. the S-M-V test program. (See section 4.2.2, this report.)

This quarter's work on the S-M-V hardware was in three areas:

- . changes and additions to permit digitization of video signals from the large format video camera and the video microscope.
- . logic design for the incremental mode control
- . corrections and modifications to already completed facilities.

As of this quarter the following has been accomplished towards modifying the SMV for digitization of video pictures for storage and play back:

1. The logic design has been completed for necessary changes to existing SMV circuitry.
2. Logic design has been completed for additional circuitry necessary to the task.
3. Itemization of necessary wiring changes are complete.
4. Over 60% of the wire lists, for the necessary additional IC logic cards, have been completed.

The incremental mode logic design is completed.

A few minor problems involving the power supply have been corrected. The Scanner is now producing pictures of high quality in spite of the presence of a small amount of A.C. noise. Figure 1 is a photograph of the monitor screen displaying the digitized output of the scanner. In this example, there are 1024 picture

elements in the vertical direction and 928 in the horizontal. The horizontal dimension appears longer because of the 8:10 aspect ratio of the raster. Figure 2 shows some of the flexibility of the S-M-V system. A window with one-fourth the area of the previous example was scanned using twice the sampling density. The window was then magnified by a factor of two (on the diagonal) and displayed. In both figures, sixteen levels of grey-scale were discriminated.

J. Read & J. Wenta

4.1.11 Scan/Display Devices

The work concentration in the scanner area for this quarter has been on preparing the microscope stages for digital, rather than servo-motor drive. This method eliminates the need for touchy servo system drive design and fringe counting while maintaining $\pm 2\mu\text{m}$ relocation accuracy in X and Y. The stage will now move by $\sim 34\mu\text{m}$ steps rather than continuously. Digital focusing of the slides by $1\mu\text{m}$ steps has been provided. One scanner is being built for flying spot work. The other now contains a high resolution television camera; but it can be restored for flying spot work when necessary.

The large format (14 x 17 in.) television system awaits arrival of the camera bed support. The back illuminator is now in.

The local video distribution network is completely designed and about 85% built. This enables the output of any of the three high resolution television outputs to be switched between or shared among the SMV control (for video digitizing), the character generator (for text insertion on the video), the video graph printer, two remote terminals, and a spare. This is a very flexible and convenient video patch and signal conditioning network.

R. Amendola

FIGURE 1

FIGURE 2

4.1.12 Intermachine Link

The PDP8/Illiad III intermachine link has been operational without error during the last quarter. Final drawings are about 90% cross-referenced.

4.1.13 Low Speed Terminal Network

As indicated last quarter a commercial mini-computer will be used as the data concentrator for the low speed terminals. Bids were let on the machine and a DEC PDP8/E was selected. Anticipated delivery is January 1971.

R. Borovec

4.1.14 Power Distribution

Sections 2, 3, 4, and 6 had power applied to them this last quarter. This makes a total of six sections (including Sections 13 and 14 previously up) out of the 14 sections of the mainframe which now have power. In the next quarter Sections 1 and 5 will have power applied to them.

R. P. Harms

4.2 SOFTWARE DEVELOPMENTS

4.2.1 Supervisor-Processor Interface Definition

The Supervisor-Processor Interface underwent a final reworking this quarter. The Operating System for the Illiac III system is now described in section 5 of the Illiac III Programming Manual, which will be printed soon.

The Illiac III Operating System is charged with the control of all program flow in the Illiac III system. It supervises all operations which the user tasks are either incapable of executing or not allowed to perform. In particular, the Operating System schedules tasks, allocates time and hardware and initiates all I/O operations.

The Illiac III Operating System has three major components: the Executive Program, the Supervisor Program and the Operating System Tables. The Executive Program is primarily concerned with job flow. Job flow involves the process whereby a given input job is broken down into tasks which in turn are scheduled for handling by the Supervisor Program. The Supervisor Program is principally concerned with task flow. Task flow involves the control of a given task during its operation. Thus the Supervisor is directly responsible for time allocation, I/O requests, and other ongoing problems concerning individual tasks. Eventually when the task is finished the Supervisor Program notifies the Executive which then proceeds to schedule the next job.

The Operating System Tables are the data base from which the Executive and Supervisor operate. Items in the Operating System Tables include the Segment Directory, the priority tables, the storage allocation tables, etc.

The Taxicrinic Processors have been designed so that the operations of the Supervisor Program might be facilitated. With this in mind several instructions have been implemented which can be used by the supervisor to perform its assigned functions. This allows the

hardware to perform many of the more mundane system operations, such as interrupt handling, dynamic segment linking, etc.

B. J. Nordmann

4.2.2 S-M-V Test Program

A PDP/8 program was written to demonstrate some of the capabilities of the Scanner-Monitor-Video (S-M-V) system, and to provide a flexible, easy-to-use way of setting up test exercises for the system.

The program works by reading Initial State Assignment (ISA) words from a DEC tape previously written using the SEP program described elsewhere (file no. 830). An ISA word is a block of scanner parameters defining the subset of the raster to be scanned by the flying spot, as well as the sampling resolution, number of bits of gray scale, etc. While composing an ISA word for storage on DEC tape, an operator can specify the length of time each word is to be in effect when executed.

The ISA words subsequently read from the DEC tape are loaded sequentially into Illiac III core via an interface (file no. 839) and each is executed for the specified time. When the last ISA word in the file is read, the program repositions the tape to the beginning of the file and starts over.

To date the program has been used primarily to set up demonstrations for visitors and for maintenance checks.

J. Read

4.2.3 Taxicrinic Processor Simulation

During the past quarter, modifications to existing Simulator Sequences were made.

In addition, four new sequences were debugged. These sequences provide for Pointer Stack Operations: The ASGET sequence obtains a memory cell from Available Space; ASRESTORE returns the cell to the Available Space file. STACKPR makes use of ASGET to obtain a cell from memory, construct a Pointer Field for it, and initiate a memory read into the cell. UNSTACKPR uses ASRESTORE to return a cell to the Available Space mode, and to eliminate its Pointer Field from the Pointer Stack.

By necessity, the DCL Manual "Taxicrinic Processor of Illiac III: Simulation Manual", by Mary Ann Kreger, has been modified to reflect the current status of the system.

J. P. O'Donnell

From the study of this application we hope to develop efficient heuristics for parsing within a global relational-constraint model.

John Schwebel

Reports and File Numbers Issued

File Number

844

Harms, R. P., "Iterative Array
Driver Noise", September 3, 1970.

4.3 IMAGE PROCESSING THEORY

4.3.1 Scan/Display Control

During this quarter, work was begun on a programming system for the PDP-8e to permit interactive use of the Scanner-Monitor-Video facility now in operation. The system has been designated SHOW-AND-TELL to reflect its interactive and picture-processing capabilities.

As of this writing, an overall system design is nearing completion and will be shortly distributed as a file note. Coding has been started on certain well-defined subroutines.

The initial version of SHOW-AND-TELL will be oriented toward development of programs to encode a digitized scene for further processing by global interpretation system. (On the 360, in general.) A design objective is to facilitate the trial-and-error mode of experimentation inherent in producing programs of this type.

The programs to be developed with SHOW-AND-TELL operate on parts of the input picture and have as output a symbolic representation which is much easier to process than the original gray scale raster. The encoding programs are to be based on the plane-parallel operations of the Illiac III's pattern articulation unit.

J. Read

4.3.2 Cellular Mosaic Decomposition of a Scene

Preliminary experiments have been done to isolate regions of interest in a scene by using PAX, the PAU simulator on the IBM 360, operations on digitized pictures. These experiments have shown in particular that a gross segmentation of PAP smear pictures can be done using simple PAX operations.

J. Schwebel

4.3.3 Graph Transformation Grammars

In order to gain insight into the computational complexity involved in implementing a picture processing system using graph transformation models, work on programs for processing abstract graphs of pictures was begun. These programs will be applied to graphs derived from scanning electron micrographs.

The programs are being done in PL/I on the IBM 360/75 and make use of GASP¹ (Graph Algorithm Software Package), which is embedded in PL/I, for some of the graph operations.

The first program completed implements the generalized version of the SEE program which was described in the DCS Quarterly Progress Report for July, August, September, 1969. Simple graph operations are adequate to isolate objects in block like scenes.

The next programs will provide for simplified input data formats, detection of simple closed regions, and for extensions to handle larger data sets so that the more complex scanning electron micrographs can be treated.

J. Schwebel

¹S. Chase, GASP Manual, pp. 114-129 in DCS Quarterly Tech. Progress Report, Oct., Nov., Dec., 1969.

4.4 DOCUMENTATION

4.4.1 Drawings

During this quarter a total of 487 drawings (including drawings related to Opto/Mechanical design of Illiac III scanners) have been processed by 1018 drafting section as follows:

Large drawings	127
Medium drawings	53
Small drawings	30
Layouts	35
Drawing changes	93
Report drawings	7
Miscellaneous	<u>142</u>
TOTAL	487

Twenty two logic layout drawings and flow charts for SMV incremental mode control logic have been submitted to drafting. 50% have been drawn in ink and prints returned for pin number assignment and cross referencing.

TP and CIU control logic drawings were completed (except for final cross referencing) up to current design.

Power Turn-On logic drawings (for stage 4 - Over/Under regulator) are 100% completed and signed off.

TM logic drawings except for cross referencing are completed.

PAU display system drawings all completed and signed off.

PDP/8 Interface drawings are 80% completed including cross referencing and are ready to be signed off.

Twenty one AU processing hardware logic drawings have been redrawn. Alphabetized signal name list has been made to facilitate the cross referencing of approximately 140 AU drawings.

S. Zundo

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5. ILLIAC IV

(This work was supported in part by the Department of Computer Science, University of Illinois, Urbana, Illinois, and in part by the Advanced Research Projects Agency as administered by the Rome Air Development Center, under Contract No. USAF 30(602)-4144.)

REPORT SUMMARY

Diagnostics have been produced for all Processing Element (PE) and Memory Logic Unit (MLU) printed circuit card types, including several new and revised types. Diagnostics have been generated for approximately forty percent of those Control Unit (CU) printed circuit cards for which netlists have been received from Burroughs.

The Combinational logic and path tests were maintained and work continued on the control logic phase of the off-line PE diagnostics.

The software effort continues to make good progress. Operating System I (OSI) is virtually complete and has been run successfully on the Burroughs B5500. However, Burroughs' failure to maintain reasonable progress in delivering a satisfactory B6500 MCP and B6500 Compatible ALGOL may cause some delay while the Operating System is translated to B6500 Extended ALGOL. The detailed specification of Operating System II (OSII) is being resumed.

GLYPNIR, Version II, which allows better array handling and I/O facilities, will be released next quarter. Work is well under way in providing a COCKROACH (ILLIAC IV FORTRAN) to GLYPNIR translator for educational and experimental purposes. The Macro-assembler is being consolidated and properly documented.

The PDP-11 System for the Center for Advanced Computation port to the ARPA net is expected to be delivered during the next

quarter; much of the software has been designed and implemented using a PDP-11 simulator on the B5500.

Project expenditures and commitments through August, 1970:

Burroughs Corporation	\$23,766,784.00
University of Illinois	5,659,542.92

Amendment V to the Burroughs sub-contract is pending approval.

The ILLIAC IV Project Business Office now has an accounting clerk who assists in financial matters and related record keeping.

HARDWARE

5.1 Diagnostics

5.1.1 Logic Simulation

5.1.1.1 PE Simulator

The PE Simulator was used principally for verification of the Burroughs functional tests. Some minor discrepancies between the simulator and the actual PE were discovered and corrected.

5.1.1.2 CU Simulator System

Aside from changes to make the generation of boards more trouble-free and the correction of an error in the automatic naming of files, the CU Card Simulator System has remained unchanged.

The compiler for TESLA (the test language used to generate flip-flop initializations), however, has undergone various changes. A new command (FFRAND) has been added to simulate the effect of random settings when the power for a board has been turned on. This aids in determining whether a series of initialization commands will have the proper effect in all cases. The new TESLA compiler also allows automatic file naming, zipping the appropriate board simulator, and more complete documentation of output. Since various bugs have appeared with the more frequent usage of TESLA, a still newer version is under way and should be operational soon.

Two programs (PUNCH/SIGNALS and PUNCH/STORAGE) were written to create decks for running TESLA.

To facilitate the debugging of TESLA, CUTEST/CONTROL, and any other programs which produce simulator input files, a program to

interpret simulator input (SIMIN/PRINTER) was written. It has proved decidedly useful.

Work on the CU Section Simulator continued this quarter. The I-0 algorithm for partitioning CU cards [1] was implemented, and a system of programs capable of generating input-part and output-part simulator bodies was completed.

5.1.2 Card Test Generation

5.1.2.1 Card Test Generation System

The major problem which has been encountered in running the test generation system on CU cards is the size of the cards, which causes long program running times and the creation of many large disk files. These effects cause some undesirable conditions.

In order to execute successfully any program which requires more than an hour of continuous processor time, it is necessary that the program be able to recover from HALT/LOADS. This has been done for the test-failure cross reference program (CUFAIL/XREF) and will be done for the LOCATE simulator. A HALT/LOAD proof program to print cross reference dictionaries, which may be up to 3000 pages in length, has been written (CUFAIL/PRINTER). Also, to enable programs which have been zipped but have not yet completed execution to restart execution after a HALT/LOAD, all the programs on the system are being modified so that any program may have a data deck.

Large disk files cause situations in which no additional disk space is available to users, making further processing impossible. Because many of the files simply need to be large, this is a difficult problem to solve completely. Disk allocations on any output files that were found to be over-allocated have been cut down. The most helpful solution, to date, has been to load from the board tape only those files which are needed for the programs to be run. To facilitate this, an

automatic loading program (LOADME/WWOFK) has been written which decides from the contents of the tape which files are to be loaded.

Numerous large files have also caused severe cramps in our supply of backup storage medium (magnetic tapes). Various solutions have been attempted with a certain amount of success. Since library tapes are likely to be only partially used at best (particularly for some of the smaller boards) some of the large files, which previously had their own tapes, have been converted to library files and stored on the library tapes. Two utility programs (CUFAIL/COPY and LOCATE/COPY) have been written to accomplish the storage conversion. At present, nearly all tapes are over 70% utilized. The efficient utilization of tapes has the disadvantage of considerably increasing the amount of time to load or dump files to the tapes. Some thought is presently being expended on ways of automatically removing outdated files.

Since there may be as many as 200 to 300 disk files involved in each board by the time test generation is completed, organizational problems can result. A program to print compact and alphabetized tape directory listings (TAPEDIR/WWOFK) has proved valuable in counteracting this problem.

5.1.2.2 Card Test Translation System

Using the experience gained from earlier versions, the final version of the CU Card Test Translation System was implemented and debugged early in the quarter. The new version emphasizes economical usage of both real and process time during its operation. The new, extensively revised, XALGOL version of the PEX compiler proved itself far faster and more efficient than its predecessor. The PEXTAP translators for both the main-programs and initializations were revised to produce in-line code, eliminating hundreds of slow procedure calls and making full use of the eight microsequence memory registers in the exerciser. Consequently, both translation and compilation are

30% faster, with an average process-to-real time ratio of 6:10. The INIT program can be executed from a teletype which speeds creation of initialization code; for example, 50 INITs in 15 minutes.

Wrap-around test procedures in the form of two pseudo-boards, TEST1 and TEST2, were created to test the reliability of the CU Card Tester. This was accomplished by writing two netlists in which all pins were used (half as input and half as output), with each input logically connected to an output pin. Any discrepancies in testing will reflect malfunctions and/or errors in the yet virgin CU Card Tester Exerciser.

5.1.2.3 PE Card Test Generation

Seventeen new or revised PE card logic prints were received at the beginning of the quarter. Tests for these were quickly generated and forwarded to Burroughs.

During the last week of the quarter thirteen more PE card revisions were received. Tests for these will be generated during the first few days of the new quarter. In addition, an invalid test sequence was generated for the A16 card and must be corrected.

5.1.2.4 CU Card Test Generation

Due to personnel changeover, vacations, and machine down-time, test generation fell considerably behind projections this quarter. Nevertheless, the following processing has taken place on the sixty-six board types whose netlists have been received from Burroughs:

Board Simulators Generated	60
Failure Detection Complete	31
Test Tapes Generated	27
Dictionaries Generated	30
Test Tapes Sent to Burroughs	26
Dictionaries Sent to Burroughs	23

The continuing lack of feed-back, due to the non-functioning of the Burroughs CU Card Tester for the entire past quarter, is disheartening.

5.1.3 PE Diagnostics

5.1.3.1 Path Tests

In this quarter the path tests were maintained. The updated path tests have been sent to Burroughs.

5.1.3.2 Combinational Tests

The combinational tests were completed during this quarter. The test sequences have been sent to Burroughs.

5.1.3.3 Control Logic Tests

The control logic test is divided into three main tasks: equation generation, test pattern generation for the logic being tested, and test sequence generation with respect to the PEX and PE.

Updating of the equations is 90% complete. The completion of this first task requires the latest version of the PE backplane netlist which has not been received from Burroughs.

The second task is complete. The algorithm used for test generation is new and unique. The completeness of its fault location capability was reviewed and the study revealed some flaws in the algorithm. A new one has, therefore, been derived.

A file editing program has been written for obtaining the control logic test sequences in PE exerciser assembly language. Initializations for the tests, test data inputs, and expected responses are generated manually. Progress was impaired by a lack of knowledge of the design details of the PE, unavailability of the latest backplane netlist, and inconsistencies between logic diagrams and wire

lists. Greater progress is expected in the future following a better acquaintance with the PE design.

5.1.3.4 Functional Tests

Verification of all but a couple of the Burroughs functional tests has been completed using the PE Simulator. Almost all functional tests were found to be correct. Those containing errors were reported to Burroughs.

SOFTWARE

5.2 Operating System

5.2.1 Operating System I

All modules (see following page) of the operating system except the Job Partner, Hardware Supervisor, and OS4 (that part of the operating system which resides in the ILLIAC IV) are coded, debugged, integrated, and running as a unity on the B5500. A Simulated Hardware Supervisor is being provided for the B5500 integration which will allow the completion of the Job Partner, and the running of OS4 (under the ILLIAC IV simulator) with this integrated system. OS4 has been held up because of the recent discovery of undocumented changes in the interrupt system, which necessitated its rewriting. The Hardware Supervisor is being delayed by the poor reliability of the B6500 and its software. These delays, in turn, prevent the completion of the Job Partner, in the light of Burroughs' statements that Compatible ALGOL will have the lowest priority as far as completion and maintenance is concerned; further delays will be necessitated while the entire operating system is translated from Compatible to Extended ALGOL. Despite these delays, the entire operating system should be integrated and working with the ILLIAC IV simulator by the end of November.

Work is proceeding with the following enhancements to the operating system:

- enhanced communication over the 48-bit path between the B6500 and ILLIAC IV which will allow more diverse control of the system by ILLIAC IV;

—> Job Information Flow
 - -> System Information Flow

Operating System I: Module Configuration

- adding timing and other instrumentation to the operating system (there was none in the original design), to help with its tuning in simulation or with the real ILLIAC IV;
- augmented version of break facilities to help with debugging and scheduling;
- an investigation of scheduling algorithms to ILLIAC IV, including a timing simulation of ILLIAC IV;
- disk map checking facilities in the ILLIAC Control Language, to insure that the disk mapping requested by the user is realizable and to inform him if it is not so before his job execution is commenced.

User, System, and Maintenance documentation is being prepared.

5.3 Compilers and Translators

5.3.1 GLYPNIR

Version II of GLYPNIR will be released very shortly. The major enhancements (compared to Version I) are:

- I/O statements for:
 - a) semi-formatted I/O statements for use with the ILLIAC IV Simulator,
 - b) block oriented, unbuffered disk I/O;
- vectors as a data type (previously, vectors had to be accessed with pointers);
- improved interface with assembly language, allowing easier embedding of Macro-assembler code within GLYPNIR code;

- more extensive standard mathematical routines and
intrinsic for routing, rotating, and shifting.

5.4 Macro-Assembler

The Macro-assembler, as it stands, evolved from the assembler, and, as a consequence, its workings are rather fortuitous. Thus, despite the fact that most users are finding it satisfactory, some bugs occurring in the "evolutionary" part of the Macro-assembler are becoming very difficult to find and correct. This part of the Macro-assembler is thus being re-designed and rewritten. The re-write should be finished by the end of October. It will not affect running programs.

An effort to collect and compile a unified, coherent Macro-assembler Manual from the scattered literature, now available, continues.

5.5 Interactive Communications and Graphics

When it became apparent that the ILLIAC IV might not be located on the Urbana Campus of the University of Illinois, steps were taken to ensure that both the University of Illinois and Burroughs (Paoli) were linked to the ARPA Net. This involves interfacing an IMP to the B6500 at Paoli and an IMP to a PDP-11 at Urbana. Limited graphics facilities will be interfaced to the PDP-11; but the main function of the PDP-11 is to handle ARPA Net and user protocol for the Center. In order to make the best of the limited time available, a PDP-11 simulator, assembler, and a higher level language with which to program the operating system were started. It is anticipated that the PDP-11 will be delivered by the end of 1970 and that the link to Paoli will be operational by April 1971.

• Hardware Status

- the basic system design around the PDP-11 has
been completed;
- the PDP-11 System bid is in progress; the system
is expected to be ordered on October 15, 1970;

- a graphics terminal has been ordered;
- a PDP-11 to IMP interface has been designed, checked, and is under construction;
- the B6500 to IMP interface proposal was returned to Paoli on August 18, 1970 for reconsideration by Burroughs;
- hardware configuration checked at Digital Equipment Corporation August 31, 1970.

- Software Status

- preliminary investigations are under way into B6500 MCP code changes for data-communications;
- PDP-11 System, Version I, is 50% coded;
- a PDP-11 assembler on the B5500 is working and is being extended;
- a PDP-11 simulator on the B5500 is being coded and debugged;
- a single contour line generation routine for ILLIAC IV is being completed and checked;
- a surface presentation routine for ILLIAC IV is coded;
- a Calcomp type plot system for the terminal is being designed.

5.6 Debugging Package

Work on the debugging package has progressed to the stage where a simple version will shortly be made available with the ILLIAC IV simulator on the B5500. Further information is presented in FOURUM Communication No. 26.

5.7 B5500 Operation

	<u>No. of Jobs</u>	<u>Process Hours</u>
July	25,989	180.85
August	19,330	208.62

A few days were lost during the quarter due to air-conditioning problems; these are now solved. There has been a hardware problem with the memory mod files; although it has been fixed, memory checks still occasionally appear--a HALT/LOAD usually restores the machine.

Throughput has been good and response time has been fine. The present status of the MCP is Mark X, LEVEL 36.43.

APPLICATIONS

5.8 Numerical Analysis

5.8.1 Matrix Inversion and Solution of Linear Algebraic Equations

This quarter, the method of Householder triangularization as described in the last QPR [2] was coded in ASK and executed on the SSK simulator. This program, which consists of several routines, inverts a matrix or solves a matrix equation, $AX = B$, where A , B , and X are matrices.

The task at hand is to provide an iterative improvement scheme using the results of the above program. Two routines are coded in ASK: one for improvement of the solution of the matrix equation, and another for improving the inverse of a matrix. The former routine is in a check-out phase on the simulator, and the latter routine, the improvement for the inverse of a matrix, is executing correctly on the simulator.

The procedure for the improvement of the solution is as follows: If X_0 is the result obtained from Householder triangularization, the residual vector or matrix is obtained,

$$R_m = B - AX_m .$$

The correction matrix, S_{xm} , can be found by solving the equation

$$AS_{xm} = R_m .$$

Provided that double precision arithmetic is not used and that the upper triangle and other requisite vectors are saved from the original

reduction, S_{xm} is readily obtained by back-substitution. The improved solution becomes:

$$X_{m+1} = X_m + S_{xm} .$$

The improvement of the inverse involves a similar procedure--without the necessity of solving a matrix equation at each iteration. If X_0 is the result of Householder triangularization, find

$$D_0 = I - AX_0 .$$

Obtaining D_0 , the improved inverse may be derived as:

$$X_m = X_{m-1} (I + D_{m-1}) ,$$

where $D_m = D_0^{2^m}$.

5.8.2 Eigenvalue Problems

5.8.2.1 Jacobi's Algorithm

Jacobi's algorithm for finding eigenvalues of symmetric matrices has been written and debugged and is in the stage of being tested for different-size matrices. A document describing the algorithm and the features of the program, written in ASK, is being written.

5.8.2.2 Eberlein's Algorithm

A Jacobi-like algorithm for real non-symmetric matrices is under investigation. A short description of the algorithm [3] may be presented as: "A matrix, A, is normalized by undergoing a sequence of orthogonal transformations. Once the matrix is normalized (i.e., the matrix $C = (A \cdot A^T - A^T A)$ is arbitrarily small) one is able to reduce the matrix to a diagonal form and, thus, obtain the eigenvalues of A."

The orthogonal transformation matrices are of the form:

$$(1) \quad M_{\ell} = \begin{cases} (I_{1u} \cdot I_{2v}) & (u, v) \text{ different from } (2k-1, 2k) \forall k \\ I & \text{otherwise} \end{cases}$$

This transformation is used to speed up the rate of convergence.

(u, v) is found by searching for $\max |c_{ij}| (i \neq j)$. The transformation brings the element, c_{ij} , thus found, into the position $(2k-1, 2k)$, where it will have the most appreciable effect on the convergence of the algorithm.

$$(2) \quad P_{\ell} = \text{diag } (T_1^{(\ell)}, T_2^{(\ell)}, \dots, T_{n/2}^{(\ell)})$$

$$\text{with } T_k = \begin{bmatrix} \cos \varphi_k^{(\ell)} & \sin \varphi_k^{(\ell)} \\ -\sin \varphi_k^{(\ell)} & \cos \varphi_k^{(\ell)} \end{bmatrix}.$$

$$\varphi_k \text{ is determined by } \tan 2\varphi_k^{(\ell)} = \frac{c_{2k-1, 2k-1}^{(\ell)} - c_{2k, 2k}^{(\ell)}}{2c_{2k-1, 2k}^{(\ell)}}.$$

The orthogonal matrix, P , is chosen such that the off-diagonal elements, $c_{2k-1, 2k}$, for all k attain their maximum positive value.

$$(3) \quad Q_{\ell} = \text{diag } (S_1^{(\ell)}, S_2^{(\ell)}, \dots, S_{n/2}^{(\ell)})$$

$$\text{with } S_1^{(\ell)} = S_2^{(\ell)} = \dots = S_{n/2}^{(\ell)} = \begin{bmatrix} \cosh \psi_{\ell} & \sinh \psi_{\ell} \\ \sinh \psi_{\ell} & \cosh \psi_{\ell} \end{bmatrix}.$$

ψ_ℓ is derived from:

$$\tanh 4 \psi_\ell = -2k_2(A'_\ell) k_1(A'_\ell) ,$$

where

$$A'_\ell = (M_\ell P_\ell)^T A_\ell (M_\ell P_\ell) ,$$

with

$$k_2 = \sum_{k,m} D_{km} E_{km} \text{ and } k_1 = \sum_{k,m} (D_{km}^2 + E_{km}^2)$$

$$D_{km} = (a_{2k-1,2m-1} - a_{2k,2m}) \text{ and } E_{km} = (a_{2k-1,2m} - a_{2k,2m-1}) .$$

Where (1), (2) and (3) are applied to $A_{\ell+1}$, i.e.,

$$A_{\ell+1} = (M_\ell P_\ell Q_\ell)^{-1} A_\ell (M_\ell P_\ell Q_\ell) ,$$

$$\Delta N^2(A_\ell) \rightarrow 0 \text{ as } \ell \rightarrow \infty, \text{ hence } N^2(C_\ell) \rightarrow 0 ,$$

A_ℓ is arbitrarily close to being normal.

The following tests were undertaken in an attempt to find when A is close to being normal for a finite ℓ .

Tests showed that when plotting $\Delta N^2(A)$ against ℓ , the rate of convergence levels off at $\Delta N^2(A) = O(10^{-10})$ rather quickly, but the matrix, A , does not show satisfactory normalization.

Tests also showed that at $\Delta N^2(A) = 0(10^{-10})$ the elements of c and, especially, $\max |c_{ij}|$ begin to oscillate as soon as they reach the order of $\epsilon = 10^{-5}$. This oscillation is critically reflected in the transformation matrix, F , which is close to the identity-matrix at that point and, therefore, does not contribute significant changes in A toward normalization.

A suggestion which might solve the problem is to check

$$F = |c_{2k-1,2k-1} - c_{2k,2k}| \leq 10^{-b}, \text{ where } b \text{ ranges from } 1-3.$$

If this test is satisfied, then ϕ_k should not be determined by using $F \neq 0$, but rather by using the ϕ_k for $F = 0$ [3]. Investigation for determining a most general b and its effect on the matrix under consideration is under way--early indications show promising results.

5.8.2.3 QR-Algorithm

The ASK program for finding eigenvalues of up to 64×64 real Hessenberg matrices using the QR-algorithm [4] has been written. The program is currently in the final stage of being debugged on the SSK simulator; it is expected to be complete by the end of October.

5.9 Linear Programming

Assembly and simulation of segments of the Linear Programming System (LPS) code continues as a major task of the linear programming group. The LP project has been allocated one hour each day of priority use of the B5500 computer for this purpose. During this time an average of approximately 2 ASK compilations and 2 SSK simulated executions can be run. The inclusion of macro instructions in the ASK code stream significantly increases the compile time over that of non-macro codes. Most of the LP codes now contain the macro I/O instructions discussed in the previous QPR, and thus computer throughput has been reduced.

Software efforts of the LP group have included debugging the LP I/O macros and developing subroutine linkage conventions for ASK applications programs. User documentation for the I/O macros has been provided.

Code development for the LP matrix reinversion routine, INVERT, was begun this quarter. A modular system flowchart was drawn up for the inversion procedure discussed in "An Error Analysis of Solutions to Sparse Linear Programming Problems" by R. Jonathan Lermitt [5]. Many modifications had to be made in the implementation design of this algorithm. Detailed flowcharts and ILLIAC IV assembly code were produced for the initial data processing modules of the INVERT routine.

At a recent meeting, the 7th Mathematical Programming Symposium held in the Netherlands, E. Hellerman and D. Ranck presented a paper entitled, "Reinversion with the Preassigned Pivot Procedure", outlining an LP inversion technique which produces an improved inverse. It is claimed that implementation of this scheme for the CDC and IBM LP systems performs reinversion six to ten times faster than the previous procedure and substantially reduces the number of non-zeros in the inverse matrix file. In discussions with one of the authors, it was determined that this scheme is suitable for the ILLIAC IV LP system. The code already produced for the previous INVERT design is still applicable; new system module flowcharts will be developed during the next quarter.

5.10 Long Codes

Following an extensive revision to provide better documentation, the system identification programs were used to study the ability of the identification algorithms to estimate the parameters of linear dynamic systems under a variety of conditions. In order to study the effects of varying levels of noise contamination, the variance of the essentially Gaussian noise vectors added to the system state vectors (plant noise) and the variance of the noise vectors added to the observation vectors (observation noise) were independently varied by

scaling the noise vectors used. The observed vector for a given time step should be affected by the observation noise vector occurring at the current time step only, while plant noise vectors from previous time steps should affect the observation through the transition matrix. Since it is desirable to have the noise terms for a given time step uncorrelated with the noise from previous time steps, plant noise was expected to have a more detrimental effect on the accuracy of the identification process than observation noise. The experiments conducted, however, showed the reverse is often true. To cope with this, a new algorithm specifically designed to minimize observation noise contamination has been developed and is being implemented. Studies were also begun to determine the ability of the identification algorithms to identify systems formed by subjecting transformation matrices in the more desirable companion matrix form to arbitrary non-singular similarity transformations.

5.11. Large Scale Planning

Much of the work in this area during the past quarter has been concentrated on the geometric matrix generator mentioned in the last QPR [2]. The rationale for this generator, its preliminary specification, and a brief discussion of a proposed report generator follow.

5.11.1 Matrix Generator

Since linear programming matrices are typically very sparse and contain repetitive, dense sub-arrays of non-zero coefficients, they lend themselves to formulation by the use of matrix-generation codes. There are several possible approaches to the problem of matrix generation, including model-specific generators, generators based on algebraic functions relating variables, and generation languages. The approach to be used here is that of language. Since the number of geometric structures which occur as sub-arrays within a linear programming matrix is small, the generator language is designed to allow the user to define

sub-arrays in geometric terms, and build a matrix for a specific problem by providing dimensions and coefficients for these sub-arrays.

The structures occurring in linear programming matrices are:

- (i) point;
- (ii) row;
- (iii) column;
- (iv) square;
- (v) rectangle;
- (vi) parallelogram;
- (vii) diagonal;
- (viii) band;
- (ix) lower band;
- (x) upper band;
- (xi) lower triangle; and
- (xii) upper triangle.

Structures (vi) through (xii) have left and right mirror images, which are themselves structures. Also, a band matrix is an extension of a diagonal and can be represented as 5-diagonal, 3-diagonal, etc. "Upper band" and "lower band" are structures in which exists the main diagonal with one or more secondary diagonal(s) above or below it.

Since these structures, in combination, form the structure of a sparse matrix, their existence can be exploited to form a linear programming matrix. This is the philosophy of the matrix generator.

In order to use this principle to create a matrix, it is necessary to define the structure required for a sub-array, its location in the matrix, its dimensions, the coefficients to be inserted, and the number of times the structure is repeated across the matrix.

Sub-array location in the matrix is defined by an (x,y) coordinate system, with (0,0) at the northwest corner of the matrix. This coordinate system is also used to identify the blocks of columns and rows to which the specific real-world activities and constraints

relate. (User-generated real names can be input and passed to the report generator for solution interpretation.)

The characteristics of the structure definitions are:

- (i) POINT
 - Size - none given
 - Value - only one number
 - Repeat Factor - single element repeated horizontally by number given as repeat factor
- (ii) ROW
 - Size - one number gives number of columns spanned
 - Value - values given are accepted, one per column.
If the number of values is less than the given size, the last value is repeated for the remaining columns.
 - Repeat Factor - row structure defined is repeated specified number of times.
- (iii) COLUMN
 - Same as ROW, mutatis mutandis
- (iv) SQUARE
 - Size - one number taken as the number of rows and columns
 - Value - only one number given, which is assigned to all S^2 elements
 - Repeat Factor - horizontal repetition of the S^2 substructure
- (v) RECTANGLE
 - Size - two numbers are accepted, with c referring to columns and r to rows
 - Value - one number is assigned to all cr elements
 - Repeat Factor - horizontal repetition of cr-element substructure
- (vi) PARALLELOGRAM [Left and Right]
 - Size - two numbers, the first refers to number of elements in each diagonal and the second to the number of diagonals
 - Value - number of values equal to the number of diagonals accepted, the first referring to the uppermost and the others to lower diagonals, in order
 - Repeat Factor - horizontal repetition
- (vii) DIAGONAL [Left and Right]
 - Same as ROW, mutatis mutandis

(viii) BAND [Left and Right]
 Size - two numbers accepted; the numbers of
 diagonals, b, and the number of elements
 on the main diagonal, d. The number of
 elements on adjacent subdiagonals is
 d - 1.
 Value - as for PARALLELOGRAM
 Repeat Factor - matrix of size d x d with banded structure
 is repeated horizontally

(ix) LOBAND [Left and Right]
 Same as BAND

(x) HIDAND [Left and Right]
 Same as BAND

(xi) LOTRI [Left and Right]
 Size - one number, d, is taken as the size of a
 square submatrix
 Value - each number given is used as the value
 for all elements of one lower triangular
 matrix. A sequence of numbers will
 define an equal number of lower trian-
 gular matrices, with entries equal to
 the numbers in the sequence.
 Repeat Factor - the sequence of lower triangular matrices
 defined by the given values are repeated
 horizontally

(xii) HITRI [Left and Right]
 Same as LOTRI

The matrix generator will permit the user to structure his model using declarations giving the starting coordinates, the sub-structure, its dimensions, the value(s) to be inserted, and the repeat factor. For example, the statement

50,100;LOTRI(50):1.0*10

causes the generation of a 50 by 50 left-lower triangular matrix of values 1.0, starting at row 50 and column 100, and repeated 10 times horizontally. This one statement thus generates 12,750 matrix coefficients which would have been entered, using conventional means, as 12,750 entries <ROW NO. COLUMN NO. VALUE>. Similarly, the statement

400,1000;COL(12):LABORA*50

will create 50 contiguous columns of 12 values drawn from a file named LABORA, starting at row 400 and column 1000. The conventional procedures would have required 600 card entries to input these data.

5.11.2 Report Generator

A major source of the costs of using linear programming is that of interpretation of solutions. In the conventional use of linear programming the solution output, consisting of lists of basis vectors and details concerning them, must be manually interpreted. When the model is of the magnitude of a sectoral model, the task of interpreting the solution is formidable and costly. The objective of a report generation system is to facilitate the output of interpretive reports of the solution to a linear programming problem.

The report generator to be developed here is closely related to the matrix generator discussed above. The real-world names of activities and constraints will be defined by the user as input to the matrix generator. The sets of columns and rows spanned by these names will be given dimensions in terms of the (x,y) coordinate system used by the matrix generator. This will enable the report generator to match the real-world names with the column and row names internally assigned by the linear programming code. Report formats will be variable and will allow some user-defined variations dependent on the requirements of the decision makers receiving the output. This will be accomplished by allowing the user to specify the sets of linear programming output to be passed through the report generator. For example, if the user desires the marginal products of certain limiting resources, he will be able to specify these by an input declaration which will cause the linear programming "reduced costs" to be output in the report.

5.11.3 Sector Model

The generalized sector model is also in the definitional phase. The philosophy being followed is that of generic activity and constraint

sets which can be reproduced by the matrix generator under parameter control. The next report will discuss the model philosophy in more detail.

5.12 Signal Processing

The matrix convolution program is being extended to handle matrices with column dimensions in excess of 64. It is anticipated that this effort will be completed and documented in the first half of the fourth quarter. The program, written in ASK, currently is operational for the convolution of two matrices whose resulting matrix has 64 columns or less.

A preprocessor program to read 9-track input tapes and set up tables and file allocations for all line, shot, velocity and normal move-out information is approximately 25% complete. This program is being written for the B6500 computer to organize the data for operations in the ILLIAC IV, utilizing ILLIAC IV as: 1) a group of 64 serial computers; 2) a group of 128 serial computers using 32 bit mode; and 3) using the parallel concepts developed in the signal processing programs previously written as well as those planned for future development.

5.13 ILLIAC IV Education

5.13.1 Education

5.13.1.1 ILLIAC IV Text

The initial version of the ILLIAC IV textbook to be titled "An Introductory Description of the ILLIAC IV System" will be issued next quarter. Updated material will be sent to the FOURUM members who request copies of the book. Thus the distribution will be handled like that for the "Systems Characteristics and Programming Manual."

5.13.1.2 ILLIAC IV Seminars

Following is the outline of a two-day seminar on ILLIAC IV that was held on August 24th and 25th. Two more of these seminars are planned for next quarter.

August 24, 1970

Background	1 Hour	9:00 - 10:00
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Functional Components of a Computer

Buffer Concept -- IBM 7090, Overlap of Operations, Example

Pipeline Concept -- Pipelined Adder, Pipelined Instruction Execution, IBM STRETCH

Array Processor -- SOLOMON

Multiprocessors -- Multiprogramming and Multiprocessing, General Multiprocessor, Intrinsic Multiprocessor

ILLIAC IV

Hardware Structure	5 Hours	10:00 - 12:00 2:00 - 5:00
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ILLIAC IV Array -- General Description, Two Illustrative Problems, Data Allocation Considerations, A More Refined Description

ILLIAC IV Input/Output (I/O) System -- I/O Subsystem, Disk File System, B6500 Control Computer, Datacommunications Processor

Test/Repair Equipment and Diagnostics

August 25, 1970

Software	5 Hours	9:00 - 12:00 2:00 - 4:00
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Programming Languages -- ASK, GLYPNIR, FORTRAN

Operating System

Utilities

Capabilities and Applications	1 Hour	4:00 - 5:00
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5.13.1.3 CS-491-B

The graduate course "Architecture, Applications, and Languages for a Parallel Computer" (Computer Science 491-B) is being offered again this fall. The outline follows:

I. Background

8 classes

- A. Functional Components of a Computer
- B. Buffer Concept
 - 1. Overlap of Operations
 - 2. Example
- C. Pipeline Concept
 - 1. Pipelined Adder
 - 2. Pipelined Instruction Execution
- D. Array Processor
 - 1. SOLOMON
- E. Multiprocessors
 - 1. Multiprogramming and Multiprocessing
 - 2. General Multiprocessor
 - 3. Intrinsic Multiprocessor
- F. ILLIAC IV

II. Hardware Structure

14 classes

- A. ILLIAC IV Array
 - 1. General Description
 - 2. Two Illustrative Problems
 - a. Summing an Array of Numbers
 - b. Relaxation Solution to Laplace's Equation in Two Dimensions
 - 3. Data Allocation Considerations
 - 4. A More Refined Description
 - a. Processing Element
 - b. Processing Unit
 - i. Processing Element Memory (PEM)
 - ii. Memory Logic Unit (MLU)
 - c. Control Unit
 - i. Advanced Station (ADVAST)
 - ii. Final Station (FINST)
 - (a) Final Queue (FIQ)
 - (1) Final Data Queue (FDQ)
 - (2) Final Instruction Queue (FIQ)
 - iii. Memory Service Unit (MSU)
 - iv. Test and Maintenance Unit (TMU)
 - v. Instruction Look Ahead (ILA)

- B. ILLIAC IV Input/Output (I/O) System
 - 1. I/O Subsystem
 - a. Control Descriptor Controller (CDC)
 - b. Input/Output Switch (IOS)
 - c. Buffer Input/Output Memory (BIOM)
 - 2. Disk File System
 - 3. B6500 Control Computer
 - a. CPU
 - b. Memory
 - c. Multiplexor
 - d. Peripherals
 - 4. Datacommunications Processor
 - a. Remote Terminals
 - b. Interactive Graphics
 - c. Microfilm Printer
 - d. Laser Memory
 - e. ARPA Network
- C. Test/Repair Equipment and Diagnostics
 - 1. Processing Element Exerciser (PEX)
 - 2. Processing Element Memory Exerciser (PEMX)
 - 3. Control Unit Card Tester (CUCT)
 - 4. Diagnostics

III. Software

15 classes

- A. Operating System
 - 1. General Philosophy
 - 2. ILLIAC IV from the Users Point of View
 - 3. Details of Operating System
 - a. Burroughs B6500 MCP
 - b. Job Parser
 - c. The Creeper
 - d. Disk Management
 - e. Collector and Loader
 - f. Job Partner
 - g. Operating System IV
 - h. Data Processor on Other Modules
 - 4. Implementation of the Operating System
- B. Programming Languages
 - 1. General Philosophy and a Brief History
 - 2. The Assembler System
 - a. Assembler
 - b. Macro Generator
 - c. Simulator
 - 3. Intermediate Languages
 - a. GLYPNIR
 - b. FORTRAN
 - 4. Higher Level Languages
 - a. Experience with TRANQUIL
 - b. APL
 - 5. Implementation Techniques

C. Utilities

1. Data Communications Software
2. Program Debugging Software
3. Statistical Package
4. Linear Programming Package

IV. Capabilities and Applications

3 classes

5.13.2 Documentation

5.13.2.1 Quarterly Progress Report

The distribution list of the ILLIAC IV QPR has been effectively decreased by approximately 200 people as the result of a "weeding" letter to QPR recipients.

5.13.2.2 FOURUM

Requests for research documents have been steadily received from FOURUM subscribers since the publication of the July issue of FOURUM.

One hundred documents per month have been requested by FOURUM members (outside the University of Illinois).

ADMINISTRATION .

5.14 Administration and Services

5.14.1 Financial Report

Actual expenditures and commitments for July and August, 1970:

	<u>July</u>	<u>August</u>
Burroughs Corporation	\$714,784.00	\$431,000.00
University of Illinois	210,074.86	198,097.02

Expenditures and commitments to date--through August, 1970:

Burroughs	\$23,766,784.00
University	5,659,542.92

Budgeted expenditures--First Quarter, Fiscal Year 1971:

	<u>July</u>	<u>August</u>	<u>September</u>
Burroughs	\$244,630.00	\$239,078.00	\$167,502.00
University	195,398.00	195,398.00	195,398.00

5.14.2 Personnel Report

Project personnel strength:

Professional	42 1/4
Non-Academic	18
Research Assistants	26
Hourlies	24
Illini Girls (Secretarial Assistants)	<u>7</u>
	117 1/4

The ILLIAC IV Project Business Office now has an accounting clerk who assists in financial matters and related record keeping.

5.14.3 Contract Status

Amendment V to the Burroughs sub-contract is pending approval.

The building designed to house the Center for Advanced Computation is within approximately thirty days of the originally scheduled occupancy date of January, 1971.

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6. NUMERICAL METHODS, COMPUTER ARITHMETIC AND ARTIFICIAL LANGUAGES

6.1 Approximation of Continuous Functions by Non-Negative Algebraic Polynomials

The usual approach to study approximation of a continuous function $f(x)$ by algebraic polynomials is to make the transformation $x = \cos \theta$, and then study the approximation of the continuous, even and periodic function $f(\cos \theta)$ over $[0, 2\pi]$ by trigonometric polynomials. Korovkin's well-known theorem (see [1], Lemma 13.3.4) is the general result in this connection; and Jackson's theorem ([1], Theorem 13.3.7) is deduced from it for algebraic polynomials by reverting back to the x variable.

Attempts have been made to study the approximation of a continuous f by algebraic polynomials independently of the trigonometric approach. Some of these 'direct' methods, however, make use of certain auxiliary results like those on the degree of approximation by linear positive operators and approximation of functions of class $Lip\ 1$.

We studied this problem. We have been able to establish a result, corresponding to Korovkin's theorem, which gives an estimate for the approximation of a continuous function f by polynomials resulting from the convolution of f with a non-negative algebraic polynomial p_n . Jackson's theorem can be deduced from it by choosing a particular p_n whose second Chebyshev-Fourier coefficient is sufficiently close to -1 .

The results are to appear in [2].

M. M. Chawla

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We studied a factorization method due to Stone [3]. We discovered that the iteration (1) is convergent if and only if

$\text{Re}[\lambda_i(A^{-1}B)] > \frac{\omega}{2} - 1$, where Re denotes "the real part of", and $\lambda_i(A)$ is an eigenvalue of A . It has been shown that the

$$(A + B)T_{N+1} = (A + B)T_N - \omega(AT_N - q) \quad (1)$$

symmetric Stone factorization yields a positive definite $(A + B)$, [1].

We showed that for any iteration (1) with A and $A + B$ positive definite the following hold:

1. There is convergence if and only if $A + 2B$ is positive definite;
2. There is convergence if and only if $\omega < 2/\lambda_{\max}((A + B)^{-1}A)$;
3. The best choice for ω is $\omega_B = \frac{2}{\lambda_{\max}((A+B)^{-1}A) + \lambda_{\min}((A+B)^{-1}A)}$;
4. With ω_B as defined in 3 the spectral radius of the iteration matrix is $1 - 2\lambda_{\min}((A + B)^{-1}A)\omega_B$.

We also showed that the factorization due to Dupont, Kendall, and Rachford [2] is convergent for $\omega \leq 1$ whenever the main diagonal of $A + B$ is greater than or equal to the main diagonal of A .

M. Diamond

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6.3 Computerized Mathematics

During this quarter, we finished our work on translating the λ -calculus into the theory of types, also called n-sorted logic. We have found a suitable set of axioms which guarantee that models of statements in n-sorted logic give rise to Henken realizations of the corresponding statements of the λ -calculus. We visualize these axioms as being incorporated into a resolution style theorem prover as additional rules of inference, much as paramodulation was introduced to replace the equality axioms. To show how this might be done, we modified our old first-order theorem-prover enough to handle some "small" second order theorems from "Introduction to Mathematical Logic" by Church. We added two sections of code to handle certain of the axioms as new rules of inference and some new storage areas for extra bookkeeping. Very little of the old code needed modification. These modifications took less than twenty hours of coding and debugging. This points up one advantage to theorem provers of the kind we are proposing: they are so much like first order resolution procedures, that many of the meta-theorems, and even the actual programs, are almost identical, so that first order researchers will find the change over to higher order very easy. Our program proved some second order theorems in as little as 18/100 second.

In the next quarter we will put all our results together in preparation for writing a doctoral thesis. We will also look into the question of completeness of our method.

Lawrence J. Henschen

7. THEORY OF DIGITAL COMPUTER ARITHMETIC

(Supported in part by the National Science Foundation under Grant Number US NSF GJ 813.)

During the quarter, some effort supported under the contract was turned in a new direction indicated by results of the Ph.D. thesis of Bruce DeLugish (described in the previous quarterly report). In the past, arithmetic unit construction has been based almost exclusively on the use of fixed radix number systems; i.e., weighted sums of series. Unfortunately, the computational procedures easily formulated are limited to multiplication, division, and with somewhat more difficulty square and higher roots.

The results of DeLugish's thesis show that use of a continued product formulation extends the range of computational procedures to include the logarithm, the exponential, and the trigonometric and inverse trigonometric functions as well as multiplication, division, and the square root. One must make the distinction that although the computational procedure is based theoretically on a continued product formulation, the continued product representation of the result is ephemeral in the following sense. At any given step, the requirements of the computational procedure determine one coefficient ϵ_i of one term of the form $1 + 2^{-i}\epsilon_i$. The coefficient ϵ_i is employed simultaneously in a separate arithmetic unit for conversion of the result to conventional fixed radix form. Thus the entire set of coefficients ϵ_i ($i = 1, 2, \dots, k$) necessary for the product $\prod_{i=1}^k (1 + 2^{-i}\epsilon_i)$ is never simultaneously available.

The above results indicate a more general direction for future research. What other representations of numbers exist, and what class of computational procedures can easily be formulated for each such representation? To gain further insight into this more general problem, a study was begun during the quarter of continued fractions.

The first requirement is a continued fraction representation with a corresponding conversion procedure which is easily realizable with con-

ventional fixed radix hardware. Consider the finite continued fraction with k partial numerators p_i and k partial denominators q_i ($i = 1, 2, \dots, k$), whose value is P_k/Q_k , i.e.

$$\frac{P_k}{Q_k} = \cfrac{p_1}{q_1 + \cfrac{p_2}{q_2 + \cfrac{p_3}{q_3 + \dots + \cfrac{p_k}{q_k}}}}$$

P_k and Q_k are determined from the recursions:

$$P_i = q_i P_{i-1} + p_i P_{i-2} \quad i = 2, 3, \dots, k$$

$$Q_i = q_i Q_{i-1} + p_i Q_{i-2} \quad P_0 = 0 \quad P_1 = p_1 \quad Q_0 = 1 \quad Q_1 = q_1$$

It is clear that P_k and Q_k can be separately and simultaneously determined in two binary arithmetic units in $k-1$ addition times if the p_i and q_i are chosen to be simple in the binary sense. The choice $p_i = 1$ for all i is easily justified on the basis of later results. The digit set for q_i is initially assumed to be two-valued, and after some investigation it was found that choice of the digit set $q_i = \{1/2, 1\}$ yields continued fractions

whose values $\frac{P_k}{Q_k}$ are continuous in the limit over the interval as defined by

the following equation:

$$1/2 \leq \lim_{k \rightarrow \infty} \frac{P_k}{Q_k} \leq 1$$

These properties indicate that a suitable continued fraction representation exists, such that conversion to conventional binary can be achieved by repetitive use of two binary adders in parallel, followed by a division to determine the quotient P_k/Q_k .

Determination of a problem and the appropriate corresponding computational procedure is much more difficult. The particular problem chosen for investigation was the solution of the limited class of quadratics

$$x^2 + b_k x - c_k = (x-u)(x+v) = 0$$

such that $1/2 \leq u \leq 1$ and $1 \leq v \leq 2$. The problem, specifically, is, given b_k and c_k , find u (and hence $v = b_k + u$). This problem was selected because of the following property of infinite periodic continued fractions, of period k . If the sum of the first $k-1$ terms is P_{k-1}/Q_{k-1} and the sum of the first k terms is P_k/Q_k , then the quadratic coefficients b_k and c_k are $b_k = (Q_k - P_{k-1})/Q_{k-1}$ and $c_k = P_k/Q_{k-1}$. The value of the infinite periodic continued fraction is then u , the positive root of the quadratic. The problem is then resolved specifically to the following one. Given $(Q_k - P_{k-1})/Q_{k-1}$ and P_k/Q_{k-1} (Note that k is unknown.), find the sequence of partial denominators q_i ($i = 1, 2, \dots, k$).

The first two approaches to a computational procedure were similar. Given the limited information about the values of continued fractions of order $k-1$ and order k implicit in b_k and c_k , determine the sequence of

partial denominators

$$a) \quad q_{k+1} = q_1, \quad q_{k+2} = q_2, \quad \dots, \quad q_{2k} = q_k, \quad \text{or}$$

$$b) \quad q_k, \quad q_{k-1}, \quad \dots, \quad q_1$$

After extensive investigation, it appears possible to prove that either of these approaches requires knowledge of the solution in order to determine the q_i , hence these approaches were abandoned.

The third and fourth approaches were based on the observation that the value u of the infinite periodic continued fraction of period k with $p_i = 1$, $q_i = \{1/2, 1\}$, ($i = 1, 2, \dots, k$) is also the value u of the infinite periodic continued fraction of period one with each $p_i = c_k$ and each $q_i = b_k$ ($i = 1, 2, \dots, \infty$). That is,

$$u = \frac{c_k}{b_k + u}.$$

Approaches three and four may therefore be considered as methods of conversion from one form of infinite continued fraction to that form which is easily converted to a conventional binary representation.

Computational approach number three, in successive steps, generates q_1, q_2 , etc., such that

$$u = \frac{c_k}{b_k + \frac{c_k}{b_k + \frac{c_k}{b_k + \dots}}} = \frac{1}{q_1 + \frac{\gamma_{k-1}}{\beta_{k-1} + \frac{\gamma_{k-1}}{\beta_{k-1} + \dots}}} = \frac{1}{q_1 + \frac{1}{q_2 + \frac{\gamma_{k-2}}{\beta_{k-2} + \frac{\gamma_{k-2}}{\beta_{k-2} + \dots}}}} = \text{etc.}$$

For this approach, the recursion relations are

$$\beta_{k-n} = 2q_n - \frac{\beta_{k-n+1}}{\gamma_{k-n+1}} \text{ and } \gamma_{k-n} = \frac{1 + q_n \beta_{k-n+1}}{\gamma_{k-n+1}} - q_n^2$$

for $n = 1, 2, \dots$, with $\beta_k = b_k$ and $\gamma_k = c_k$ for the first step. Clearly, this procedure requires two divisions as well as other operations at each step, and is unsuitable for mechanization.

The fourth approach, in successive steps, generates partial quotients q_1, q_2 , etc., by increasing the periodicity of periodic continued fractions, as follows:

$$u = \frac{c_k}{b_k + \frac{c_k}{b_k + \frac{c_k}{b_k + \dots}}} = \frac{1}{q_1 + \frac{c_{k-1}}{b_{k-1} + 1}} = \frac{1}{q_1 + 1} = \text{etc.}$$

After a considerable amount of algebra, the recursion relations can be shown to be:

$$b_{k-n} = q_n c_{k-n+1} - q_{n-1} c_{k-n+2} + b_{k-n+2}$$

$$c_{k-n} = -q_n b_{k-n} + q_n b_{k-n+1} + c_{k-n+2}$$

It should be noted that the relative simplicity of these recursions is dependent on the fact that $P_n Q_{n-1} - P_{n-1} Q_n = (-1)^{n-1}$, which requires that the partial numerators p_i be 1. For $n = 1$, the recursions require that $b_{k+1} = 0$, $c_{k+1} = 1$, and $q_0 = 0$.

To summarize, a technique exists to generate solutions to a limited class of quadratics based on additive recursions and employing continued

fractions. Results thus far are considered promising, but inconclusive. Technical feasibility will require the discovery of additional problems with compatible methods of solution.

The investigation reported here was conducted during the summer of 1970 and was supported in part by the Applied Mathematics Department, Brookhaven National Laboratory, Upton, Long Island, New York.

J. E. Robertson

8. SWITCHING THEORY AND LOGICAL DESIGN

(Supported in part by the National Science Foundation under Grant Number USNSFGJ-503)

During this quarter, our research was focussed on the following:

- (1) Logical design of optimal MOS networks by implicit enumeration. Our computational results suggest that it is feasible for at least small numbers of cells and field-effect transistors.
- (2) Improvement of logical design by the branch-and-bound method. The algorithm which was originally started by E.S. Davidson is improved by our new gimmick, named "redundancy check." It is being further improved.
- (3) Comparison of logical design by the implicit enumeration method and by the branch-and-bound method in terms of programming time and computation time. For this objective, a program for logical design with a mixture of AND and OR gates was prepared. The branch-and-bound method is much more time-consuming to program, but is much faster. Detailed comparison will be continued.

L.E. Shiau continued to write a masters degree thesis on logical design of optimal one-bit adder by the implicit enumeration method.

S. MUROGA

The program to design MOS logical circuits by integer programming has been finished. Some examples have been tested.

Thirty-six 3-variable representative functions have been solved. Twenty-seven of them require not more than two cells. Nine of them require three cells. The number of FET's required is listed as follows:

No. of FET's	No. of Functions
4	1
6	4
7	3
8	11
9	5
10	5
11	4
12	1
14	2

(T.K. Liu)

The computer program for the synthesis problem of optimal NOR networks by the branch-and-bound method has been completed. This program generates optimal NOR networks which are assumed to have either uncomplemented input variables only, or both uncomplemented and complemented input variables. The two types of restrictions, namely the maximum number of fan-ins and/or fan-outs of the gates, and the maximum number of levels of the network can be imposed in solving the problem. The documentation of the program is being prepared.

With this program, the optimal networks of some functions of three variables have been obtained with the assumption of the maximum level of three, and with the assumption of both uncomplemented and complemented variables available. A complete catalog of such optimal networks will be made soon.

Development of the computer program for the synthesis problem of optimal AND-OR networks by the branch-and-bound method has been started. So far, more than half of the programming work is completed.

(T. Nakagawa)

An improved redundancy check program to increase computation efficiency in the branch-and-bound algorithm for optimal NOR networks (see Quarterly Report, April-May-June, 1970, by T. Nakagawa) has been coded and debugged. This program is based on two properties of NOR networks, one of which determines the conditions of removing an existing connection and the other determines the conditions of adding a new connection. Adding a new connection is done only when some other gates or connections can be removed by adding such a connection.

The improved redundancy check program accelerated the convergence of the algorithm more than the previous one. However, the rate of improved computation efficiency still varies, depending on particular functions. For example, one of the 8-gate functions, which couldn't be solved within 112 seconds by the previous program, can be solved within 44 seconds now. Yet there are some functions for which the new program still does not yield any improvement. Further effort to improve this program is being made.

(H.C. Lai)

With some difficulty, the all-interconnection NOR program I have been using was adapted to handle 4-variable, 8-gate problems. The formulation required 1,112 variables, 4,995 inequalities and 30,950 non-zero coefficients, and occupied over 400K bytes of core.

The two 8-gate functions chosen were expected to be among the 8-gate problems requiring the least amount of computation time. The choice was made in accordance with our earlier observation that, in general, the more true vectors a function has, the faster it will run (i.e., less computation time) relative to other functions requiring the same number of gates. So two functions with 13 true vectors were run. The first required 995 seconds and 13,455 iterations; the second, 1,514 seconds and 18,948 iterations. Also, two more 5-gate functions, 50 more 6-gate functions, and 28 more 7-gate functions were run since last quarter.

Circuit diagrams have been drawn up for all the circuits found that realize the functions of up through 6 gates. These are for future reference and redundancy check studies.

Some statistics follow which are for all 4-variable NOR problems that have been run. Note: AVG = average, LEAS = least, LEV = levels, and INTR = interconnections. The number of interconnections and the number of levels were somewhat variable for a given function (due to multiple optimal circuits). So for each function, the highest and lowest number (for levels and interconnections) was recorded. The separate averages of these upper and lower bounds lead to the following statistics.

(J. Culliney)

Statistics on Obtained Optimal Circuits

# OF GATES	# OF FNS	AVG COST	LRGST COST	SMLST COST	MOST INTR	LEAS INTR	AVG MOST INTR	AVG LEAS INTR	MOST LEV	LEAS LEV	AVG MOST LEV	AVG LEAS LEV
3	13	6.308	8	6	2	2	2.000	2.000	3	2	2.462	2.462
4	60	8.967	12	7	4	3	3.467	3.467	4	2	2.917	2.917
5	234	11.479	18	8	6	4	5.064	4.974	5	2	3.321	3.235
6	83	14.277	19	9	9	5	6.916	6.627	5	2	3.639	3.422
7	46	16.478	23	13	12	6	8.587	8.326	6	3	4.304	4.087
8	2	13.500	19	18	11	10	11.000	10.500	5	3	4.000	3.500

9. SOUPAC SECTION

(Statistically Oriented Users Programming and Consulting)

In September SOUPAC was expanded into two systems each containing all application programs, but varying in variable limits and space requirements. The smaller system which was designed to accomodate up to 80% of the users will reduce the 75 CPU units charged to 62% of the previous value under the current rate structure. Plans exist for another savings feature made possible by OS release 18.6. The latter will be related to the handling of temporary sequential data sets.

Load modules for SOUPAC systems have been sent to several places. At this writing, it is known that a SOUPAC system is functioning at the University of Ottawa.

Support routines and four pilot programs are presently operating using dynamic allocation. Dynamic allocation is a method whereby the programs so coded will run in any size core above a specified minimum (160,60K presently) and move data or program in or out as required. Since dynamic requires extensive reprogramming, it may be some time before some programs exist in this form. The programs that are available in dynamic can handle large numbers of variables. When this was a criterion, as many as twice the previous maximum for that program could be handled.

The SOUPLOG program which keeps track of SOUPAC and individual program usage produced usage counts for the last 10 days of September. More than 70 programs per day were run in SOUPAC. This figure is up over counts from earlier sources. The SOUPAC manual continues to be much sought. A revised edition reflecting recent changes was obtained

in September. Extensive further revisions are still being planned. A record of SOUPAC user visits and the consulting done is being taken; so far the results are too sketchy to evaluate. The SOUPAC Seminar is being offered again this Fall.

Kern W. Dickman
Project Director

10. IBM SYSTEM/360 SERVICE

(Supported in part by the National Science Foundation under Grant No. NSF-GP-7634.)

10.1 Software Development

HASP

Over the weekend of July 4, the System/360-75 was converted from ASP to HASP. This was expected, based on measured timing comparisons, to increase considerably the efficiency and therefore the capacity of the system.

Express

At the same time, the Express Batch Monitor began operation. Using a dedicated, on-line card reader and printer, this system was running small Assembler G and FORTRAN G jobs on a "cafeteria line" instant turnaround basis.

ATS

The Administrative Terminal System (ATS), an on-line document processing system using 2741 typewriters, was also installed in July. Initial operation was 9:00 a.m. to 5:00 p.m., Monday through Friday.

PLAGO

In August, the PLAGO load-and-go PL/I compiler was made available. This WATFOR-like system was obtained from Polytechnic Institute of Brooklyn.

10.2 Hardware Development

System/360-75

At the same time HASP was installed, new core, disk, and drum storage was installed on the 360-75. The new core brings the system to 1024K main core. (There is also 1024K bulk core.) There are five new 2314 disk drives, attached through a new (fourth) selector channel. The new drum is the second 2301 drum on the system. The tape drives were moved to the selector subchannel of the multiplexor channel.

Illinet File Number (Hardware)

For the past three years a file number has been prepared to give the hardware description of our system. Illinet 1970 was completed and is being printed now. It is File No. 860.

PDP-7/630 Hardware

The PDP-7/630 hardware has been dedicated to 360 service for over a year now and has served the timesharing line handling function very well. It operates continuously with five different types of line interfaces. They are:

110 baud	Data set (TTY)	8 ports
110 baud	Direct connect (TTY)	16 ports
135 baud	Data set (2741)	2 ports
Touch-Tone	403 Data sets	3 ports
Fast (100 ch/sec.)	Direct connect	3 ports

Some investigation is being done to upgrade the communications scanner portion (630) from its discrete logic to integrated circuit packages.

Touch-Tone Receivers

The addition of 403 Data Sets to our PDP-7/630 timesharing hardware has proved to be very useful for 360 users. It allows them, through the use of touch-tone phones, to make direct inquiries as to progress of their job and receive an answer immediately.

There are three such sets operating in this "Jobs-Out Inquiry" mode now.

Teletypewriter Repair

This information, because of its first listing, will give data from the first of January, 1970. A total of 100 repair calls were made consisting of 70 in-house (DCL) and 30 outside (CE, E. CHEM, EE Annex, ENG HALL, ERL, ME, MRL, Noyes Lab., Physics, Physics Research Lab., Vet. Medicine). Forty-three different

teletypes were repaired with a total of 340 hours of repair time. Considering a 23 day-month, this is about one call each two days, and two man months of labor.

10.3 Subroutine Library

Subroutine Library Write-Ups

Several steps were taken to improve the availability and usefulness of the subroutine write-ups.

Write-ups may now be obtained by requesting a copy of the desired write-up from the 360/20 operator. The old procedure required the running of a special user program, and was more expensive and time consuming for the user.

The index for the subroutine library write-ups no longer uses the SHARE classification system. The routines have been regrouped under general, descriptive headings which are more meaningful to the user. The index also now includes the following for each routine: A descriptive statement concerning its purpose and use, the date of the latest program revision, and the date of the latest write-up revision.

In addition, 30 write-ups were revised to correct misleading or inaccurate information and to add additional explanations concerning usage, e.g., segments of sample programs.

Subroutine Library Programs

Eight subroutines were revised to make them more efficient and easier to use. Special features were also added to some routines to aid users in debugging their programs.

Eight routines which were no longer useful were deleted from the library.

Twenty new routines were added to the library, including programs to do the following:

Solve simultaneous linear equations,
perform double precision interval arithmetic,
generate special matrices for testing purposes,
count input-output requests for particular $G\emptyset$ steps,
approximate given functions,
provide easy to use plotting routines,
calculate bounds on eigenvalues for particular matrices.

10.4 LOG SUMMARIES

Table I - IBM 360/75

Summary of Use

July, 1970

Scheduled Engineering	11:08:00	
Unscheduled Engineering	<u>6:02:00</u>	
	Subtotal	17:10:00
Batch	580:00:00	
System Maintenance and Development	<u>146:50:00</u>	
	Total	744:00:00

Table II - IBM 360/75

Summary of Use

July, 1970

Multiplexer Problem	1
Console I	<u>1</u>
Total	<u><u>2</u></u>

CENTISECONDS--36C/75 PROCESSOR TIME

DEPT ¹	NUMBER OF RUNS			NUMBER OF UNITS		
	CLASS ²	RES	TOTAL	CLASS ²	RES	TOTAL
AAE	658	690	1348	1222113	1181864	2403977
ACCY	1238	128	1366	448100	144694	592794
ADV	0	22	22	0	52758	52758
AGE	0	382	382	0	535230	535230
AGEC	0	558	558	0	858678	858678
AGENT	0	20	20	0	12484	12484
AGRIC	0	2	2	0	6949	6949
AGRON	179	196	375	1157279	44156	1201475
ANS	0	248	248	0	445909	445909
ANTH	0	6	6	0	29980	29980
ARCH	325	1	326	77863	57	77920
ASTR	25	204	229	152202	320848	473050
AVI	0	57	57	0	54814	54814
BADM	4192	184	4376	1691281	133722	1825003
BECDSR	0	163	163	0	152692	152692
CAS	0	1	1	0	507	507
CE	3487	3737	7224	2734597	4566591	7301188
CEUSA	0	2	2	0	616	616
CHF	7	2742	2749	334	5630060	5630394
CIRCE	0	378	378	0	1508104	1508104
CGMM	40	0	40	11034	0	11034
CRC	0	102	102	0	220477	220477
CSL	0	188	188	0	128520	128520
CATLOG	0	1	1	0	534	534
DCS	9859	1516	11375	1969105	5204893	7173998
DS	0	91	91	0	95812	95812
ECCN	526	493	1019	3564681	440323	4005004
ED	24	273	297	5809	278379	284188
EDADM	0	50	50	0	19929	19929
EDPSY	423	23	446	207025	20885	227910
EE	278	1450	1728	29219	1571398	1600617
ENGADM	0	476	476	0	397081	397081
ENGCS	0	727	727	0	392762	392762
ENGLSH	0	40	40	0	210330	210330
ENGRDV	0	2	2	0	456	456
EXDC	0	52	52	0	23428	23428
FIN	184	64	248	235435	28826	264261
FOR	0	8	8	0	1269	1269
FR	0	19	19	0	7077	7077
FT	0	30	30	0	37738	37738
GENE	2998	85	3083	588897	14548	603445
GEOG	0	41	41	0	9634	9634
GEOI	288	36	324	276753	14729	291482
GRDCOL	0	24	24	0	2309	2309
GSA	0	5	5	0	3060	3060
HEC	0	24	24	0	25721	25721
HED	0	8	8	0	22818	22818
HONORS	0	6	6	0	2402	2402
HORT	0	55	55	0	16827	16827
ICR	25	1048	1073	10957	411634	422591
IE	74	31	105	17693	60720	78413
IFCL	0	2	2	0	11072	11072
ILLUNI	0	6	6	0	6505	6505

ILP	163	4	167	188611	931	189542
I REC	0	23	23	0	16533	16533
I AW	0	107	107	0	41296	41296
I IRS	0	14	14	0	5415	5415
MATH	54	100	154	3254	39599	42853
MATRI	0	2598	2598	0	3868806	3868806
MCBIO	0	13	13	0	2538	2538
MF	374	875	1249	452440	795687	1248127
MMPF	0	110	110	0	31302	31302
MUSIC	120	286	406	18014	69309	87323
NHS	0	110	110	0	64489	64489
NUCF	228	466	694	149340	344575	493915
OAS	0	34	34	0	100813	100813
CIR	0	498	498	0	893446	893446
PEM	134	63	197	157799	34820	192619
PEW	0	37	37	0	35234	35234
PHYR	0	61	61	0	35674	35674
PHYCS	44	2027	3071	14909	3495246	3510155
PHYSL	0	124	124	0	22308	22308
PHYX	0	929	929	0	2930594	2930594
POIS	161	276	437	378851	437201	816052
PROVST	0	32	32	0	23402	23402
PSYCH	427	1574	2001	628231	2820739	3448970
RFC	76	9	85	238077	11848	249925
SCONS	0	110	110	0	94058	94058
SCS	0	11	11	0	53381	53381
SGS	0	537	537	0	404168	404168
SOC	30	197	227	13185	295129	308314
SOCW	0	93	93	0	547901	547901
SPCH	0	13	13	0	6928	6928
SPED	0	1	1	0	11556	11556
SPL	0	289	289	0	592021	592021
SWS	0	1668	1668	0	1852557	1852557
TAM	348	814	1162	1388745	1138732	2527477
UICOMM	0	75	75	0	35438	35438
USOC	0	44	44	0	93071	93071
VPP	76	24	100	6561	8494	15055
VTED	0	22	22	0	28245	28245
ZDDI	0	362	362	0	81184	81184

SUBTOTAL	27065	22727	59792	18038394	46727517	64765911
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DCSSYS ³	0	10104	10104	0	8120565	8120565
OVPHED ⁴	0	1844	1844	0	4009	4009
REFUND ⁵	0	267	267	0	1569819	1569819
UADP ⁶	0	132	132	0	41401	41401
XDCS ⁷	0	467	467	0	179792	179792
XMAINT ⁸	0	448	448	0	412101	412101
XSSS ⁹	0	1384	1384	0	255474	255474

TOTAL	27065	47373	74438	18038394	57310678	75349072
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- 1 See list of departmental codes following
2 Training and Education
3 System Improvement and Modifications
4 System Use in Excess of User Estimated Usage
5 Rerun of User Jobs Due to Machine or System Error

- 6 University Overhead Administrative Use
7 System Updating
8 System Maintenance
9 Special Short Shots

TABLE III JULY 1970

INPUT/OUTPUT REQUESTS--360/75

DEPT ¹	NUMBER OF RUNS			NUMBER OF UNITS		
	CLASS ²	RES	TOTAL	CLASS ²	RES	TOTAL
AAE	660	691	1351	115121	91023	206144
ACCY	1239	128	1367	157776	24164	181940
ADV	C	22	22	0	36433	36433
AGE	0	382	382	0	204117	204117
AGFC	0	558	558	0	385024	385024
AGENT	0	20	20	0	7832	7832
AGRIC	0	2	2	0	2033	2033
AGRON	179	196	375	30022	33162	63184
ANS	0	249	249	0	86573	86573
ANTH	0	6	6	0	8865	8865
ARCH	325	1	326	33020	0	33020
ASTR	25	206	231	11740	40073	51813
AVI	C	58	58	0	43393	43393
BADM	4198	184	4382	260457	29656	290113
BECBSR	0	163	163	0	127394	127394
CAS	0	1	1	0	27	27
CE	3488	3738	7226	472375	657917	1170292
CEUSA	0	2	2	0	5017	5017
CHE	7	2744	2751	60	589217	589277
CIRCF	0	378	378	0	399713	399713
COMM	40	0	40	3041	0	3041
CRC	0	102	102	0	187913	187913
CSL	0	188	188	0	25557	25557
DATLOG	0	1	1	0	443	443
DCS	9863	1517	11380	446262	352022	798284
DS	0	91	91	0	14199	14199
ECON	526	493	1019	269221	212778	481999
ED	24	273	297	0	168907	168907
EDADM	C	50	50	0	17148	17148
EDPSY	423	23	446	118823	5894	124717
EE	278	1450	1728	9443	235283	244726
ENGADM	C	476	476	0	127096	127096
ENGOST	C	727	727	0	135630	135630
ENGLISH	0	40	40	0	4930	4930
ENGRDV	0	2	2	0	288	288
EXDC	0	52	52	0	1847	1847
FIN	184	64	248	108322	19231	127553
FOR	0	8	8	0	363	363
FR	0	19	19	0	3731	3731
FT	C	30	30	0	24542	24542
GFNE	2999	85	3084	113122	9093	122215
GFOG	0	41	41	0	4358	4358
GEUL	288	36	324	104866	12217	117083
GROCEL	0	24	24	0	0	0
GSA	C	5	5	0	169	169
HFC	0	24	24	0	8746	8746
HED	0	8	8	0	246	246
HONORS	C	6	6	0	1394	1394
HORT	0	55	55	0	6513	6513
ICR	25	1048	1073	6107	317308	323415
IE	74	31	105	7450	8971	16421
IFCL	0	2	2	0	1392	1392
ILLUNI	C	6	6	0	558	558

ILR	163	4	167	110496	101	110597
IREC	0	24	24	0	3662	3662
LAW	0	107	107	0	24277	24277
LIBS	0	14	14	0	4040	4040
MATH	54	100	154	3043	9933	12976
MATRI	0	2600	2600	0	410482	410482
MCBIC	0	13	13	0	1197	1197
ME	374	877	1251	52646	81355	134001
MMPE	0	110	110	0	7822	7822
MUSIC	120	286	406	10723	24513	35236
NHS	0	110	110	0	49224	49224
NUCE	228	466	694	31915	82593	114508
OAS	0	34	34	0	20244	20244
QIR	0	498	498	0	155449	155449
PEM	134	63	197	203575	17021	220596
PEW	0	37	37	0	31552	31552
PHYB	0	61	61	0	10438	10438
PHYCS	44	2029	3073	5118	401598	406716
PHYSL	0	124	124	0	27621	27621
PHYX	0	931	931	0	352526	352526
POLS	161	276	437	205693	117042	322735
PROVST	0	32	32	0	6475	6475
PSYCH	427	1574	2001	401202	2086249	2487451
REC	76	9	85	181694	12419	194113
SCONS	0	110	110	0	29999	29999
SCS	0	11	11	0	16579	16579
SGS	0	537	537	0	241830	241830
SOC	30	197	227	6033	115383	121416
SOCW	0	93	93	0	277085	277085
SPCH	0	13	13	0	4359	4359
SPED	0	1	1	0	1306	1306
SRL	0	289	289	0	277433	277433
SWS	0	1668	1668	0	498212	498212
TAM	248	815	1163	40525	135787	176312
UICMM	0	75	75	0	17953	17953
UOSCP	0	44	44	0	42138	42138
VPP	76	24	100	5562	1923	7485
VTFD	0	22	22	0	9249	9249
ZOOL	0	362	362	0	40134	40134

SUBTOTAL	27080	32746	59826	3525453	10367603	13893056
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DCSSYS ³	0	10104	10104	0	5283279	5283279
OVRHFC ⁴	0	1839	1839	0	799	799
REFUNC ⁵	0	232	232	0	183430	183430
UADP ⁶	0	132	132	0	48979	48979
XDCS ⁷	0	467	467	0	789428	789428
XMAINT ⁸	0	448	448	0	364372	364372
XSSS ⁹	0	1384	1384	0	113349	113349

TOTAL	27080	47352	74432	3525453	17151239	20676692
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- 1 See list of departmental codes following
 2 Training and Education
 3 System Improvement and Modifications
 4 System Use in Excess of User Estimated Usage
 5 Rerun of User Jobs Due to Machine or System Error

- 6 University Overhead Administrative Use
 7 System Updating
 8 System Maintenance
 9 Special Short Shots

TABLE III JULY 1970

UNITS CHARGED--36C/75

DEPT ¹	NUMBER OF RUNS			NUMBER OF UNITS		
	CLASS ²	RES	TOTAL	CLASS ²	RES	TOTAL
AAE	657	690	1347	58460	45001	103461
ACCY	1238	128	1366	24850	9524	34374
ADV	0	22	22	0	7359	7359
AGE	0	382	382	0	41645	41645
AGEC	0	557	557	0	76017	76017
AGENT	0	20	20	0	824	824
AGRIC	0	2	2	0	502	502
AGRON	178	196	374	45154	3645	48799
ANS	0	246	246	0	40275	40275
ANTH	0	6	6	0	3206	3206
ARCH	323	1	324	4426	2	4428
ASTR	26	206	232	13396	21379	34775
AVI	0	58	58	0	7912	7912
BADM	4179	184	4363	112875	9159	122034
RECBRS	0	163	163	0	18470	18470
CAS	0	1	1	0	32	32
CE	3482	3737	7219	203006	295704	498710
CEUSA	0	2	2	0	170	170
CHE	7	2739	2746	13	310507	310520
CIRCE	0	378	378	0	150342	150342
COMM	40	0	40	796	0	796
CRC	0	102	102	0	31989	31989
CSL	0	187	187	0	9693	9693
CATLOG	0	1	1	0	39	39
DCS	9743	1512	11255	107167	254954	362121
DS	0	91	91	0	7268	7268
ECON	526	487	1013	157956	42713	200669
ED	24	270	294	220	34934	35162
EDADM	0	50	50	0	1222	1222
EDPSY	421	23	444	25115	2202	27317
EE	273	1450	1723	1366	83723	85089
ENGADM	0	476	476	0	21578	21578
ENGCS	0	727	727	0	27568	27568
ENGLISH	0	40	40	0	15237	15237
ENGRDV	0	2	2	0	26	26
EXDC	0	52	52	0	987	987
FIN	183	64	247	23268	3596	26864
FOR	0	8	8	0	53	53
FR	0	19	19	0	398	398
FT	0	30	30	0	4751	4751
GENE	2985	85	3070	30606	839	31445
GEOG	0	41	41	0	780	780
GEOI	288	36	324	19503	745	20248
GROCOL	0	24	24	0	89	89
GSA	0	5	5	0	193	193
HEC	0	24	24	0	2838	2838
HED	0	8	8	0	1902	1902
HONCPS	0	6	6	0	309	309
HORT	0	54	54	0	1212	1212
ICR	25	1048	1073	1288	49636	50924
IE	74	31	105	912	3093	4005
IFCL	0	2	2	0	1029	1029
ILLUNI	0	6	6	0	432	432

ILK	163	4	167	24422	85	24507
IREC	0	23	23	0	1658	1658
LAW	0	107	107	0	2590	2590
LIBS	0	13	13	0	702	702
MATH	54	99	153	359	1679	2038
MATRI	0	2596	2596	0	249370	249370
MCRIC	0	13	13	0	133	133
ME	373	874	1247	20408	43621	64029
MMPE	0	109	109	0	2116	2116
MUSIC	119	286	405	1336	3579	4915
NHS	0	110	110	0	4664	4664
NUCF	227	466	693	9245	17125	26370
OAS	0	34	34	0	5985	5985
OIR	0	497	497	0	62942	62942
PFM	133	63	196	25503	4114	29617
PEW	0	37	37	0	5230	5230
PHYB	0	61	61	0	1802	1802
PHYCS	44	3027	3071	806	189274	190080
PHYSL	0	122	122	0	2239	2239
PHYX	0	531	931	0	195442	195442
POLS	161	274	435	47058	44744	91802
PROVST	0	32	32	0	2455	2455
PSYCH	422	1570	1992	81912	376433	458345
REC	76	9	85	33762	2001	35763
SCONS	0	108	108	0	8313	8313
SCS	0	11	11	0	5775	5775
SGS	0	537	537	0	38079	38079
SOC	30	197	227	1272	32614	33886
SOCW	0	93	93	0	66795	66795
SPCH	0	12	12	0	925	925
SPED	0	1	1	0	1062	1062
SRL	0	286	286	0	63534	63534
SWS	0	1667	1667	0	132229	132229
TAM	347	811	1158	53610	75570	129580
UICOMM	0	75	75	0	2086	2086
UNSCP	0	45	45	0	11223	11223
VPP	76	24	100	570	407	977
VTED	0	22	22	0	2802	2802
ZOOL	0	361	361	0	5233	5233

SUBTOTAL	26897	32686	59583	1130648	3318733	4449381
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DCSSYS ³	0	10078	10078	0	803536	803536
OVRHED ⁴	0	1640	1640	0	11	11
REFUND ⁵	0	253	253	0	85494	85494
UADP ⁶	0	132	132	0	3151	3151
XDCS ⁷	0	466	466	0	36868	36868
XMAINT ⁸	0	448	448	0	32512	32512
XSSS ⁹	0	1376	1376	0	17128	17128

TOTAL	26897	47079	73976	1130648	4297433	5428081
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1 See list of departmental codes following

2 Training and Education

3 System Improvement and Modifications

4 System Use in Excess of User Estimated Usage

5 Rerun of User Jobs Due to Machine or System Error

6 University Overhead Administrative Use

7 System Updating

8 System Maintenance

9 Special Short Shots

TABLE III JULY 1970

SECONDS--1800 REAL TIME

DEPT ¹	NUMBER OF RUNS			NUMBER OF UNITS		
	CLASS ²	RES	TOTAL	CLASS ²	RES	TOTAL
AGE	0	16	16	0	16594	16594
CE	0	1	1	0	483	483
EE	0	11	11	0	6334	6334
GEOL	0	1	1	0	1365	1365
MATRL	0	6	6	0	721	721
MUSIC	0	4	4	0	282	282
NUCE	0	7	7	0	1493	1493
PHYCS	0	4	4	0	-1345	-1345
PHYSL	0	6	6	0	1022	1022
VPP	0	2	2	0	248	248
<hr/>						
SUBTOTAL	0	58	58	0	27197	27197
<hr/>						
DCSSYS ³	0	57	57	0	5902	5902
REFUND ⁴	0	7	7	0	7598	7598
XDCS ⁵	0	1	1	0	152	152
<hr/>						
TOTAL	0	123	123	0	40849	40849
<hr/>						

1 See list of departmental codes following

2 Training and Education

3 System Improvement and Modifications

4 Rerun of User Jobs Due to Machine or System Error

5 System Updating

Table I - IBM 360/20

Summary of Use

July, 1970

Scheduled Engineering	11:44
Unscheduled Engineering	3:12
Maintenance	4:37
Production	393:23
Idle	<u>118:35</u>
Total Time	531:31

Table II - 360/20

Summary of Machine Errors

July, 1970

2560 MFCM

Total

1
1

MINUTES--360/20 REAL TIME

DEPT ¹	NUMBER OF RUNS			NUMBER OF UNITS		
	CLASS ²	RES	TOTAL	CLASS ²	RES	TOTAL
AAE	3	9	12	9	39	48
ACCY	2	1	3	9	14	23
ADV	0	3	3	0	3	3
AGE	0	9	9	0	67	67
AGEC	0	38	38	0	379	379
AGRON	1	7	8	13	37	50
ANS	0	61	61	0	278	278
ARCH	3	0	3	35	0	35
ARL	0	9	9	0	37	37
ASTR	1	13	14	3	70	73
AVI	C	1	1	0	2	2
BADM	35	7	42	480	56	536
BECBSF	0	3	3	0	16	16
CE	51	87	138	266	1289	1555
CHE	0	42	42	0	734	734
CIRCE	0	2	2	0	55	55
COM	C	1	1	0	63	63
CGMM	2	0	2	6	0	6
CRC	C	4	4	0	49	49
CSL	0	11	11	0	84	84
CATLOC	0	1	1	0	7	7
DGS	119	46	165	235	242	477
DS	0	9	9	0	324	324
DSFA	0	26	26	0	507	507
EQON	26	17	43	118	357	475
FD	8	25	33	10	456	466
EDPSY	5	2	7	51	8	59
EE	2	36	38	7	441	448
ENGADM	0	8	8	0	64	64
ENGST	0	26	26	0	242	242
ENGLST	0	2	2	0	4	4
FIN	8	13	21	272	411	683
FOP	0	8	8	0	59	59
FT	0	1	1	0	14	14
GENE	38	0	38	567	0	567
GEOG	C	1	1	0	60	60
GEOL	4	0	4	29	0	29
GRDCOL	0	2	2	0	8	8
HONORS	0	1	1	0	2	2
HORT	0	4	4	0	8	8
ICR	0	19	19	0	186	186
IE	4	0	4	18	0	18
ILR	31	3	34	647	26	673
IREC	0	5	5	0	39	39
LAW	C	1	1	0	7	7
MATH	0	2	2	0	16	16
MATRI	0	38	38	0	348	348
ME	18	19	37	162	56	258
MUSIC	0	16	16	0	98	98
NHS	C	1	1	0	4	4
NUCE	2	11	13	8	33	41
OAS	0	4	4	0	89	89
CIR	0	21	21	0	326	326

PEM	11	5	16	110	22	132
PEW	0	3	3	0	25	25
PHYB	0	1	1	0	3	3
CS	0	38	38	0	587	587
SL	0	1	1	0	2	2
PHYX	0	1	1	0	2	2
PDLS	4	31	35	37	167	204
PROVST	0	3	3	0	17	17
PSYCH	10	131	141	98	2098	2196
REC	20	8	28	513	120	633
SCONS	0	3	3	0	10	10
SCS	0	4	4	0	83	83
SGS	0	22	22	0	519	519
SOC	0	25	25	0	450	450
SOCW	0	14	14	0	75	75
SPCH	0	3	3	0	55	55
SRL	0	3	3	0	229	229
SWS	0	1	1	0	13	13
TAM	3	28	31	22	166	188
UICOMM	0	3	3	0	22	22
UDSCR	0	13	13	0	145	145
VPH	0	1	1	0	3	3
VPP	0	1	1	0	3	3
VTFD	0	14	14	0	129	129
ZOOL	0	4	4	0	41	41

SUBTOTAL	411	1037	1448	3725	12740	16465
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DCSSYS 3	0	244	244	0	2937	2937
REFUND 4	0	7	7	0	313	313
XDCS 5	0	3	3	0	49	49
XMAINT 6	0	114	114	0	7803	7803

TOTAL	411	1405	1816	3725	23842	27567
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- 1 See list of departmental codes following
- 2 Training and Education
- 3 System Improvement and Modifications
- 4 Rerun of User Jobs Due to Machine or System Error
- 5 System Updating
- 6 System Maintenance

TABLE III JULY 1970

MINUTES--SERVICE PROGRAMMING

DEPT ¹	NUMBER OF RUNS			NUMBER OF UNITS		
	CLASS ²	RES	TOTAL	CLASS ²	RES	TOTAL
AGEC	0	5	5	0	600	600
CIRCE	0	10	10	0	3495	3495
ED	0	6	6	0	840	840
FT	0	1	1	0	7	7
MATRL	0	7	7	0	1080	1080
PHYSL	0	3	3	0	630	630
REC	2	0	2	480	0	480
<hr/>						
TOTAL	2	32	34	480	6652	7132
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¹ See list of departmental codes following

² Training and Education

TABLE III AUGUST 1970

CARDS KEYFLNCHED

DEPT ¹	NUMBER OF RUNS			NUMBER OF UNITS		
	CLASS ²	RES	TOTAL	CLASS ²	RES	TOTAL
ACCY	0	2	2	0	1800	1800
AGEC	0	3	3	0	10000	10000
ANS	C	11	11	0	2850	2850
AVI	0	2	2	0	700	700
BADM	0	1	1	0	9000	9000
CE	0	6	6	0	1450	1450
CHE	0	2	2	0	550	550
CCS	C	8	8	0	6550	6550
ECON	0	5	5	C	3500	3500
ED	0	46	46	0	31300	31300
EE	C	18	18	0	6200	6200
ENGLSH	C	2	2	0	900	900
FIN	0	1	1	0	150	150
FOR	0	1	1	0	2200	2200
FT	C	1	1	0	100	100
GEOG	1	3	4	2750	1200	3950
GEOI	0	1	1	0	250	250
HORT	C	1	1	0	200	200
ICR	4	1	5	650	100	750
ILR	0	9	9	0	4650	4650
LAW	0	1	1	0	800	800
ME	5	0	5	1900	0	1900
MHS	C	3	3	0	2200	2200
PEW	0	3	3	0	2500	2500
PHYCS	C	1	1	0	1000	1000
FCLS	2	4	6	900	1700	2600
PROVST	C	1	1	0	50	50
PSYCH	1	9	10	1800	6800	8600
REC	1	3	4	200	9000	9200
SOC	C	1	1	C	800	800
SOCK	1	3	4	4000	1600	5600
ZOGL	C	1	1	0	100	100

SUBTOTAL	15	154	169	12200	110200	122400
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CCSSYS ³	0	26	26	0	7800	7800
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TOTAL	15	180	195	12200	118000	130200
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¹ See list of departmental codes following

² Training and Education

³ System Improvement and Modifications

TABLE III JULY 1970

COVER CHARGE--HASP

DEPT ¹	NUMBER OF RUNS			NUMBER OF UNITS		
	CLASS ²	RES	TOTAL	CLASS ²	RES	TOTAL
AAE	368	329	697	368	329	697
ACCY	537	102	639	537	102	639
ADV	0	22	22	0	22	22
AGE	0	166	166	0	166	166
AGEC	0	457	457	0	457	457
AGENT	0	10	10	0	10	10
AGRIC	0	3	3	0	3	3
AGRON	98	49	147	98	49	147
ANS	0	192	192	0	192	192
ANTH	0	5	5	0	5	5
ARCH	165	1	166	165	1	166
ASTR	14	110	124	14	110	124
AVI	0	47	47	0	47	47
BADM	3365	80	3445	3365	80	3445
BECSBR	0	75	75	0	75	75
CAS	0	1	1	0	1	1
CE	1417	1716	3133	1417	1716	3133
CEUSA	0	2	2	0	2	2
CHE	6	1259	1265	6	1259	1265
CIRCF	0	150	150	0	150	150
COMM	21	0	21	21	0	21
CRC	0	64	64	0	64	64
CSL	0	159	159	0	159	159
DATLOG	0	1	1	0	1	1
DCS	5795	582	6377	5795	582	6377
DS	0	36	36	0	36	36
ECON	268	280	548	268	280	548
ED	23	202	225	23	202	225
EDADM	0	8	8	0	8	8
EDPSY	417	25	442	417	25	442
EE	125	621	746	125	621	746
ENGADM	0	209	209	0	209	209
ENGOST	0	201	201	0	201	201
ENGLISH	0	25	25	0	25	25
ENGRDV	0	2	2	0	2	2
EXDC	0	3	3	0	3	3
FIN	127	58	185	127	58	185
FOR	0	2	2	0	2	2
FR	0	10	10	0	10	10
FT	0	20	20	0	20	20
GENE	2074	26	2100	2074	26	2100
GEOG	0	32	32	0	32	32
GEOL	107	22	129	107	22	129
GRDCOL	0	24	24	0	24	24
GSA	0	5	5	0	5	5
HEC	0	20	20	0	20	20
HED	0	8	8	0	8	8
HONORS	0	6	6	0	6	6
HORT	0	14	14	0	14	14
ICR	25	394	419	25	394	419
IE	25	21	46	25	21	46
IFCL	0	2	2	0	2	2
ILLUNI	0	2	2	0	2	2

ILR	118	4	122	118	4	122
I REC	0	23	23	0	23	23
LAW	0	35	35	0	35	35
LIBS	0	5	5	0	5	5
MATH	20	35	55	20	35	55
MATRL	0	1328	1328	0	1328	1328
MCBIO	0	4	4	0	4	4
ME	157	541	698	157	541	698
MMPE	0	49	49	0	49	49
MUSIC	70	68	138	70	68	138
NHS	0	58	58	0	58	58
NUCE	148	218	366	148	218	366
OAS	0	36	36	0	36	36
OIR	0	340	340	0	340	340
PFM	111	62	173	111	62	173
PEW	0	27	27	0	27	27
PHYB	0	24	24	0	24	24
PHYCS	22	1296	1318	22	1296	1318
PHYSL	0	46	46	0	46	46
PHYX	0	268	268	0	268	268
POLS	149	272	421	149	272	421
PROVST	0	31	31	0	31	31
PSYCH	276	1150	1426	276	1150	1426
REC	54	9	63	54	9	63
SCONS	0	35	35	0	35	35
SCS	0	10	10	0	10	10
SGS	0	274	274	0	274	274
SOC	32	200	232	32	200	232
SOCW	0	61	61	0	61	61
SPCH	0	12	12	0	12	12
SPED	0	1	1	0	1	1
SRL	0	130	130	0	130	130
SWS	0	793	793	0	793	793
TAM	173	395	568	173	395	568
UICDMM	0	25	25	0	25	25
UOSCR	0	43	43	0	43	43
VPP	34	21	55	34	21	55
VTED	0	19	19	0	19	19
ZOOL	0	134	134	0	134	134

SUBTOTAL	16341	15942	32283	16341	15942	32283
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DCSSYS ³	0	3748	3748	0	3748	3748
OVRHFD ⁴	0	1662	1662	0	1662	1662
REFUND ⁵	0	312	312	0	312	312
UADP ⁶	0	53	53	0	53	53
XDCS ⁷	0	217	217	0	217	217
XMAINT ⁸	0	224	224	0	224	224
XSSS ⁹	0	798	798	0	798	798

TOTAL	16341	22956	39297	16341	22956	39297
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1 See list of departmental codes following

2 Training and Education

3 System Improvement and Modifications

4 System Use in Excess of User Estimated Usage

5 Rerun of User Jobs Due to Machine or System Error

6 University Overhead Administrative Use

7 System Updating

8 System Maintenance

9 Special Short Shots

TABLE III JULY 1970

COVER CHARGE--XPRESS BATCH

DEPT ¹	NUMBER OF RUNS			NUMBER OF UNITS		
	CLASS ²	RES	TOTAL	CLASS ²	RES	TOTAL
AAE	32	39	71	32	39	71
ACCY	6	0	6	6	0	6
AGE	0	9	9	0	9	9
AGEC	0	100	100	0	100	100
AGRON	3	3	6	3	3	6
ANS	0	13	13	0	13	13
ANTH	0	1	1	0	1	1
ARCH	68	0	68	68	0	68
ASTR	0	1	1	0	1	1
BADM	358	2	360	358	2	360
CE	249	54	303	249	54	303
CHE	0	22	22	0	22	22
COMM	1	0	1	1	0	1
CRC	0	2	2	0	2	2
CSL	0	1	1	0	1	1
DCS	2464	120	2584	2464	120	2584
ECON	4	17	21	4	17	21
ED	0	9	9	0	9	9
EDPSY	5	0	5	5	0	5
FE	86	48	134	86	48	134
ENGADM	0	2	2	0	2	2
EXDC	0	47	47	0	47	47
FIN	6	0	6	6	0	6
FOR	0	2	2	0	2	2
GENE	362	27	389	362	27	389
GEOL	18	0	18	18	0	18
HORT	0	21	21	0	21	21
IE	22	0	22	22	0	22
LAW	0	19	19	0	19	19
LIBS	0	2	2	0	2	2
MATH	1	30	31	1	30	31
MATRL	0	73	73	0	73	73
ME	66	119	185	66	119	185
MMPE	0	2	2	0	2	2
MUSIC	13	5	18	13	5	18
NUCF	19	29	48	19	29	48
QIR	0	4	4	0	4	4
PEM	4	0	4	4	0	4
PHYB	0	3	3	0	3	3
PHYCS	0	61	61	0	61	61
PHYSL	0	27	27	0	27	27
POLS	6	2	8	6	2	8
PSYCH	38	46	84	38	46	84
SCONS	0	18	18	0	18	18
SPCH	0	1	1	0	1	1
SRL	0	48	48	0	48	48
SWS	0	19	19	0	19	19
TAM	25	43	68	25	43	68
UICOMM	0	2	2	0	2	2
VTED	0	3	3	0	3	3
ZOOL	0	28	28	0	28	28

SUBTOTAL	3856	1124	4980	3856	1124	4980
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DCSSYS ³	0	798	798	0	798	798
OV ⁴ RHED	0	214	214	0	214	214
UADP ⁵	0	25	25	0	25	25
XDCS ⁶	0	13	13	0	13	13
XSSS ⁷	0	183	183	0	183	183

TOTAL	3856	2357	6213	3856	2357	6213
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- 1 See list of departmental codes following
 - 2 Training and Education
 - 3 System Improvement and Modifications
 - 4 System Use in Excess of User Estimated Usage
 - 5 University Overhead Administrative Use
 - 6 System Updating
 - 7 Special Short Shots

Table I - IBM 360/75

Summary of Use

August 1970

Scheduled Engineering	21:00:00	
Unscheduled Engineering	26:40:00	
Air Conditioning	<u>81:02:00</u>	
	Subtotal	128:42:00
Batch	559:10:00	
System Maintenance and Development	<u>56:08:00</u>	
	Total	743:60:00

Table II - IBM 360/75

Summary of Use

August 1970

2314 Unit D Disk drive does not ready	1
2540 Reader - Punch	2
OC0, OC3, OC4 Tape Drives	3
OC2 will not read labels	1
IC0, drum - replaced card on drum	1
2260, Console typewriter	1
PDP-7	1
2848, Control unit	<u>1</u>

Total

11

TABLE III AUGUST 1970
CENTISECONDS--360/75 PROCESSOR TIME

DEPT ¹	NUMBER OF RUNS			NUMBER OF UNITS		
	CLASS ²	RES	TOTAL	CLASS ²	RES	TOTAL
AAF	636	442	1078	350500	294211	644711
ACCY	862	34	896	517051	46568	564019
ADV	0	3	3	0	1787	1787
AGE	0	216	216	0	225649	225649
AGEC	C	1185	1185	0	1010450	1010450
AGRIC	C	7	7	0	14332	14332
AGRCN	24	219	243	22583	74946	97531
ANS	0	211	211	0	314652	314652
ANTH	C	21	21	0	11166	11166
ARCH	190	0	190	93367	0	93367
ARL	0	23	23	0	57121	57121
ASTR	77	259	436	25051	300827	325878
AVI	0	39	39	0	25542	25542
BIADM	1612	398	2010	1175402	357926	1533328
BECBSR	C	62	62	0	93823	93823
CAS	C	1	1	0	210	210
CE	2799	6353	9152	1536102	5294814	6830916
CHE	12	4074	4086	574	6148893	6149467
CIRCE	C	12	12	0	-90694	-90694
CRC	C	241	241	0	282152	282152
CSL	C	51	51	0	30759	30759
CATLOG	C	24	24	C	14928	14928
DCS	10184	1806	11990	5610453	4257603	9868056
DS	C	241	241	0	270963	270963
ECCN	496	441	937	4878080	504817	5382897
ED	2	338	340	151	609467	609618
EDADM	C	79	79	0	122408	122408
EDPSY	265	12	277	115079	2040	122119
EIE	229	1191	1420	26614	2627007	2653621
ENGADM	C	598	598	0	704046	704046
ENGOST	0	565	565	0	330111	330111
ENGLISH	C	39	39	0	-8794	-8794
FIDEL	C	42	42	0	48567	48567
FIN	157	61	218	684725	34303	719028
FIOR	0	9	9	0	3444	3444
FIR	0	2	2	0	614	614
FIT	0	21	21	0	8434	8434
GENE	653	74	727	438274	86123	524497
GIECC	0	135	135	C	261901	261901
GEOL	57	240	297	49023	146461	195484
GRCCCL	C	29	29	C	80108	80108
HEC	C	4	4	0	22282	22282
HORT	0	65	65	0	89185	89185
ICR	44	437	481	58505	291036	349941
IE	C	11	11	C	27969	27969
ILR	60	135	195	96213	215452	215665
REC	0	6	6	0	8865	8865
LAW	0	147	147	0	32642	32642
LIBS	C	80	80	0	301727	301727
LIR	0	5	5	C	1648	1648
MATH	10	75	85	10103	30663	40766
MATRL	0	1775	1775	0	3563115	3563115
MCBIO	0	23	23	0	2706	2706

ME	SC5	816	1721	1365478	578606	1944084
MUSIC	81	167	248	106163	90871	197034
NHS	0	100	100	0	57291	57291
NUCE	65	391	456	42814	252329	295143
OAC	C	2	2	0	1319	1319
OAS	0	22	22	0	58289	58289
OIR	C	184	184	0	217233	217233
PEM	162	23	185	72182	41894	115076
PHYR	0	115	115	0	101769	101769
PHYCS	26	1618	1644	12368	4862847	4875215
PHYSL	C	49	49	0	13558	13558
PHYX	C	730	730	0	3207634	3207634
PCLS	150	247	397	437742	429459	867201
PSYCH	727	1623	2350	1288956	2868120	4157076
SCONS	0	81	81	0	84668	84668
SCS	0	2	2	0	16550	16550
SGS	C	459	459	0	354405	354405
SOC	60	242	302	79271	286763	366034
SOCW	97	8	105	58917	9353	68310
SPQH	C	19	19	0	12960	12960
SPEC	C	8	8	0	2608	2608
SRL	C	266	266	0	1023090	1023090
SWS	C	1163	1163	0	911621	911621
TAM	464	609	1073	4059995	853474	4913469
UICOMM	C	3	3	0	1595	1595
UOSCR	0	27	27	0	40717	40717
VPH	0	9	9	0	13355	13355
VPP	101	43	144	19592	11194	30786
VTED	C	30	30	0	65102	65102
ZOEL	C	290	290	0	70526	70526

SUBTOTAL	21207	32407	53614	23236828	45731617	68968445
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DCSSYS 3	C	11402	11402	0	8794111	8794111
CVRREC 4	0	1103	1103	0	2189	2189
REFUNC 5	C	248	248	0	1076918	1076918
UADP 6	C	117	117	0	24452	24452
XDCS 7	C	405	405	0	599622	599622
XMAINT 8	0	278	278	0	572889	572889
XSSS 9	0	582	582	0	94500	94500

TOTAL	21207	46542	67749	23236828	56896298	80133126
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1 See list of departmental codes following	6 University Overhead Administrative Use
2 Training and Education	7 System Updating
3 System Improvement and Modifications	8 System Maintenance
4 System Use in Excess of User Estimated Usage	9 Special Short Shots
5 Rerun of User Jobs Due to Machine or System Error	

TABLE III AUGUST 1970

INPLT/OUTFLT REQUESTS--26C/75

DEPT ¹	NUMBER OF RUNS			NUMBER OF UNITS		
	CLASS ²	RES	TOTAL	CLASS ²	RES	TOTAL
AAE	636	442	1078	164494	65129	229633
ACCY	862	34	896	235560	18352	253912
ADV	0	3	3	0	660	660
AGE	0	216	216	0	44217	44217
AGEC	0	1185	1185	0	499879	499879
AGRIC	0	7	7	0	6118	6118
AGRON	24	219	243	2807	22293	26100
ANS	0	212	212	0	97192	97192
ANTH	0	21	21	0	2241	2241
ARCH	190	0	190	65009	0	65009
ARL	0	23	23	0	5617	5617
ASTR	77	361	438	8185	42468	50653
AVI	0	39	39	0	26884	26884
BADM	1612	398	2010	101983	89991	191974
BECPSP	0	62	62	0	120327	120327
CAS	0	1	1	0	10	10
CE	2799	6353	9152	497326	1445128	1942464
CHE	12	4081	4093	0	752133	752133
CIRCE	0	12	12	0	-10137	-10137
CRC	0	241	241	0	119519	119519
CSL	0	51	51	0	45871	45871
DATLOG	0	24	24	0	905	905
CCS	10186	1806	11992	932444	380878	1312322
DS	0	241	241	0	71395	71895
ECON	496	441	937	136709	223620	360329
ED	2	338	340	9	285089	285098
EDADM	0	79	79	0	124193	124193
EDPSY	265	12	277	47502	1659	49161
EE	229	1192	1421	8526	217602	226128
ENGADM	0	598	598	0	201945	201945
ENGOST	0	965	965	0	303590	303590
ENGLISH	0	39	39	0	473	473
FIDEL	0	42	42	0	12359	12359
FIN	157	61	218	68316	14605	82921
FOR	0	9	9	0	144	144
FR	0	2	2	0	481	481
FT	0	22	22	0	3950	3950
GENE	653	74	727	44157	29694	73851
GEOG	0	135	135	0	65782	65782
GEOL	58	240	298	12166	64166	76332
GRCCOL	0	29	29	0	32688	32688
HEC	0	4	4	0	5729	5729
HORT	0	65	65	0	9321	9321
ICR	44	438	482	86002	154980	240982
IE	0	11	11	0	0	0
ILR	60	135	195	91860	150073	241933
IREC	0	6	6	0	5853	5853
LAW	0	147	147	0	11687	11687
LIPS	0	80	80	0	15636	15636
LIR	0	5	5	0	110	110
MATH	10	75	85	2501	8496	10997
MATRL	0	1777	1777	0	277544	277544
MCRIO	0	23	23	0	2253	2253

ME	905	816	1721	188425	109591	298016
MUSIC	81	167	248	39316	42922	82238
NHS	C	100	100	0	38022	38022
NUCE	65	391	456	11465	49884	61349
OAC	0	2	2	0	1264	1264
CAS	C	22	22	0	33558	33558
DIR	0	184	184	0	38440	38440
FEM	162	23	185	126527	4277	130804
PHYR	C	117	117	0	36279	36279
PHYCS	26	1619	1645	3767	205824	209591
PHYSL	C	49	49	0	11330	11330
PHYX	C	730	730	0	356577	356577
POLS	150	247	397	123538	132947	256485
PSYCH	727	1624	2351	740125	1286270	2026395
SCENS	C	81	81	0	24849	24849
SCS	0	2	2	0	7161	7161
SGS	C	459	459	0	323628	323638
SQC	60	242	302	61488	187843	249331
SQCK	57	8	105	20195	5775	25970
SPCH	C	19	19	0	8507	8507
SPEC	C	8	8	0	3736	3736
SRL	C	266	266	0	378692	378692
SWS	C	1163	1163	0	286628	286628
TAM	464	609	1073	69325	93075	162400
UICMM	0	3	3	0	790	790
UOSCR	C	27	27	0	53532	53532
VPH	C	9	9	0	15515	15515
VPP	101	43	144	14287	2446	16733
VTED	C	30	30	0	14910	14910
ZCGL	C	291	291	0	43194	43194

SUBTOTAL	21210	32427	53637	3904024	9869778	13773802
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DCSSYS ³	C	11403	11403	0	4882266	4882266
OVRHED ⁴	C	1104	1104	0	251	251
REFUND ⁵	0	226	226	0	308397	308397
UAPP ⁶	0	117	117	0	19015	19015
XDCS ⁷	C	405	405	0	1775674	1775674
XMAINT ⁸	C	278	278	0	908353	908353
XSSS ⁹	C	582	582	0	50337	50337

TOTAL	21210	46542	67752	3904024	17815071	21719095
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1 See list of departmental codes following

2 Training and Education

3 System Improvement and Modifications

4 System Use in Excess of User Estimated Usage

5 Rerun of User Jobs Due to Machine or System Error

6 University Overhead Administrative Use

7 System Updating

8 System Maintenance

9 Special Short Shots

TABLE III AUGUST 1970

UNITS CHARGED--26C/75

DEPT ¹	NUMBER OF RUNS			NUMBER OF UNITS		
	CLASS ²	RES	TOTAL	CLASS ²	RES	TOTAL
AAE	636	441	1077	25052	17270	42322
ACCY	862	34	896	39679	4571	44650
ADV	C	3	3	0	201	201
AGE	0	215	215	0	15242	15242
AGEC	0	1185	1185	0	99773	99773
AGRIC	C	7	7	0	1122	1122
AGRON	24	219	243	574	4021	4995
ANS	0	211	211	0	31672	31672
ANTH	0	21	21	0	924	924
ARCH	188	0	188	6164	0	6164
APL	0	23	23	0	2663	2663
ASTR	77	360	437	1378	19880	21258
AVI	C	38	38	0	4243	4243
BADM	1609	398	2007	62063	32561	94624
BECPSP	0	62	62	0	15800	15800
CAS	C	1	1	0	13	13
CE	2795	6349	9144	107727	442216	550943
CHE	12	4074	4086	19	364539	364558
CIRCE	0	11	11	0	-11331	-11331
CRC	C	241	241	0	28318	28318
CSL	0	51	51	0	4105	4105
CATLOG	C	24	24	0	950	950
CCS	10161	1805	11966	248968	253930	502898
DS	0	241	241	0	21733	21733
ECON	496	440	936	198507	47473	245980
ED	2	338	340	5	59902	59907
EDADM	C	79	79	0	8578	8578
EDPSY	263	12	275	11446	383	11829
EE	223	1191	1414	1240	103501	104741
ENGADM	0	598	598	0	40950	40950
ENGOST	C	966	966	0	24024	24024
ENGLSH	C	39	39	0	-1071	-1071
FIDEL	C	42	42	0	2465	2465
FIN	157	61	218	42579	3578	46157
FOR	C	9	9	0	175	175
FR	C	2	2	0	39	39
FT	C	21	21	0	914	914
GENE	651	74	725	19839	5474	25313
GEOG	0	135	135	0	21386	21386
GEOL	57	240	297	2804	12546	15350
GRDCCL	0	29	29	0	9251	9251
HEC	0	4	4	0	2313	2313
HORT	0	65	65	0	6427	6427
ICR	44	437	481	11725	33163	44888
IE	C	11	11	0	1357	1357
ILR	60	135	195	15508	29191	44699
IREC	C	6	6	0	1213	1213
LAW	C	146	146	0	1670	1670
LIBS	0	80	80	0	21965	21965
LIR	C	5	5	C	143	143
MATH	10	75	85	998	1568	2566
MATRL	C	1773	1773	0	189219	189219
MCBIO	C	23	23	0	176	176

ME	505	816	1721	70978	32012	102990
MUSIC	81	167	248	7684	5924	13608
NHS	C	100	100	C	5856	5856
NUCE	65	292	457	2610	13881	16491
CAC	C	2	2	0	213	213
GAS	C	22	22	0	7579	7579
OIR	C	184	184	0	14135	14135
FEM	162	23	185	11829	3807	15636
PHYB	0	115	115	0	5768	5768
PHYCS	26	1618	1644	650	196936	157586
PHYSL	0	49	49	0	1042	1042
PHYX	C	731	731	0	206320	206320
FOLS	150	247	397	45473	44199	89672
PSYCH	727	1623	2350	144299	305599	449898
SCCAS	0	81	81	0	7246	7246
SCS	0	2	2	0	1958	1958
SGS	0	459	459	0	37625	37625
SOC	60	242	302	11590	38671	50261
SOCW	97	8	105	3839	1250	5089
SPOF	C	19	19	0	1765	1765
SPEC	C	8	8	0	520	520
SRL	C	266	266	0	103818	103818
SWS	C	1162	1162	0	70472	70472
TAM	464	607	1071	196429	67546	263975
LICOMM	C	3	3	0	91	91
UQSCR	0	26	26	0	7398	7398
VPH	0	9	9	0	2381	2381
VPP	101	42	143	1596	578	2174
VTEC	C	20	30	0	6476	6476
ZOCL	C	290	290	0	5749	5749

SUDTOTAL	21165	22393	53558	1293652	3180604	4474256
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DCSSYS ³	0	11368	11368	0	803627	803627
OVRFED ⁴	0	1027	1027	0	4	4
REFUNC ⁵	0	242	242	0	83772	83772
UADP ⁶	C	117	117	C	1530	1530
YDCS ⁷	C	405	405	0	94415	94415
XMAINT ⁸	C	278	278	0	62563	62563
XSSS ⁹	0	582	582	0	8943	8943

TOTAL	21165	46412	67577	1293652	4235458	5529110
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1 See list of departmental codes following

2 Training and Education

3 System Improvement and Modifications

4 System Use in Excess of User Estimated Usage

5 Rerun of User Jobs Due to Machine or System Error

6 University Overhead Administrative Use

7 System Updating

8 System Maintenance

9 Special Short Shots

TABLE III AUGUST 1970

SECONDS--1000 REAL TIME

DEPT ¹	NUMBER OF RUNS			NUMBER OF UNITS		
	CLASS ²	RES	TOTAL	CLASS ²	RES	TOTAL
AGE	0	-2	-2	0	-1027	-1027
CE	0	2	2	0	3666	3666
CCS	1	0	1	6	0	6
EE	0	11	11	0	2144	2144
GEOL	0	5	5	0	2904	2904
MATRL	0	8	8	0	1396	1396
MUSIC	0	3	3	0	493	493
NUCF	0	-2	-2	0	-562	-562
PHYSL	0	6	6	0	594	594
SWS	0	7	7	0	3422	3422
VPP	1	1	2	96	51	147
<hr/>						
SUBTOTAL	2	39	41	102	13091	13193
<hr/>						
DCSSYS ³	0	56	56	0	6294	6294
REFUNC ⁴	0	14	14	0	6019	6019
<hr/>						
TOTAL	2	109	111	102	25404	25506
<hr/>						

1 See list of departmental codes following

2 Training and Education

3 System Improvement and Modifications

4 Rerun of User Jobs Due to Machine or System Error

Table I - IBM 360/20

Summary of Use

August, 1970

Scheduled Engineering	3:44
Maintenance	4:18
Production	317:41
Idle	<u>165:17</u>
Total Time	491:00

Table II - IBM 360/20

Summary of Machine Errors

August, 1970

A record has been set!

August, 1970, is the first month that no unscheduled engineering was done on the IBM 360/20 since July, 1968, when the 360/20 was put into actual operation.

TABLE III AUGUST 1970

MINUTES--260/20 REAL TIME

DEPT ¹	NUMBER OF RUNS			NUMBER OF UNITS		
	CLASS ²	RES	TOTAL	CLASS ²	RES	TOTAL
AAE	7	6	13	48	29	77
ACCY	2	3	5	89	81	170
ADV	0	2	2	0	21	21
AGE	C	5	5	0	28	28
AGED	C	24	24	0	892	892
AGRIC	0	2	2	0	21	21
AGRCN	C	10	10	0	39	39
ANS	C	48	48	0	199	199
ANTH	0	1	1	C	4	4
ARCH	13	0	13	130	0	130
ARL	C	6	6	0	121	131
ASTR	C	13	13	0	121	131
AVI	C	12	12	0	187	187
EADM	16	18	34	241	280	521
CE	37	94	131	190	1561	1751
CELSA	0	5	5	0	323	333
CHF	0	55	55	0	662	663
CIRCF	C	1	1	0	4	4
CCM	C	2	2	0	84	84
CRC	0	11	11	0	123	123
CSL	C	4	4	0	32	32
DATLOG	0	10	10	0	58	58
DCS	113	45	158	446	290	736
CS	0	9	9	0	519	519
CSFA	0	25	25	0	703	703
ECCN	33	26	59	397	454	851
ED	0	23	23	0	458	458
EDADM	0	1	1	0	4	4
EDPSY	7	0	7	95	0	95
EE	3	56	59	10	443	453
ENGADM	0	13	13	0	78	78
ENGCS	C	12	12	0	129	129
FIN	3	3	6	33	11	44
FOR	C	7	7	0	180	180
GENE	17	2	19	123	59	192
GECC	1	10	11	9	44	53
GECL	C	21	21	0	248	248
GROCC	0	14	14	0	97	97
HORT	0	7	7	C	23	23
ICR	3	65	68	26	1480	1516
IE	2	1	3	19	5	24
ILR	14	33	47	312	322	634
LAW	C	2	2	0	10	10
MATH	1	12	13	2	30	32
MATRL	C	42	42	0	324	324
ME	24	21	45	181	90	271
MUSIC	2	17	19	71	103	174
NHS	C	4	4	0	28	28
NUCE	5	27	32	35	163	198
OAS	C	1	1	0	2	2
CIR	0	5	5	C	188	188
PEM	6	1	7	65	12	77
PHYCS	1	41	42	80	427	507

PHYSL	C	3	3	0	20	20
PHYX	0	3	3	0	17	17
POLS	5	20	35	82	338	420
PSYCH	12	91	103	125	757	920
REC	3	2	5	99	3	10
SCS	0	1	1	0	3	3
SGS	C	21	21	0	662	662
SOC	0	25	25	0	1258	1258
SOCK	0	2	2	0	3	3
SPCH	0	1	1	0	11	11
SPEC	C	1	1	0	6	6
SRL	C	6	6	0	156	156
SWS	C	2	2	0	21	21
TAM	6	32	38	22	157	179
UICMM	C	3	3	0	25	25
UOSCP	C	7	7	0	421	421
USGS	C	1	1	0	2	2
VPH	0	3	3	0	15	15
VPP	0	1	1	0	5	5
VTED	C	9	9	0	355	355
ZOGL	C	5	5	0	24	24

SUBTOTAL	336	1127	1463	2950	16164	19114
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CCSSYS ³	C	315	315	0	2867	2867
REFUND ⁴	0	5	5	0	121	121
UADP ⁵	C	2	2	0	5	5
XMAINT ⁶	C	159	159	0	10695	10695

TOTAL	336	1608	1944	2950	29852	32802
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- 1 See list of departmental codes following
 - 2 Training and Education
 - 3 System Improvement and Modifications
 - 4 Rerun of User Jobs Due to Machine or System Error
 - 5 University Overhead Administrative Use
 - 6 System Maintenance

TABLE III AUGUST 1970

MINUTES--SERVICE PROGRAMMING

DEPT ¹	NUMBER OF RUNS			NUMBER OF UNITS		
	CLASS ²	RES	TOTAL	CLASS ²	RES	TOTAL
ANTH	C	2	2	0	420	420
CIRCE	C	4	4	0	435	435
ED	0	2	2	0	600	600
FT	0	1	1	0	413	413
GEOG	0	1	1	0	120	120
MATRL	C	3	3	0	300	300
PEW	C	1	1	0	2340	2340
PHYSI	C	2	2	0	240	240
<hr/>						
TOTAL	0	16	16	0	4868	4868
<hr/>						

1 See list of departmental codes following

2 Training and Education

TABLE III JULY 1970

CARDS KEYPUNCHED

DEPT ¹	NUMBER OF RUNS			NUMBER OF UNITS		
	CLASS ²	RES	TOTAL	CLASS ²	RES	TOTAL
ADV	0	1	1	0	600	600
AGEC	C	3	3	0	300	300
ANS	0	7	7	0	1700	1700
ANTH	2	0	2	700	0	700
BADM	3	0	3	550	0	550
CE	C	7	7	0	2100	2100
CHE	0	1	1	0	400	400
CRC	C	1	1	0	900	900
DCS	1	2	3	600	300	900
DS	C	1	1	0	600	600
ECON	1	2	3	100	1750	1850
ED	0	60	60	0	24500	24500
ENGLISH	0	1	1	0	1000	1000
FIN	2	2	4	500	700	1200
FT	C	1	1	0	100	100
GENE	1	0	1	100	0	100
GEOG	0	1	1	0	400	400
GSA	C	1	1	0	2800	2800
ILR	0	2	2	0	950	950
IREC	C	3	3	0	600	600
OIR	C	2	2	0	200	200
PEM	4	0	4	1700	0	1700
PHYS	0	1	1	0	500	500
POLS	2	7	9	1200	2750	3950
PSYCH	1	23	34	1200	13950	15150
SOC	C	2	2	0	3700	3700
SOCW	3	0	3	800	0	800
UOSCP	0	2	2	0	10550	10550
ZOOL	0	1	1	0	150	150
<hr/>						
SUBTOTAL	20	144	164	7450	71500	78950
<hr/>						
DCSSYS ³	0	31	31	0	6600	6600
REFUND ⁴	C	1	1	0	600	600
<hr/>						
TOTAL	20	176	196	7450	78700	86150

1 See list of departmental codes following

2 Training and Education

3 System Improvement and Modifications

4 Rerun of User Jobs Due to Machine or System Error

TABLE III AUGUST 1970

COVER CHARGE--PASS

DEPT ¹	NUMBER OF RUNS			NUMBER OF UNITS		
	CLASS ²	FES	TOTAL	CLASS ²	RES	TOTAL
AAE	197	242	439	197	242	439
ACCY	435	24	459	435	24	459
ADV	C	3	3	0	3	3
AGE	0	78	78	0	78	78
AGEC	0	649	649	0	649	649
AGRIC	C	7	7	0	7	7
AGRON	10	110	120	10	110	120
ANS	C	174	174	0	174	174
ANTH	C	11	11	0	11	11
ARCH	80	0	80	80	0	80
ARL	C	21	21	0	21	21
ASTR	35	147	182	35	147	182
AVI	0	25	25	0	25	25
BADM	1080	204	1284	1080	204	1284
EECPSR	C	16	16	0	16	16
CAS	C	1	1	0	1	1
CE	1193	1579	2772	1193	1579	2772
CHE	12	1933	1945	12	1933	1945
CIRCE	C	7	7	0	7	7
CRC	C	104	104	0	104	104
CSL	C	51	51	0	51	51
CATLOC	C	21	21	0	21	21
CCS	4774	728	5502	4774	728	5502
DS	C	102	102	0	102	102
ECON	275	276	551	275	276	551
ED	2	217	219	2	217	219
EDADM	0	22	22	0	22	22
EDPSY	191	12	203	191	12	203
EE	116	528	644	116	528	644
ENGADM	C	295	295	0	295	295
ENGOST	0	350	350	0	350	350
ENGLISH	0	34	34	0	34	34
FIDEI	C	21	21	0	21	21
FIN	60	62	122	60	62	122
FOR	0	7	7	0	7	7
FR	C	1	1	0	1	1
FT	C	8	8	0	8	8
GENE	350	32	382	350	32	382
GEGC	C	102	102	0	102	102
GEOL	35	177	212	35	177	212
GRUCCOL	C	23	23	0	23	23
HEC	0	4	4	0	4	4
HORI	C	35	35	0	35	35
ICP	21	270	291	21	270	291
IE	C	11	11	0	11	11
ILR	58	105	163	58	105	163
IREC	0	6	6	0	6	6
LAW	C	33	33	0	33	33
LIBS	C	85	85	0	85	85
LIR	0	5	5	0	5	5
MATH	6	39	45	6	39	45
NATRI	0	918	918	0	918	918
MCRIO	0	9	9	0	9	9

ME	357	449	806	357	449	806
MUSIC	81	65	146	81	65	146
NHS	0	90	90	0	90	90
NUCE	33	165	198	33	165	198
OAC	0	2	2	0	2	2
OAS	0	22	22	0	22	22
OIR	0	136	136	0	136	136
PEM	75	24	99	75	24	99
PHYB	0	59	59	0	59	59
PHYCS	16	783	799	16	783	799
PHYSL	0	22	22	0	22	22
PHYX	0	224	224	0	224	224
POLS	149	150	299	149	150	299
PSYCH	427	1024	1451	427	1024	1451
SCCAS	0	33	33	0	33	33
SCS	0	2	2	0	2	2
SGS	0	217	217	0	217	217
SCC	61	207	268	61	207	268
SOOW	41	8	49	41	8	49
SPCH	0	19	19	0	19	19
SPFC	0	8	8	0	8	8
SRL	0	151	151	0	151	151
SWS	0	607	607	0	607	607
TAM	223	276	499	223	276	499
UICCM	0	1	1	0	1	1
UOSCP	0	26	26	0	26	26
VPH	0	9	9	0	9	9
VPP	48	30	78	48	30	78
VTED	0	26	26	0	26	26
ZOCL	0	95	95	0	95	95

SUBTOTAL	10441	14854	25295	10441	14854	25295
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DCSSY ³	0	4439	4439	0	4439	4439
QVRFC ⁴	0	1042	1042	0	1042	1042
REFUN ⁵	0	270	270	0	270	270
UADP ⁶	0	39	39	0	39	39
XDCS ⁷	0	204	204	0	204	204
XMAIN ⁸	0	156	156	0	156	156
XSSS ⁹	0	448	448	0	448	448

TOTAL	10441	21452	31893	10441	21452	31893
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1 See list of departmental codes following	6 University Overhead Administrative Use
2 Training and Education	7 System Updating
3 System Improvement and Modifications	8 System Maintenance
4 System Use in Excess of User Estimated Usage	9 Special Short Shots
5 Rerun of User Jobs Due to Machine or System Error	

TABLE III AUGUST 1970

COVER CHARGE--XERESS PATCH

DEPT ¹	NUMBER OF RUNS			NUMBER OF UNITS		
	CLASS ²	RES	TOTAL	CLASS ²	RES	TOTAL
AAF	79	24	103	79	24	103
AGE	0	16	16	0	16	16
AGEC	0	24	24	0	24	24
AGRON	0	2	2	0	2	2
ANS	0	1	1	0	1	1
ANTH	0	5	5	0	5	5
ARCH	9	0	9	9	0	9
ASTR	14	35	49	14	35	49
AVI	0	14	14	0	14	14
BADM	94	0	94	94	0	94
CE	48	89	137	48	89	137
CHE	0	22	22	0	22	22
CRC	0	73	73	0	73	73
DCS	934	202	1136	934	202	1136
DS	0	1	1	0	1	1
ECCN	10	8	18	10	8	18
ED	0	5	5	0	5	5
EDPSY	23	0	23	23	0	23
FE	48	21	69	48	21	69
ENGARM	0	2	2	0	2	2
ENGOST	0	7	7	0	7	7
FIN	4	0	4	4	0	4
FT	0	1	1	0	1	1
GENE	92	4	96	92	4	96
GFCL	0	1	1	0	1	1
ICR	0	2	2	0	2	2
ILR	2	0	2	2	0	2
LAW	0	19	19	0	19	19
MATH	0	17	17	0	17	17
MATRI	0	31	31	0	31	31
ME	101	77	178	101	77	178
MLSTC	0	3	3	0	3	3
NUCE	0	37	37	0	37	37
PHYB	0	22	22	0	22	22
PHYCS	0	28	28	0	28	28
PHYSL	0	2	2	0	2	2
PHYX	0	2	2	0	2	2
PCLS	1	0	1	1	0	1
PSYCH	96	89	185	96	89	185
SCONS	0	9	9	0	9	9
SRL	0	14	14	0	14	14
TAM	25	34	69	25	34	69
UQSCR	0	1	1	0	1	1
VPP	0	2	2	0	2	2
VTED	0	3	3	0	3	3
ZOOL	0	15	15	0	15	15

SUBTOTAL

1590

964

2554

1590

964

2554

DCSSYS 3	C	410	410	0	410	410
OVRREC 4	C	81	81	0	81	81
REFUNC 5	C	8	8	0	8	8
UADP 6	C	54	54	0	54	54
XDCS 7	C	1	1	0	1	1

TOTAL	1590	1518	3108	1590	1518	3108
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- 1 See list of departmental codes following
 - 2 Training and Education
 - 3 System Improvement and Modifications
 - 4 System Use in Excess of User Estimated Usage
 - 5 Rerun of User Jobs Due to Machine or System Error
 - 6 University Overhead Administrative Use
 - 7 System Updating

Table I - IBM 360/75

Summary of Use

September, 1970

Scheduled Engineering
 Unscheduled Engineering

15:56:00

11:07:00

Subtotal

39:60:00

Batch
 System Maintenance and Development

629:36:00

50:24:00

Total

720:00:00

Table II - IBM 360/75

Summary of Use

September, 1970

2703 Data Transfer Control
 2501 Card Reader

1

1

Total

2

TABLE III SEPTEMBER 1970

CENTISECONDS--360/75 PROCESSOR TIME

DEPT ¹	NUMBER OF RUNS			NUMBER OF UNITS		
	CLASS ²	RES	TOTAL	CLASS ²	RES	TOTAL
AAE	803	269	1072	440580	555161	1035741
ACCY	1144	15	1159	200647	102623	303270
ADV	C	10	10	0	7669	7669
AGE	21	198	219	2669	68222	70891
AGEC	0	583	583	0	438766	438766
AGRON	124	295	419	9968	587176	597144
ANS	0	428	428	0	447934	447934
ANTH	0	1	1	0	2847	2847
ARCH	95	1	96	19368	210	19578
ARL	0	59	59	0	288846	288846
ASTR	0	86	86	0	57177	57177
AVI	0	85	85	0	68961	68961
BADM	1456	196	1652	97546	247593	345139
BECPSR	0	43	43	0	42988	42988
BICPH	0	189	189	0	49525	49525
CE	470	3769	4239	197756	5610621	5808377
CHE	208	2155	2363	317157	5867627	6184784
CIRCF	0	33	33	0	-14945	-14945
CRC	0	69	69	0	38952	38952
CSL	0	99	99	0	123814	123814
DATLOG	C	25	25	0	18222	18222
DCS	13210	1397	14607	2632060	1633773	4265833
DS	0	190	190	0	120029	120029
ECON	58	143	241	1770689	294704	2065393
ED	59	370	429	8182	339422	347604
EDADM	0	30	30	0	13970	13970
EDPSY	92	2	94	9729	762	10501
EE	321	809	1130	187662	1105889	1293551
ENGADM	0	548	548	0	553045	553045
ENGCS	0	1681	1681	0	550002	550002
ENGH	202	0	202	19523	0	19523
FIDEL	0	4	4	0	6773	6773
FIN	712	121	833	66911	124903	191814
FOR	0	1	1	0	495	495
FT	0	21	21	0	11001	11001
GENE	162	47	209	38514	53880	92394
GEOG	18	75	93	5434	14535	19969
GEOL	296	126	422	127907	134602	262509
HEC	0	3	3	0	6233	6233
HORT	0	36	36	0	11618	11618
ICR	0	529	529	0	149042	149042
IE	13	14	27	13606	7663	21269
ILLUMI	0	12	12	0	29915	29915
ILR	0	248	248	0	233573	233573
IRFC	0	6	6	0	928	928
LAW	0	113	113	0	21120	21120
LIRS	0	13	13	0	28264	28264
LINC	19	0	19	4200	0	4200
MATH	118	212	330	10590	269697	28028
MATRI	0	1822	1822	0	4088212	4088212
MORIO	0	13	13	0	4856	4856
ME	1451	581	2032	687747	1021768	1709515
MMPE	0	160	160	0	28012	28012

MUSIC	159	643	802	26405	235883	262288
MISC	C	51	51	0	34780	34780
M	93	490	583	8161	1048480	1056641
OAC	0	1	1	0	852	852
CAS	C	29	29	0	54995	54995
DIR	0	299	299	0	285705	285705
PBM	0	24	24	0	7557	7557
PEW	0	6	6	0	8545	8545
PHYB	0	122	122	0	117399	117399
PHYCS	229	1535	1764	26736	2051933	2078669
PHYSL	0	62	62	0	9741	9741
PHYX	0	682	682	0	1005427	1005427
PDLS	71	27	98	10702	50022	60724
PSYCH	84	908	992	55354	1509724	1565078
REC	-2	16	14	-46524	132490	85966
SCONS	0	51	51	0	68670	68670
SCS	0	6	6	0	234122	234122
SGS	0	536	536	0	224963	224963
SOC	0	57	57	0	71433	71433
SOCW	C	9	9	0	66038	66038
SPCH	C	18	18	0	8213	8213
SRL	0	395	395	0	-181332	-181332
SWS	0	1306	1306	0	1503625	1503625
TAM	84	557	641	108425	525952	634377
UICOMM	0	14	14	0	15387	15387
UNSCF	0	34	34	0	96538	96538
URPLAN	10	0	10	1389	0	1389
USGS	0	1	1	0	777	777
VPH	C	6	6	0	3700	3700
VPP	0	34	34	0	8201	8201
WPGU	C	9	9	0	1557	1557
ZOOL	0	106	106	0	29773	29773

SUBTOTAL	21820	25969	47789	7059103	34739825	41798928
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DCSSYS ³	0	10799	10799	0	7940141	7940141
OVRHED ⁴	0	1440	1440	0	3533	3533
REFUND ⁵	0	259	259	0	1256404	1256404
UADP ⁶	0	24	24	0	3953	3953
XDCS ⁷	0	371	371	0	361984	361984
XMAINT ⁸	0	536	536	0	153875	153875
XSSS ⁹	C	805	805	0	214109	214109

TOTAL	21820	40203	62023	7059103	44673824	51732927
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See list of departmental codes following

2 Training and Education

3 System Improvement and Modifications

4 System Use in Excess of User Estimated Usage

5 Rerun of User Jobs Due to Machine or System Error

6 University Overhead Administrative Use

7 System Updating

8 System Maintenance

9 Special Short Shots

TABLE III SEPTEMBER 1970

INPUT/OUTPUT REQUESTS--360/75

DEPT ¹	NUMBER OF RUNS			NUMBER OF UNITS		
	CLASS ²	RES	TOTAL	CLASS ²	RES	TOTAL
AAE	803	269	1072	144524	44065	188589
AGCY	1144	15	1159	122229	7176	129405
ADV	0	10	10	0	8163	8163
AGE	21	198	219	1769	27925	29694
AGEC	0	583	583	0	368376	368376
AGRON	124	295	419	3729	38160	41889
ANS	0	428	428	0	157226	157226
ANTH	0	1	1	0	1684	1684
ARCH	95	1	96	13090	520	13610
ARL	0	59	59	0	6630	6630
ASTR	0	87	87	0	8823	8823
AVI	0	85	85	0	49750	49750
BADM	1456	196	1652	11230	49570	60800
PECBSR	0	43	43	0	15739	15739
BIOPH	0	189	189	0	14401	14401
CE	470	2770	4240	40619	1186212	1226831
CHE	208	2155	2363	10280	549471	559751
CIRCE	0	33	33	0	2599	2599
CRC	0	70	70	0	14936	14936
CSL	0	99	99	0	10	10
DATLOC	0	25	25	0	1802	1802
ECS	13209	1397	14606	1092241	170029	1262270
DS	0	191	191	0	46929	46929
ECCN	98	143	241	17457	104284	121741
ED	59	372	431	202	165042	165244
EDADM	0	30	30	0	14528	14528
EDPSY	92	2	94	5649	796	6445
EE	321	809	1130	30691	152415	183106
ENGADM	0	548	548	0	222550	222550
ENGCS	0	1681	1681	0	427021	427021
ENGH	202	0	202	14265	0	14265
FIDEL	0	4	4	0	1350	1350
FIN	712	121	833	21202	26464	47666
FOR	0	1	1	0	0	0
FT	0	21	21	0	730	730
GENE	162	47	209	10265	14652	24917
GEOG	18	75	93	2812	10283	13095
GEOI	296	126	422	73247	35373	108620
HEC	0	3	3	0	852	852
HORT	0	36	36	0	5949	5949
ICR	0	530	530	0	38849	38849
IE	13	14	27	3551	3829	7380
ILLUNI	0	12	12	0	1780	1780
ILR	0	249	249	0	110633	110633
IREC	0	6	6	0	422	422
LAW	0	113	113	0	10560	10560
LIBS	0	13	13	0	933	933
LING	19	0	19	3805	0	3805
MATH	118	212	330	1796	39991	41787
MATRL	0	1822	1822	0	282057	282057
MCBIO	0	13	13	0	2900	2900
ME	1451	581	2032	120187	71348	191535
MMPE	0	160	160	0	7427	7427

MUSIC	159	643	802	8155	231516	230
NHS	0	51	51	0	13350	133
NUCE	93	491	584	4325	85542	855
OAC	0	1	1	0	627	627
OAS	0	29	29	0	20761	20761
OIP	0	300	300	0	110571	110571
PFM	0	24	24	0	1425	1425
PEW	0	6	6	0	10503	10503
PHYB	0	123	123	0	52058	52058
PHYCS	229	1536	1765	16949	179517	196466
PHYSI	0	62	62	0	3306	3306
PHYX	0	682	682	0	406239	406239
PCLS	71	27	98	4340	8036	12376
PSYCH	84	909	993	25290	634987	660277
REC	-2	16	14	-9895	13965	4070
SCONS	0	51	51	0	16078	16078
SCS	0	6	6	0	219141	219141
SGS	0	536	536	0	186689	186689
SDC	0	57	57	0	29164	29164
SDCW	0	9	9	0	15007	15007
SPCH	0	19	19	0	7715	7715
SRL	0	395	395	0	-204979	-204979
SWS	0	1306	1306	0	333400	333400
TAM	84	559	643	13843	92241	106084
UICOMM	0	14	14	0	5413	5413
UOSCP	0	34	34	0	119151	119151
URPLAN	10	0	10	120	0	120
USGS	0	1	1	0	0	0
VPH	0	6	6	0	1051	1051
VPP	0	34	34	0	1903	1903
WPGU	0	9	9	0	584	584
ZCCI	0	106	106	0	5659	5659

SUBTOTAL	21819	25985	47804	1807967	7127834	8935801
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DCSSYS 3	0	10800	10800	0	5403924	5403924
QVRPCC 4	0	1441	1441	0	939	939
REFUND 5	0	243	243	0	529823	529823
UADP 6	0	24	24	0	14636	14636
XDCS7	0	371	371	0	1499661	1499661
XMAINT 8	0	536	536	0	160848	160848
XSS59	0	805	805	0	63959	63959

TOTAL	21819	40205	62024	1807967	14801624	16609591
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- 1 See list of departmental codes following
- 2 Training and Education
- 3 System Improvement and Modifications
- 4 System Use in Excess of User Estimated Usage
- 5 Rerun of User Jobs Due to Machine or System Error
- 6 University Overhead Administrative Use
- 7 System Updating
- 8 System Maintenance
- 9 Special Short Shots

TABLE III SEPTEMBER 1970

UNITS CHARGED--360/75

DEPT ¹	NUMBER OF RUNS			NUMBER OF UNITS		
	CLASS ²	RES	TOTAL	CLASS ²	RES	TOTAL
AAE	802	269	1071	27896	26141	54037
ACCY	1144	15	1159	12512	10158	22670
ADV	0	10	10	0	1232	1232
AGE	21	198	219	154	5051	5205
AGEC	0	583	583	0	46138	46138
AGRON	123	295	418	490	27302	27792
ANS	0	427	427	0	41582	41582
ANTH	0	1	1	0	374	374
ARCH	95	1	96	1360	29	1389
ARL	0	59	59	0	10545	10545
ASTR	0	86	86	0	3313	3313
AVI	0	85	85	0	9278	9278
BADM	1445	196	1641	4265	22309	26574
BECBSR	0	43	43	0	3379	3379
BIOPH	0	189	189	0	2483	2483
CE	457	3767	4224	10582	421309	431891
CHE	208	2155	2363	22528	399606	422134
CIRCE	0	33	33	0	-3140	-3140
CRC	0	70	70	0	3580	3580
CSL	0	99	99	0	10173	10173
CATALOG	0	25	25	0	1116	1116
DCS	12968	1394	14362	140485	103271	243756
DS	0	189	189	0	9212	9212
ECON	98	143	241	68004	21579	89583
ED	58	370	428	315	35464	35779
EDADM	0	30	30	0	1591	1591
EDPSY	85	2	87	1010	128	1138
EE	316	808	1124	8566	60954	69520
ENGADM	0	548	548	0	40111	40111
ENGCS	0	1680	1680	0	38082	38082
ENGH	202	0	202	1189	0	1189
FIDEL	0	4	4	0	330	330
FIN	707	121	828	3554	8364	11918
FOR	0	1	1	0	15	15
FT	0	21	21	0	820	820
GENE	162	47	209	1873	3462	5335
GEOG	18	75	93	329	938	1267
GEOL	296	126	422	9299	9724	19023
HEC	0	3	3	0	584	584
HORT	0	36	36	0	827	827
ICR	0	529	529	0	8643	8643
IE	13	14	27	725	482	1207
ILLUNI	0	12	12	0	1940	1940
IIR	0	249	249	0	24198	24198
IREC	0	6	6	0	67	67
LAW	0	113	113	0	1289	1289
LIBS	0	13	13	0	2294	2294
LING	18	0	18	252	0	252
MATH	115	211	326	450	15469	15919
MATRL	0	1822	1822	0	231496	231496
MCBIO	0	13	13	0	306	306
ME	1430	579	2009	37902	67107	105009
MMPE	0	160	160	0	1906	1906

MUSIC	158	643	801	1197	17503	18700
NHS	0	51	51	0	2866	2866
NUCE	93	490	583	404	60790	61194
CAC	0	1	1	0	122	122
DAS	C	29	29	0	5340	5340
OIR	0	299	299	0	23081	23081
PEM	C	24	24	0	697	697
PEW	C	5	5	0	1318	1318
PHYB	0	122	122	0	6954	6954
PHYCS	228	1534	1762	1552	81827	83379
PHYSI	0	60	60	0	481	481
PHYX	0	682	682	0	84687	84687
POLS	69	25	94	1132	4743	5875
PSYCH	83	907	990	4527	144747	149274
REC	-2	16	14	-4662	11733	7071
SCONS	0	51	51	0	5948	5948
SCS	0	6	6	0	41698	41698
SGS	0	536	536	0	24391	24391
SOC	0	57	57	0	6272	6272
SOCW	0	9	9	0	6693	6693
SPCH	C	19	19	0	1307	1307
SPL	0	394	394	0	-43161	-43161
SWS	0	1306	1306	0	120486	120486
TAM	84	558	642	5785	36927	42712
UICCMF	0	14	14	0	869	869
UQSCR	0	34	34	0	17481	17481
URPLAN	8	0	8	56	0	56
USGS	0	1	1	0	47	47
VPH	0	6	6	0	183	183
VPP	0	24	34	0	414	414
WPGU	C	9	9	0	88	88
ZOOL	C	106	106	0	1621	1621

SUBTOTAL	21502	25553	47455	363731	2400764	2764495
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DCSSYS ³	0	10734	10734	0	786255	786255
OVRHED ⁴	0	1037	1037	0	0	0
REFUNC ⁵	0	252	252	0	135603	135603
UADP ⁶	0	23	23	0	568	568
XDCS ⁷	0	349	349	0	72579	72579
XMAINT ⁸	0	535	535	0	12321	12321
XSSS ⁹	0	805	805	0	11573	11573

TOTAL	21502	39688	61190	363731	3419663	3783394
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1 See list of departmental codes following

2 Training and Education

3 System Improvement and Modifications

4 System Use in Excess of User Estimated Usage

5 Rerun of User Jobs Due to Machine or System Error

6 University Overhead Administrative Use

7 System Updating

8 System Maintenance

9 Special Short Shots

TABLE III SEPTEMBER 1970

SECONDS--1800 REAL TIME

DEPT ¹	NUMBER OF RUNS			NUMBER OF UNITS		
	CLASS ²	RES	TOTAL	CLASS ²	RES	TOTAL
EE	0	5	5	0	2021	2021
ENGCST	0	1	1	0	101	101
MATRL	0	5	5	0	721	721
PHYCS	0	1	1	0	210	210
VPP	0	2	2	0	118	118
	0			0		

SUBTOTAL	0	14	14	0	3171	3171
DCSSYS ³	0	3	3	0	3158	3158
REFUNC ⁴	0	3	3	0	850	850

TOTAL	0	20	20	0	7187	7187

1 See list of departmental codes following

2 Training and Education

3 System Improvement and Modifications

4 Rerun of User Jobs Due to Machine or System Error

Table I - IBM 360/20

Summary of Use

September, 1970

Scheduled Engineering	5:27
Unscheduled Engineering	44:10
Maintenance	5:01
Production	237:56
Operator Training	3:31
Idle	<u>194:25</u>
Total Time	490:30

Table II- IBM 360/20

Summary of Machine Errors

September, 1970

2560 MFCM	10
2203 Printer	<u>1</u>
Total	<u><u>11</u></u>

TABLE III SEPTEMBER 1970

MINUTES--360/20 REAL TIME

DEPT ¹	NUMBER OF RUNS			NUMBER OF UNITS		
	CLASS ²	RES	TOTAL	CLASS ²	RES	TOTAL
AAE	3	6	9	58	67	125
ACCY	2	0	2	128	-4	124
AGE	0	3	3	0	3	3
AGEC	0	18	18	0	181	181
AGRON	2	19	21	47	466	513
ANS	0	52	52	0	524	524
ARCH	5	0	5	70	0	70
ARL	0	7	7	0	18	18
ASTR	0	22	22	0	80	80
AVI	0	3	3	0	45	45
BACM	10	12	22	172	166	338
BIOPH	0	1	1	0	1	1
CE	6	66	72	10	810	820
CEUSA	0	4	4	0	182	182
CHE	0	29	29	0	356	356
CCM	0	1	1	0	31	31
CRC	0	1	1	0	7	7
CSL	0	2	2	0	14	14
CATLOG	0	11	11	0	87	87
DCS	96	33	129	1173	220	1393
DS	0	17	17	0	170	170
DSFA	0	28	28	0	1050	1050
ECON	11	14	25	249	371	620
ED	4	12	16	10	60	70
EDPSY	11	0	11	546	0	546
EE	1	29	30	1	295	296
ENGADM	0	12	12	0	43	43
ENGCS	0	14	14	0	183	183
ENGH	12	0	12	83	0	83
FIDEL	0	1	1	0	4	4
F-IN	7	3	10	225	174	399
GENE	5	3	8	52	141	193
GECG	0	4	4	0	14	14
GEOL	11	11	22	48	46	94
HEC	0	1	1	0	1	1
HORT	0	5	5	0	51	51
ICR	0	15	15	0	104	104
IE	2	0	2	24	0	24
ILLUNI	0	3	3	0	11	11
ILR	0	13	13	0	102	102
LAW	0	3	3	0	3	3
MATH	3	6	9	17	7	24
MATRL	0	15	15	0	135	135
ME	60	14	74	357	145	502
MUSIC	2	8	10	4	21	25
NHS	0	4	4	0	7	7
NUCE	0	16	16	0	77	77
QIR	0	4	4	0	169	169
PEM	0	2	2	0	29	29
PERRIF	0	2	2	0	2	2
PHYCS	8	33	41	52	225	277
PHYX	0	3	3	0	50	50
PCLS	3	7	10	28	35	63

PROVST	0	30	30	0	301	301
PSYCH	9	56	65	140	997	1137
REC	0	7	7	0	77	77
SCONS	0	1	1	0	2	2
SCS	0	2	2	0	18	18
SGS	0	21	21	0	73	73
SRL	0	9	9	0	452	452
SWS	0	4	4	0	24	24
TAM	8	40	48	57	228	285
UICCM	0	1	1	0	9	9
UOSCR	0	7	7	0	139	139
VPP	0	3	3	0	7	7
ZOCL	0	11	11	0	42	42

SUBTOTAL	281	784	1065	3551	9348	12899
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DCSSYS ³	0	255	255	0	3215	3215
REFUNC ⁴	0	9	9	0	236	236
UADP ⁵	0	2	2	0	9	9
XMAINT ⁶	0	162	162	0	16843	16843

TOTAL	281	1212	1493	3551	29651	33202
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- 1 See list of departmental codes following
 2 Training and Education
 3 System Improvement and Modifications
 4 Rerun of User Jobs Due to Machine or System Error
 5 University Overhead Administrative Use
 6 System Maintenance

TABLE III SEPTEMBER 1970

MINUTES--SERVICE PROGRAMMING

DEPT ¹	NUMBER OF RUNS			NUMBER OF UNITS		
	CLASS ²	RES	TOTAL	CLASS ²	RES	TOTAL
CIRCE	0	5	5	0	750	750
FIN	0	1	1	0	120	120
MATH	0	3	3	0	570	570
PEW	0	1	1	0	2700	2700
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TOTAL	0	10	10	0	4140	4140
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1 See list of departmental codes following

2 Training and Education

TABLE III SEPTEMBER 1970

CARDS KEYPUNCHED

PT ¹	NUMBER OF RUNS			NUMBER OF UNITS		
	CLASS ²	RES	TOTAL	CLASS ²	RES	TOTAL
AAE	0	1	1	0	700	700
AGEC	0	2	2	0	2300	2300
ANS	0	9	9	0	1100	1100
AVI	0	3	3	0	1150	1150
BADM	0	1	1	0	200	200
CE	0	9	9	0	2750	2750
CIRCE	0	1	1	0	600	600
DCS	4	4	8	800	950	1750
ECCN	0	5	5	0	7800	7800
ED	0	14	14	0	7600	7600
GEOL	1	0	1	1200	0	1200
GSA	0	1	1	0	6000	6000
ILR	0	2	2	0	450	450
LAW	0	1	1	0	200	200
ME	1	0	1	400	0	400
MUSIC	0	2	2	0	2700	2700
NHS	0	4	4	0	1750	1750
PEM	0	1	1	0	200	200
PERSOF	0	2	2	0	400	400
PHYCS	0	3	3	0	3300	3300
POLS	2	3	5	500	300	800
PSYCH	1	3	4	1300	600	1900
REC	0	4	4	0	8600	8600
SOC	0	1	1	0	300	300
TAM	0	5	5	0	1300	1300

SUBTOTAL	9	81	90	4200	51250	55450
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DCSSYS ³	0	34	34	0	7300	7300
REFUNC ⁴	0	1	1	0	6900	6900

TOTAL	9	116	125	4200	65450	69650
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1 See list of departmental codes following

2 Training and Education

3 System Improvement and Modifications

4 Rerun of User Jobs Due to Machine or System Error

TABLE III SEPTEMBER 1970

CARDS PUNCHED--LOCAL

DEPT ¹	NUMBER OF RLNS			NUMBER OF UNITS		
	CLASS ²	RES	TOTAL	CLASS ²	RES	TOTAL
AAE	3	4	7	678	652	1330
AGE	0	6	6	0	1988	1988
AGEC	0	16	16	0	12302	12302
AGRON	2	24	26	1959	13840	15799
ANS	0	19	19	0	6512	6512
ARCH	2	0	2	290	0	290
ASTR	0	6	6	0	1209	1209
AVI	0	10	10	0	2826	2826
BADM	0	15	15	0	2319	2319
BECBSR	0	6	6	0	498	498
CE	4	57	61	50	16294	16344
CHE	0	137	137	0	25185	25185
CRC	0	2	2	0	648	648
DATLOG	0	1	1	0	254	254
DCS	46	24	70	17614	3095	20709
DS	0	1	1	0	304	304
ECON	0	8	8	0	18141	18141
ED	0	8	8	0	5736	5736
EDADM	0	1	1	0	197	197
EE	0	45	45	0	11966	11966
ENGCST	0	87	87	0	7074	7074
ENGH	1	0	1	227	0	227
ENV	0	5	5	0	2131	2131
GENE	1	0	1	319	0	319
GEOG	0	2	2	0	101	101
GEOL	11	9	20	1318	1532	2850
HORT	0	3	3	0	1036	1036
ICR	0	15	15	0	2244	2244
ILR	0	21	21	0	5504	5504
LAW	0	1	1	0	49	49
MATH	2	5	7	249	1149	1398
MATRL	0	23	23	0	6240	6240
ME	72	8	80	16720	1688	18408
MUSIC	0	3	3	0	1011	1011
NHS	0	5	5	0	395	395
NUCE	0	59	59	0	6988	6988
QIR	0	14	14	0	15308	15308
PHYB	0	3	3	0	289	289
PHYCS	4	72	76	1448	14066	15514
PHYX	0	13	13	0	3322	3322
PSYCH	5	180	185	5534	43820	49354
SCCAS	0	9	9	0	1506	1506
SCS	0	4	4	0	910	910
SGS	0	19	19	0	3701	3701
SPCH	0	2	2	0	435	435
SRL	0	16	16	0	9495	9495
TAM	2	23	35	6	5528	5534
UNSCR	0	5	5	0	7653	765
VPP	0	1	1	0	310	31
ZOOL	0	1	1	0	32	32

SUBTOTAL	155	1008	1163	46412	267483	310075
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DCSSYS 3	0	206	206	0	57900	57900
REFUND 4	0	13	13	0	4572	4572
XDCS 5	0	3	3	0	219	219
XMAINT 6	0	10	10	0	4111	4111
XSSS 7	0	64	64	0	2273	2273

TOTAL	155	1304	1455	46412	336558	382970
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- 1 See list of departmental codes following
- 2 Training and Education
- 3 System Improvement and Modifications
- 4 Rerun of User Jobs Due to Machine or System Error
- 5 System Updating
- 6 System Maintenance
- 7 Special Short Shots

TABLE III SEPTEMBER 1970

CARDS READ--LOCAL

DEPT ¹	NUMBER OF RUNS			NUMBER OF UNITS		
	CLASS ²	RES	TOTAL	CLASS ²	RES	TOTAL
AAE	271	131	402	134973	41590	176563
AGCY	50	-1	49	5605	-1687	3918
ADV	0	2	2	0	994	994
AGE	7	72	79	1197	22602	23799
AGEC	0	236	236	0	150560	150560
AGRCN	33	157	190	6154	150953	157107
ANS	0	319	319	0	119760	119760
ANTH	0	1	1	0	316	316
ARCH	31	0	31	6276	0	6276
ARL	0	36	36	0	3482	3482
ASTR	0	52	52	0	22229	22229
AVI	0	75	75	0	24702	24702
BADM	217	36	253	17041	24001	41042
BEGRSP	0	6	6	0	6168	6168
BIOPH	0	26	26	0	5808	5808
CE	243	410	653	31290	181368	212658
CHE	17	168	185	5560	108275	113835
CIRCE	0	12	12	0	3798	3798
CRC	0	65	65	0	76850	76850
CSL	0	96	96	0	69460	69460
CATLOG	0	15	15	0	6323	6323
CCS	3250	284	3534	370706	155260	525966
DS	0	89	89	0	46523	46523
ECON	17	71	88	6258	37212	43470
EQ	14	174	188	618	78227	78845
EBADM	0	12	12	0	10451	10451
EDPSY	43	2	45	11998	150	11748
EE	177	335	512	7691	162010	169701
ENGADM	0	285	285	0	66026	66026
ENGCS	0	586	586	0	259798	259798
ENGH	76	0	76	8874	0	8874
FIDEL	0	2	2	0	1113	1113
FIN	64	59	123	24153	48757	72910
FOR	0	1	1	0	439	439
FT	0	11	11	0	8097	8097
GENE	108	18	126	21858	13537	35395
GEOG	9	35	44	530	5459	5989
GEOL	164	71	235	86293	33495	119788
HEC	0	3	3	0	3155	3155
FORT	0	27	27	0	15249	15249
ICR	0	229	229	0	87801	87801
IE	8	9	17	5948	5375	11323
ILLUNI	0	4	4	0	3630	3630
ILR	0	174	174	0	73710	73710
IREC	0	4	4	0	820	820
LAW	0	34	34	0	17306	17306
LIBS	0	3	3	0	2592	2592
LING	13	0	13	445	0	445
MATH	54	96	150	4052	27111	31163
MATRL	0	146	146	0	92676	92676
MCBIO	0	4	4	0	434	434
ME	675	300	975	125054	77526	202580
MMPE	0	78	78	0	8184	8184

MUSIC	52	111	163	5227	69508	10115
NHS	0	52	52	0	6876	6876
NUCE	35	229	264	2968	117773	120161
OAC	C	1	1	0	613	613
OAS	0	30	30	0	20886	20886
OIR	0	104	104	0	110218	110218
PEM	0	24	24	0	3110	3110
PEW	C	5	5	0	671	671
PHYB	C	70	70	0	15399	15399
PHYCS	88	104	192	13709	52784	66493
PHYSL	C	11	11	0	1790	1790
PHYX	0	56	56	0	25478	25478
POLS	63	24	87	11536	11703	23239
PSYCH	45	580	625	28051	314498	342549
REC	-2	8	6	-10041	13411	3370
SCONS	C	24	24	0	8017	8017
SCS	0	6	6	0	8294	8294
SGS	0	142	142	0	135651	135651
SOC	C	30	30	0	2877	2877
SOCW	C	9	9	0	15213	15213
SPCH	C	15	15	0	2102	2102
SRL	C	147	147	0	226610	226610
SWS	0	2	2	0	624	624
TAM	36	246	282	12454	119295	131749
UICOMM	0	7	7	0	3747	3747
UOSCR	0	28	28	0	51798	51798
URPLAN	2	0	2	77	0	77
USGS	0	1	1	0	112	112
VPH	0	3	3	0	2587	2587
VPP	C	1	1	0	253	253
WPGU	0	2	2	0	1273	1273
ZOCL	C	61	61	0	30218	30218

SUBTOTAL	5860	7193	12052	946155	3733104	4679259
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ECSSYS 3	0	2281	3281	0	1127412	1127412
QVRHFC 4	C	671	671	0	2037	2037
REFUNC 5	C	172	172	0	124418	124418
LADP 6	0	8	8	0	2029	2029
XDCS 7	0	116	116	0	6829	6829
XMAINT 8	0	191	191	0	36955	36955
XSSS 9	0	518	518	0	85442	85442

TOTAL	5860	12150	18010	946155	5118226	6064381
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- 1 See list of departmental codes following
 2 Training and Education
 3 System Improvement and Modifications
 4 System Use in Excess of User Estimated Usage
 5 Rerun of User Jobs Due to Machine or System Error
 6 University Overhead Administrative Use
 7 System Updating
 8 System Maintenance
 9 Special Short Shots

TABLE III SEPTEMBER 1970

LINES PRINTED--LOCAL

DEPT ¹	NUMBER OF RUNS			NUMBER OF UNITS		
	CLASS ²	RES	TOTAL		CLASS ²	TOTAL
AAF	314	131	445	286799	161121	447920
ACCY	52	0	52	14962	92633	107595
ADV	0	2	2	0	608	608
AGE	7	72	79	2548	63170	65718
AGEC	0	240	240	0	306017	306017
AGRCN	33	157	190	88247	191368	279615
ANS	0	316	316	0	246610	246610
ANTH	0	1	1	0	1851	1851
ARCH	31	0	31	10770	0	10770
ARL	0	36	36	0	16159	16159
ASTR	0	53	53	0	48587	48587
AVI	0	74	74	0	44652	44652
BADM	215	36	251	50233	77510	127743
BECESE	0	6	6	0	4362	4362
BIOPH	0	26	26	0	9375	9375
CE	247	480	727	94401	900496	994897
CHE	26	185	211	58828	325113	383941
CIRCE	0	18	18	0	56334	56334
CRC	0	60	60	0	21246	21246
CSL	0	97	97	0	158802	158802
CATLOG	0	15	15	0	8414	8414
CGS	3284	423	3707	2962324	665455	3627779
DS	0	87	87	0	91450	91450
EGCN	17	68	85	50007	62625	112632
ED	14	197	211	5534	268808	274342
EDADM	0	12	12	0	25488	25488
EDPSY	43	2	45	17079	420	17499
EE	175	347	522	55102	338152	393294
ENGADM	0	307	307	0	220127	220127
ENGOST	0	581	581	0	742961	742961
ENGH	76	0	76	58114	0	58114
FIDEL	0	4	4	0	21120	21120
FIN	64	59	123	60168	79386	139554
FOR	0	1	1	0	458	458
FT	0	11	11	0	10653	10653
GENE	108	18	126	63518	68927	132445
GEOG	9	35	44	6251	13548	19799
GEOI	162	71	233	152772	67069	219841
HEC	0	3	3	0	1599	1599
HORT	0	27	27	0	13401	13401
ICR	0	248	248	0	135067	135067
IE	8	9	17	30303	7379	37682
ILLUNI	0	4	4	0	18358	18358
ILR	0	174	174	0	97482	97482
IREC	0	4	4	0	594	594
LAW	0	34	34	0	25651	25651
LIBS	0	3	3	0	11154	11154
LING	12	0	12	59158	0	59158
MATH	58	96	154	8425	104885	113310
MATRL	0	159	159	0	195049	195049
MCBIC	0	4	4	0	2755	2755
ME	675	313	988	356384	268055	624439
MMPE	0	78	78	0	50932	50932

MUSIC	52	107	159	28786	384043	413029
AHS	0	51	51	0	15862	15862
NUCE	36	226	262	11722	335062	346714
CAC	0	1	1	0	366	366
AS	0	29	29	0	6856	6856
OIR	0	110	110	0	155380	155380
PEM	0	24	24	0	11721	11721
PEW	0	5	5	0	3764	3764
PHYB	0	71	71	0	53327	53327
PHYCS	88	184	272	35240	174341	209581
PHYSL	0	13	13	0	2863	2863
PHYX	0	78	78	0	242433	342433
POLS	63	24	87	8215	52863	61078
PSYCH	45	578	623	26590	843950	870540
REC	-2	8	6	-13955	14251	256
SCONS	0	24	24	0	38459	38459
SCS	0	6	6	0	14428	14428
SGS	0	136	136	0	194547	194947
SQC	0	30	30	0	47028	47028
SQCW	0	9	9	0	13852	13852
SPCH	0	15	15	0	3599	3599
SRL	0	143	143	0	300151	300151
SWS	0	10	10	0	10234	10234
TAM	36	259	295	28153	258019	286172
UICOMM	0	7	7	0	6317	6317
UOSCR	0	28	28	0	23872	23872
URPLAN	2	0	2	445	0	445
USGS	0	1	1	0	1691	1691
VPH	0	3	3	0	7412	7412
VPP	0	27	27	0	10295	10295
WPGU	0	3	3	0	2223	2223
ZOOL	0	60	60	0	29179	29179

SUB TOTAL	5951	7654	13605	4617083	9702264	14319347
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CCSSYS 3	0	3743	3743	0	6631064	6631064
OVRHED 4	0	740	740	0	6032	6032
REFUNC 5	0	168	168	0	266805	266805
LADP 6	0	8	8	0	9680	9680
XDCS 7	0	110	110	0	229705	229705
XMAINT 8	0	191	191	0	293288	293288
XSSS 9	0	522	522	0	131693	131693

TOTAL	5951	13136	19087	4617083	17270531	21887614
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- 1 See list of departmental codes following
 3 Training and Education
 4 System Improvement and Modifications
 5 System Use in Excess of User Estimated Usage
 6 Rerun of User Jobs Due to Machine or System Error
 7 University Overhead Administrative Use

-
- 7 System Updating
 8 System Maintenance
 9 Special Short Shots

TABLE III SEPTEMBER 1970

COVER CHARGE--HASP

DEPT ¹	NUMBER OF RUNS			NUMBER OF UNITS		
	CLASS ²	RES	TOTAL	CLASS ²	RES	TOTAL
AAE	317	131	448	317	131	448
ACCY	481	11	492	481	11	492
ADV	0	10	10	0	10	10
AGE	7	72	79	7	72	79
AGEC	0	309	309	0	309	309
AGRON	33	157	190	33	157	190
ANS	0	320	320	0	320	320
ANTH	0	1	1	0	1	1
ARCH	47	1	48	47	1	48
ARL	0	36	36	0	36	36
ASTR	0	52	52	0	52	52
AVI	0	75	75	0	75	75
BADM	541	89	630	541	89	630
BECSR	0	20	20	0	20	20
BICPH	0	116	116	0	116	116
CE	325	1313	1638	325	1313	1638
CHE	79	1134	1213	79	1134	1213
CIRCE	0	19	19	0	19	19
CRC	0	65	65	0	65	65
CSL	0	96	96	0	96	96
DATLOG	0	15	15	0	15	15
DCS	3444	442	3886	3444	442	3886
DS	0	89	89	0	89	89
ECON	41	89	130	41	89	130
ED	37	208	245	37	208	245
EDADM	0	12	12	0	12	12
EDPSY	63	2	65	63	2	65
EE	177	347	524	177	347	524
ENGADM	0	316	316	0	316	316
ENGCS	0	587	587	0	587	587
ENGH	76	0	76	76	0	76
FIDEL	0	2	2	0	2	2
FIN	201	71	272	201	71	272
FOR	0	1	1	0	1	1
FT	0	11	11	0	11	11
GENE	108	18	126	108	18	126
GEOG	9	35	44	9	35	44
GEOL	164	71	235	164	71	235
HEC	0	3	3	0	3	3
HORT	0	27	27	0	27	27
ICR	0	261	261	0	261	261
IE	8	9	17	8	9	17
ILLUMI	0	4	4	0	4	4
ILR	0	174	174	0	174	174
IREC	0	4	4	0	4	4
LAW	0	36	36	0	36	36
LIBS	0	13	13	0	13	13
LING	13	0	13	13	0	13
MATH	58	96	154	58	96	154
MATRL	0	927	927	0	927	927
MCBIC	0	4	4	0	4	4
ME	679	314	993	679	314	993
MMPE	0	78	78	0	78	78

MUSIC	52	111	163	52	111	163
NHS	0	52	52	0	52	52
CE	35	229	264	35	229	264
C	0	1	1	0	1	1
GAS	0	30	30	0	30	30
OIR	0	223	223	0	223	223
PEM	0	24	24	0	24	24
PEW	0	5	5	0	5	5
PHYB	0	73	73	0	73	73
PHYCS	104	881	985	104	881	985
PHYSL	0	39	39	0	39	39
PHYX	0	270	270	0	270	270
POLS	63	24	87	63	24	87
PSYCH	48	583	631	48	583	631
REC	-2	8	6	-2	8	6
SCCNS	0	24	24	0	24	24
SCS	0	6	6	0	6	6
SGS	0	142	142	0	142	142
SOC	0	46	46	0	46	46
SOCW	0	9	9	0	9	9
SPCH	0	17	17	0	17	17
SRL	0	173	173	0	173	173
SWS	0	700	700	0	700	700
TAM	36	260	296	36	260	296
LICOMM	0	7	7	0	7	7
UDSCP	0	28	28	0	28	28
URPLAN	2	0	2	2	0	2
USGS	0	1	1	0	1	1
VPH	0	3	3	0	3	3
VPP	0	27	27	0	27	27
WPGU	0	4	4	0	4	4
ZOOL	0	62	62	0	62	62

SUBTOTAL	7246	12355	19601	7246	12355	19601
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DCSSYS ³	0	3924	3924	0	3924	3924
OVRFFC ⁴	0	1114	1114	0	1114	1114
REFUND ⁵	0	208	208	0	208	208
UADP ⁶	0	8	8	0	8	8
XDCS ⁷	0	116	116	0	116	116
XMAINT ⁸	0	381	381	0	381	381
XSSS ⁹	0	580	580	0	580	580

TOTAL	7246	18686	25932	7246	18686	25932
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See list of departmental codes following	6 University Overhead Administrative Use
1 Training and Education	7 System Updating
3 System Improvement and Modifications	8 System Maintenance
4 System Use in Excess of User Estimated Usage	9 Special Short Shots
5 Rerun of User Jobs Due to Machine or System Error	

TABLE III SEPTEMBER 1970

COVER CHARGE--XPRESS BATCH

DEPT ¹	NUMBER OF RUNS			NUMBER OF UNITS		
	CLASS ²	RES	TOTAL	CLASS ²	RES	TOTAL
AAE	63	7	70	63	7	70
ACCY	2	0	2	2	0	2
AGE	0	1	1	0	1	1
AGEC	0	24	24	0	24	24
AGRCN	74	2	76	74	2	76
ANS	0	2	2	0	2	2
ARCH	8	0	8	8	0	8
ARL	0	2	2	0	2	2
AVI	0	5	5	0	5	5
BADM	41	0	41	41	0	41
CE	57	37	94	57	37	94
CHE	0	7	7	0	7	7
CRC	0	2	2	0	2	2
CATALOG	0	2	2	0	2	2
DCS	5080	77	5157	5080	77	5157
DS	0	13	13	0	13	13
ED	21	0	21	21	0	21
EDPSY	28	0	28	28	0	28
EE	77	48	125	77	48	125
ENGCS	0	25	25	0	25	25
ENGH	4	0	4	4	0	4
FIN	5	2	7	5	2	7
GENE	0	15	15	0	15	15
GEOL	15	4	19	15	4	19
ICR	0	32	32	0	32	32
ILR	0	5	5	0	5	5
LAW	0	8	8	0	8	8
LING	1	0	1	1	0	1
MATH	45	35	80	45	35	80
MATRL	0	21	21	0	21	21
ME	282	40	322	282	40	322
MLSTC	61	0	61	61	0	61
NUCE	23	24	47	23	24	47
PEW	0	1	1	0	1	1
PHYCS	49	9	58	49	9	58
PHYSL	0	4	4	0	4	4
PHYX	0	6	6	0	6	6
POLS	2	2	4	2	2	4
PSYCH	9	19	28	9	19	28
REC	0	1	1	0	1	1
SCONS	0	3	3	0	3	3
SRL	0	28	28	0	28	28
SWS	0	1	1	0	1	1
TAM	8	6	14	8	6	14
URPLAN	8	0	8	8	0	8
ZPOL	0	2	2	0	2	2

SUBTOTAL

5963

522

6485

5963

522

6485

CCSSYS ³	0	564	564	0	564	564
OVRHED ⁴	0	408	408	0	408	408
REFUNC ⁵	0	9	9	0	9	9
JADP ⁶	0	2	2	0	2	2
DCS ⁷	0	96	96	0	96	96
XMAINT ⁸	0	29	29	0	29	29

TOTAL	5963	1630	7593	5963	1630	7593
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- 1 See list of departmental codes following
 - 2 Training and Education
 - 3 System Improvement and Modifications
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 - 7 System Updating
 - 8 System Maintenance

TABLE III THIRD QTR 1970

CENTISECONDS--360/75 PROCESSOR TIME

DEPT ¹	NUMBER OF RUNS			NUMBER OF UNITS		
	CLASS ²	RES	TOTAL	CLASS ²	RES	TOTAL
AAE	2097	1401	3498	2013193	2071236	4084429
ACCY	3244	177	3421	1165798	294285	1460083
ADV	0	35	35	0	62214	62214
AGE	21	796	817	2669	829101	831770
AGEC	0	2726	2726	0	2307894	2307894
AGENT	0	20	20	0	12484	12484
AGRIC	0	9	9	0	21231	21231
AGRON	327	710	1037	1189830	706320	1896150
ANS	0	887	887	0	1208495	1208495
ANTH	0	28	28	0	43993	43993
ARCH	610	2	612	190598	267	190865
ARL	0	82	82	0	345967	345967
ASTR	102	649	751	177253	678852	856105
AVI	0	181	181	0	149317	149317
BAOM	7260	778	8038	2964229	739241	3703470
BECHSR	0	268	268	0	289503	289503
BIOPH	0	189	189	0	49525	49525
CAS	0	2	2	0	717	717
CE	6756	13859	20615	4468455	15472026	19940481
CEUSA	0	2	2	0	616	616
CHF	227	8971	9198	318065	17646580	17964645
CIRCE	0	423	423	0	1402465	1402465
COMM	40	0	40	11034	0	11034
CRC	0	412	412	0	541581	541581
CSL	0	338	338	0	283093	283093
DATLOG	0	50	50	0	33684	33684
DGS	33253	4719	37972	10211618	11096269	21307887
DS	0	522	522	0	486804	486804
ECON	1120	1077	2197	10213450	1239844	11453294
ED	85	981	1066	14142	1227263	1241410
EDADM	0	159	159	0	156307	156307
EDPSY	730	37	817	335843	24687	360530
EE	828	3450	4278	243495	5304294	5547789
ENGADM	0	1622	1622	0	1654172	1654172
ENGCS	0	3373	3373	0	1272875	1272875
ENGH	202	0	202	19523	0	19523
ENGLISH	0	79	79	0	201536	201536
ENGROV	0	2	2	0	456	456
EXDC	0	52	52	0	23428	23428
FIDEI	0	46	46	0	55340	55340
FIN	1053	246	1299	987071	188032	1175103
FOR	0	18	18	0	5208	5208
FR	0	21	21	0	7691	7691
FT	0	72	72	0	57173	57173
GENE	3813	206	4019	1065785	154551	1220336
GEOG	18	251	269	5434	286070	291504
GEOL	641	402	1043	453683	295792	749475
GROCOL	0	53	53	0	82417	82417
GSA	0	5	5	0	3060	306
HEC	0	31	31	0	54236	54236
HED	0	8	8	0	22818	22818
HONORS	0	6	6	0	2402	2402
HORT	0	156	156	0	117630	117630

ICR	69	2014	2083	69862	851712	921574
IE	87	56	143	31299	96352	127651
IFCL	0	2	2	0	11072	11072
LUNI	0	18	18	0	36420	36420
ILR	223	387	610	284824	453955	738780
IREC	0	35	35	0	26326	26326
LAW	0	367	367	0	95058	95058
LIRS	0	107	107	0	335406	335406
LING	19	0	19	4200	0	4200
LIR	0	5	5	0	1648	1648
MATH	182	387	569	23947	339959	363906
MATRL	0	6195	6195	0	11520133	11520133
MCBIO	0	49	49	0	10100	10100
ME	2730	2272	5002	2505665	2396061	4901726
MMPE	0	270	270	0	59314	59314
MUSIC	360	1096	1456	150582	396063	546645
NHS	0	261	261	0	156560	156560
NUCE	386	1347	1733	200315	1645384	1845699
OAC	0	3	3	0	2171	2171
OAS	0	85	85	0	214097	214097
DIR	0	981	981	0	1396384	1396384
PEM	296	110	406	230981	84271	315252
PEW	0	43	43	0	43779	43779
PHYB	0	298	298	0	254842	254842
PHYCS	299	6180	6479	54013	10410026	10464039
PHYSL	0	235	235	0	45607	45607
PHYX	0	2341	2341	0	7143655	7143655
PNLS	382	550	932	827295	916682	1743977
PROVST	0	32	32	0	23402	23402
PSYCH	1238	4105	5343	1972541	7198533	9171124
REC	74	25	99	191553	144333	335891
SCONS	0	242	242	0	247396	247396
SCS	0	19	19	0	304053	304053
SGS	0	1532	1522	0	983536	983536
SOC	90	496	586	92456	653325	745781
SOCW	97	110	207	58917	623332	682249
SPCH	0	50	50	0	28101	28101
SPED	0	9	9	0	14164	14164
SRL	0	950	950	0	1433777	1433779
SWS	0	4137	4137	0	4267803	4267803
TAM	896	1980	2376	5557165	2513158	8075323
UTCONV	0	92	92	0	52420	52420
UTSCF	0	105	105	0	230326	230326
URPLAN	10	0	10	1389	0	1389
USGS	0	1	1	0	777	777
VPH	0	15	15	0	17055	17055
VPP	177	101	278	26153	27389	54042
VTED	0	52	52	0	93347	93347
VPGU	0	9	9	0	1557	1557
ZDOL	0	758	758	0	181483	181483

JB TOTAL	70092	91103	161195	48334325	127128959	175533284
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OCSSVS ³	0	32305	32305	0	24854817	24854817
TURNED ⁴	0	4387	4387	0	9731	9731
REFUND ⁵	0	774	774	0	3903141	3903141

UADP6	0	273	273	0	69306	69806
XDCS7	0	1243	1243	0	1141393	1141398
XMAINT 8	0	1262	1262	0	1138365	1138365
XSSS9	0	2771	2771	0	564083	564083

TOTAL	70092	134118	204210	48334325	153880800	207215125
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- 1 See list of departmental codes following
 - 2 Training and Education
 - 3 System Improvement and Modifications
 - 4 System Use of Excess of User Estimated Usage
 - 5 Rerun of User Jobs Due to Machine or System Error
 - 6 University Overhead Administrative Use
 - 7 System Updating
 - 8 System Maintenance
 - 9 Special Short Shots

TABLE III THIRD QTR 1970

INPUT/OUTPUT REQUESTS--360/75

PT ¹	NUMBER OF RUNS			NUMBER OF UNITS		
	CLASS ²	RES	TOTAL	CLASS ²	RES	TOTAL
AAE	2099	1402	3501	424139	200227	624366
ACCY	3245	177	3422	515565	49692	565257
ADV	0	35	35	0	45256	45256
AGE	21	796	817	1769	276259	278028
AGEC	0	2726	2726	0	1253279	1253279
AGENT	0	20	20	0	7832	7832
AGRIC	0	9	9	0	8151	8151
AGRON	327	710	1037	36558	94615	131173
ANS	0	889	889	0	340991	340991
ANTH	0	28	28	0	12790	12790
ARCH	610	2	612	111119	520	111639
ARL	0	82	82	0	12247	12247
ASTR	102	654	756	19925	91364	111289
AVI	0	182	182	0	120027	120027
BADM	7266	778	8044	373670	169217	542887
BECPSR	0	268	268	0	263460	263460
BIOPH	0	189	189	0	14401	14401
CAS	0	2	2	0	37	37
CE	6757	13861	20618	1010330	3329257	4339587
CEUSA	0	2	2	0	5017	5017
CHF	227	8980	9207	10340	1890821	1901161
CIRCE	0	423	423	0	392175	392175
COMM	40	0	40	3041	0	3041
CRC	0	413	413	0	322368	322368
CSL	0	338	338	0	71438	71438
DATLOG	0	50	50	0	3150	3150
DCS	33258	4720	37978	2470947	902929	3373876
DS	0	523	523	0	133023	133023
ECON	1120	1077	2197	423387	540682	964069
ED	85	983	1068	211	619038	619249
EDADM	0	159	159	0	155869	155869
EDPSY	780	37	817	171974	8349	180323
EE	828	3451	4279	48660	605300	653960
ENGADM	0	1622	1622	0	551591	551591
ENGOST	0	3373	3373	0	866241	866241
ENGH	202	0	202	14265	0	14265
ENGLISH	0	79	79	0	5403	5403
ENGROV	0	2	2	0	288	288
EXDC	0	52	52	0	1847	1847
FIDEI	0	46	46	0	13709	13709
FIN	1053	246	1299	197840	60300	258140
FOR	0	18	18	0	507	507
FR	0	21	21	0	4212	4212
FT	0	73	73	0	29222	29222
GENE	3814	206	4020	167544	53439	220983
GF2G	18	251	269	2812	80423	83235
GFOL	642	402	1044	190279	111756	302035
GRDCOL	0	53	53	0	32688	32688
ISA	0	5	5	0	169	169
HEC	0	31	31	0	15327	15327
HEQ	0	8	8	0	246	246
HONOPS	0	6	6	0	1394	1394
HORT	0	156	156	0	21783	21783

ICR	69	2016	2085	92109	511137	603246
IE	87	56	143	11001	12800	23801
IFCL	0	2	2	0	1392	1392
ILLUMI	0	18	18	0	2338	2338
ILR	223	389	611	202356	260307	463163
IREC	0	36	36	0	9937	9937
LAW	0	367	367	0	46524	46524
LIBS	0	107	107	0	20609	20609
LING	19	0	19	3805	0	3805
LIR	0	5	5	0	110	110
MATH	182	387	569	7340	58420	65760
MATRL	0	6199	6199	0	970083	970083
MCBIO	0	49	49	0	6350	6350
ME	2730	2274	5004	361258	262294	623552
MMPE	0	270	270	0	15249	15249
MUSIC	360	1096	1456	58194	268951	357145
NHS	0	261	261	0	100596	100596
NUCE	386	1348	1734	47705	218019	265724
OAC	0	3	3	0	1391	1391
OAS	0	85	85	0	74563	74563
OIR	0	982	982	0	304460	304460
OFM	296	110	406	330102	22723	352325
OFM	0	43	43	0	42055	42055
PHYR	0	301	301	0	93775	93775
PHYCS	299	6184	6483	25834	786939	812773
PHYSI	0	235	235	0	42257	42257
PHYX	0	2343	2343	0	1115342	1115342
POLS	382	550	932	332571	258025	591596
PROVST	0	32	32	0	6475	6475
PSYCH	1238	4107	5345	1166617	4007506	5174123
REC	74	25	99	171799	26384	108183
SCONS	0	242	242	0	70926	70926
SCS	0	19	19	0	242381	242381
SGS	0	1532	1532	0	752157	752157
SUC	00	406	586	67521	332390	399911
SOCW	97	110	207	20195	297367	318062
SPCH	0	51	51	0	20581	20581
SPED	0	0	0	0	5042	5042
SPL	0	950	950	0	451146	451146
SKS	0	4137	4137	0	1118240	1118240
TAM	896	1983	2879	123693	321103	444796
UICFMY	0	92	92	0	24156	24156
UNOSC	0	105	105	0	214321	214321
URPLAN	10	0	10	120	0	120
USGS	0	1	1	0	0	0
VPH	0	15	15	0	16566	16566
VPR	177	101	278	16840	6272	26121
VTER	0	52	52	0	24159	24159
WPGH	0	9	9	0	584	584
ZOOL	0	759	759	0	92987	92987

SUBTOTAL	70109	91158	161267	9237444	27365215	36602659
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DCSSYS 3	0	32307	32307	0	15570469	15570469
OVERHEAD 4	0	4384	4384	0	1099	1099
REFUND 5	0	701	701	0	1021650	1021650

UADP ⁶	0	273	273	0	82630	82630
XDCS ⁷	0	1243	1243	0	4064763	4064763
YMAINT ⁸	0	1262	1262	0	1433573	1433573
SS ⁹	0	2771	2771	0	227645	227645

TOTAL	70109	134099	204208	9237444	49757934	59005378
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- 1 See list of departmental codes following
 - 2 Training and Education
 - 3 System Improvement and Modifications
 - 4 System Use of Excess of User Estimated Usage
 - 5 Rerun of User Jobs Due to Machine or System Error
 - 6 University Overhead Administrative Use
 - 7 System Updating
 - 8 System Maintenance
 - 9 Special Short Shots

TABLE III THIRD QTR 1970

UNITS CHARGED--360/75

DEPT ¹	NUMBER OF RUNS			NUMBER OF UNITS		
	CLASS ²	PES	TOTAL	CLASS ²	PES	TOTAL
AAE	2095	1400	3495	111408	88412	199820
ACCY	3244	177	3421	77041	24653	101694
ADV	0	35	35	0	8792	8792
AGE	21	795	816	154	61938	62092
AGFC	0	2725	2725	0	221928	221928
AGENT	0	20	20	0	824	824
AGPIC	0	9	9	0	1624	1624
AGRON	325	710	1035	46618	34368	81586
ANS	0	884	884	0	113529	113529
ANTH	0	28	28	0	4504	4504
ARCH	606	2	608	11950	31	11981
ARL	0	82	82	0	13208	13208
ASTP	103	652	755	14774	44572	59346
AVI	0	181	181	0	21433	21433
BADM	7233	778	8011	179203	64029	243232
BECSR	0	268	268	0	37649	37649
BIOPH	0	189	189	0	2483	2483
CAS	0	2	2	0	45	45
CE	6734	13853	20587	321315	1160229	1481544
CEUSA	0	2	2	0	170	170
CHF	227	8968	9195	22560	1074652	1097212
CIRCF	0	422	422	0	135871	135871
COMM	40	0	40	796	0	796
CRC	0	413	413	0	63887	63887
CSL	0	337	337	0	23971	23971
DATLOG	0	50	50	0	2105	2105
DCS	32872	4711	37583	436620	612155	1108775
DS	0	521	521	0	38213	38213
ECON	1120	1070	2190	424467	111765	536232
ED	84	978	1062	548	130300	130848
EDADM	0	159	159	0	11391	11391
EDPSY	769	37	806	37571	2713	40284
EE	812	3449	4261	11172	248173	259350
ENGADM	0	1622	1622	0	102639	102639
ENGCS	0	3373	3373	0	89674	89674
ENGH	202	0	202	1189	0	1189
ENGLISH	0	79	79	0	14166	14166
ENGROV	0	2	2	0	26	26
EXDC	0	52	52	0	987	987
FIDEL	0	46	46	0	2795	2795
FIN	1047	246	1293	69401	15538	84939
FOR	0	18	18	0	243	243
FR	0	21	21	0	437	437
FT	0	72	72	0	6485	6485
GENE	3798	206	4004	52318	9775	62093
GEQG	18	251	269	329	23104	23433
GEQL	641	402	1043	31606	23015	54621
GROCOL	0	53	53	0	9340	9340
GSA	0	5	5	0	193	193
HEC	0	31	31	0	5735	5735
HFD	0	3	3	0	1902	1902
HUNDOS	0	6	6	0	309	309
HORT	0	155	155	0	8466	8466

ICR	69	2014	2083	13013	91442	104455
IE	87	56	143	1637	4732	6569
IFCL	0	2	2	0	1029	1029
ILLUNI	0	18	18	0	2372	2372
IR	223	388	611	39930	53474	93404
IREC	0	35	35	0	2939	2939
LAW	0	366	366	0	5549	5549
LIRS	0	106	106	0	24961	24961
LING	18	0	18	252	0	252
LIP	0	5	5	0	143	143
MATH	179	385	564	1807	18716	20523
MATRL	0	6191	6191	0	670085	670085
MCRIO	0	49	49	0	615	615
ME	2708	2269	4977	129288	142740	272028
MMPE	0	269	269	0	4022	4022
MUSIC	358	1096	1454	10217	27006	37223
NHS	0	261	261	0	13386	13386
NUCF	385	1348	1733	12259	91796	104055
OAC	0	3	3	0	335	335
OAS	0	85	85	0	22904	22904
OIR	0	980	980	0	100158	100158
PEM	295	110	405	37332	8613	45950
PEW	0	42	42	0	6548	6548
PHYB	0	298	298	0	14524	14524
PHYCS	298	6179	6477	3008	468037	471045
PHYSL	0	231	231	0	3762	3762
PHYX	0	2344	2344	0	486449	486449
POLS	380	546	926	93663	93686	187349
PROVST	0	32	32	0	2455	2455
PSYCH	1232	4100	5332	230738	826779	1057517
REC	74	25	99	29100	13734	42834
SCONS	0	240	240	0	21507	21507
SCS	0	19	19	0	49431	49431
SGS	0	1532	1532	0	100095	100095
SOC	90	496	586	12862	77557	90419
SOCW	97	110	207	3839	74738	78577
SPCH	0	50	50	0	3997	3997
SPED	0	9	9	0	1582	1582
SRL	0	946	946	0	124191	124191
SWS	0	4135	4135	0	323187	323187
TAM	895	1976	2871	255824	180443	436267
UICOMM	0	92	92	0	3046	3046
USCR	0	105	105	0	36102	36102
URPLAN	8	0	8	56	0	56
USGS	0	1	1	0	47	47
VPH	0	15	15	0	2564	2564
VPP	177	100	277	2166	1399	3565
VTED	0	52	52	0	9278	9278
WPGU	0	9	9	0	88	88
ZOOL	0	757	757	0	12603	12603

SUBTOTAL	69564	91032	160596	2788031	8900101	11688132
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DCSSYS 3	0	32180	32180	0	2393418	2393418
OVERHEAD 4	0	3704	3704	0	15	15
REFUND 5	0	747	747	0	304869	304869

ADP ⁶	0	272	272	0	5249	5249
XDCS ⁷	0	1220	1220	0	203862	203862
XMAINT ⁸	0	1261	1261	0	107396	107396
XSSS ⁹	0	2763	2763	0	37644	37644

TOTAL	69564	133179	202743	2738031	11952554	14740585
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- 1 See list of departmental codes following
 - 2 Training and Education
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 - 4 System Use of Excess of User Estimated Usage
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 - 9 Special Short Shots

TABLE III THIRD QTR 1970

SECONDS--1800 REAL TIME

DEPT ¹	NUMBER OF RUNS			NUMBER OF UNITS		
	CLASS 2	PES	TOTAL	CLASS 2	RES	TOTAL
AGE	0	14	14	0	15567	15567
CE	0	3	3	0	4149	4149
DCS	1	0	1	6	0	6
EE	0	27	27	0	10499	10499
ENGCS	0	1	1	0	101	101
GFOL	0	6	6	0	4269	4269
MATPL	0	19	19	0	2838	2838
MUSIC	0	7	7	0	775	775
NUCF	0	5	5	0	931	931
PHYCS	0	5	5	0	-1135	-1135
PHYSL	0	12	12	0	1616	1616
SWS	0	7	7	0	3432	3432
VPP	1	5	6	96	417	513
				0		
<hr/>						
SUB TOTAL	2	111	113	102	43459	43561
<hr/>						
DCSSYS ³	0	116	116	0	15354	15354
REFUND ⁴	0	24	24	0	14475	14475
XDCS ⁵	0	1	1	0	152	152
<hr/>						
TOTAL	2	252	254	102	73440	73542
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1 See list of departmental codes following

2 Training and Education

3 System Improvement and Modifications

4 Rerun of User Jobs Due to Machine or System Error

5 System Updating

TABLE III THIRD QTR 1970

MINUTES--360/20 REAL TIME

DEPT ¹	NUMBER OF RUNS			NUMBER OF UNITS		
	CLASS ²	RES	TOTAL	CLASS ²	RES	TOTAL
AAF	13	21	34	115	135	250
ACCY	6	4	10	226	91	317
ADV	0	5	5	0	24	24
AGE	0	17	17	0	93	92
AGEC	0	80	80	0	1452	1452
AGRIC	0	2	2	0	21	21
AGRON	3	36	39	60	542	602
ANS	0	161	161	0	1001	1001
ANTH	0	1	1	0	4	4
ARCH	21	0	21	235	0	235
ARL	0	22	22	0	186	186
ASTR	1	48	49	3	281	284
AVI	0	16	16	0	234	234
BADM	61	37	98	893	502	1395
BECSO	0	3	3	0	16	16
BIOPH	0	1	1	0	1	1
CE	94	247	341	466	3660	4126
CEUSA	0	9	9	0	515	515
CHE	0	126	126	0	1753	1753
CIRCE	0	3	3	0	59	59
COM	0	4	4	0	173	173
COMM	2	0	2	6	0	6
CRC	0	16	16	0	179	179
CSL	0	17	17	0	130	130
DATLOG	0	22	22	0	152	152
DOS	320	124	452	1954	752	2606
DS	0	35	35	0	1013	1013
DSFA	0	79	79	0	2260	2260
ECON	70	57	127	764	1182	1946
ED	12	60	72	20	974	994
EDADM	0	1	1	0	4	4
EDPSY	23	2	25	692	3	700
EE	6	121	127	18	1179	1197
ENGADM	0	33	33	0	185	185
ENGOST	0	52	52	0	554	554
ENGH	12	0	12	83	0	83
ENGLISH	0	2	2	0	4	4
FIDEL	0	1	1	0	4	4
FIN	18	19	37	530	596	1126
FJR	0	15	15	0	239	239
FT	0	1	1	0	14	14
GENE	60	5	65	752	200	952
GEQG	1	15	16	9	118	127
GEOL	15	32	47	77	294	371
GROCOL	0	16	16	0	105	105
HEC	0	1	1	0	1	1
HONORS	0	1	1	0	2	2
HORT	0	16	16	0	82	82
ICP	3	99	102	36	1770	1806
IF	8	1	9	61	5	66
ILLUMI	0	3	3	0	11	11
ILR	45	49	94	959	450	1409
IPSC	0	5	5	0	39	39

LAW	0	6	6	0	20	20
MATH	4	20	24	19	53	72
MATRL	0	95	95	0	307	307
'	102	54	156	700	331	1031
MUSIC	4	41	45	75	222	297
NHS	0	9	9	0	39	39
NUCE	7	54	61	43	273	316
OAS	0	5	5	0	91	91
OIR	0	30	30	0	683	683
PEM	17	8	25	175	63	238
PERRIF	0	2	2	0	2	2
PEW	0	3	3	0	25	25
PHYB	0	1	1	0	3	3
PHYCS	9	112	121	132	1239	1371
PHYSL	0	4	4	0	22	22
PHYX	0	7	7	0	69	69
POLS	12	68	80	147	540	687
PROVST	0	33	33	0	318	318
PSYCH	31	278	309	363	3892	4255
REC	23	17	40	612	200	812
SCONS	0	4	4	0	12	12
SCS	0	7	7	0	104	104
SGS	0	64	64	0	1254	1254
SOC	0	50	50	0	1708	1708
SOCW	0	16	16	0	78	78
SPCH	0	4	4	0	66	66
SPFD	0	1	1	0	6	6
SRL	0	18	18	0	877	877
SWS	0	7	7	0	58	58
TAM	17	100	117	101	551	652
UICOMM	0	7	7	0	56	56
UOSCR	0	27	27	0	705	705
USGS	0	1	1	0	2	2
VPH	0	4	4	0	18	18
VPP	0	5	5	0	15	15
VTED	0	23	23	0	484	484
ZOOI	0	20	20	0	107	107

SUBTOTAL	1028	2948	3976	10226	38252	48478
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DCSSYS ³	0	814	814	0	9019	9019
REFUND ⁴	0	21	21	0	670	670
UADP ⁵	0	4	4	0	14	14
XDCS ⁶	0	3	3	0	49	49
XMAINT ⁷	0	435	435	0	35341	35341

TOTAL	1028	4225	5253	10226	83345	93571
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1 See list of departmental codes following

2 Training and Education

3 System Improvement and Modifications

4 Rerun of User Jobs Due to Machine or System Error

5 University Overhead Administrative Use

6 System Updating

7 System Maintenance

TABLE III THIRD QTR 1970

MINUTES--SERVICE PROGRAMMING

3

DEPT ¹	NUMBER OF RUNS			NUMBER OF UNITS		
	CLASS ²	PES	TOTAL	CLASS ²	RES	TOTAL
AGFC	0	5	5	0	600	600
ANTH	0	2	2	0	420	420
CIRCF	0	19	19	0	4680	4680
ED	0	8	8	0	1440	1440
FIN	0	1	1	0	120	120
FT	0	2	2	0	420	420
GEOG	0	1	1	0	120	120
MATH	0	3	3	0	570	570
MATRL	0	10	10	0	1380	1380
PEW	0	2	2	0	5040	5040
PHYSL	0	5	5	0	870	870
REC	2	0	2	480	0	480

TOTAL	2	58	60	480	15660	16140

1 See list of departmental codes following

2 Training and Education

TABLE III THIRD QPTR 1970

CARDS KEY-PUNCHED

EPT ¹	NUMBER OF RUNS			NUMBER OF UNITS		
	CLASS ²	RES	TOTAL	CLASS ²	RES	TOTAL
AAE	0	1	1	0	700	700
ACCY	0	2	2	0	1800	1800
ADV	0	1	1	0	600	600
AGEC	0	8	8	0	12500	12500
ANS	0	27	27	0	5650	5650
ANTH	2	0	2	700	0	700
AVI	0	5	5	0	1850	1850
BADM	3	2	5	550	9200	9750
CE	0	22	22	0	6300	6300
CHE	0	3	3	0	950	950
CIRCE	0	1	1	0	600	600
CRC	0	1	1	0	900	900
DCS	5	14	19	1400	7300	9200
DS	0	1	1	0	600	600
ECON	1	12	13	100	13050	13150
ED	0	120	120	0	63400	63400
EE	0	18	18	0	6200	6200
ENGLISH	0	3	3	0	1900	1900
FIN	2	3	5	500	850	1350
FDR	0	1	1	0	2200	2200
FT	0	2	2	0	200	200
GENE	1	0	1	100	0	100
GEOG	1	4	5	2750	1600	4350
GEOI	1	1	2	1200	250	1450
GSA	0	2	2	0	8300	8300
HORT	0	1	1	0	200	200
ICR	4	1	5	650	100	750
ILR	0	13	13	0	6050	6050
IREC	0	3	3	0	600	600
LAW	0	2	2	0	1000	1000
ME	6	0	6	2300	0	2300
MUSIC	0	2	2	0	2700	2700
NHS	0	7	7	0	3950	3950
QIR	0	2	2	0	200	200
PEM	4	1	5	1700	200	1900
PERSONE	0	2	2	0	400	400
PEW	0	3	3	0	2500	2500
PHYS	0	5	5	0	4800	4800
POLS	6	14	20	2600	4750	7350
PROVST	0	1	1	0	50	50
PSYCH	3	45	48	4300	21350	25650
REC	1	7	8	200	17600	17800
SOC	0	4	4	0	4800	4800
SOCW	4	3	7	4800	1600	6400
TAM	0	5	5	0	1300	1300
UNSCD	0	2	2	0	10550	10550
ZOOL	0	2	2	0	250	250

SUBTOTAL

44

379

423

23850

232950

256300

DCSSYS ³	0	91	91	0	21700	21700
REFUND ⁴	0	2	2	0	7500	7500

TOTAL	44	472	516	23850	262150	286000
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1 See list of departmental codes following

2 Training and Education

3 System Improvement and Modifications

4 Rerun of User Jobs Due to Machine or System Error

TABLE III. THIRD QUTR 1970

CARDS READ--LOCAL

DEPT ¹	NUMBER OF RUNS			NUMBER OF UNITS		
	CLASS ²	RES	TOTAL	CLASS ²	RES	TOTAL
AAE	717	702	1419	239441	178924	418365
ACCY	510	27	537	143671	21714	165385
ADV	0	27	27	0	17320	17320
AGE	7	315	322	1197	171964	173161
AGEC	0	1149	1149	0	653506	653506
AGENT	0	10	10	0	4914	4914
AGRIC	0	10	10	0	5448	5448
AGRON	141	316	457	69239	288920	358159
ANS	0	685	685	0	253044	253044
ANTH	0	17	17	0	5099	5099
ARCH	275	1	276	88160	121	88281
ARL	0	57	57	0	14063	14063
ASTR	49	310	359	45155	179090	224245
AVI	0	147	147	0	52628	52628
BADM	3924	213	4137	380173	82725	462898
BFCBSR	0	90	90	0	88916	88916
BIRPH	0	26	26	0	5808	5808
CAS	0	2	2	0	515	515
CE	1952	1533	3485	548735	814894	1363629
CFUSA	0	2	2	0	14	14
CHF	17	638	655	5560	431544	437104
CIRCF	0	137	137	0	84558	84558
COMM	21	0	21	13732	0	13732
CRC	0	233	233	0	307241	307241
CSL	0	294	294	0	204901	204901
DATLOG	0	33	33	0	14188	14188
DCS	13568	1096	14664	1603955	554811	2158766
DS	0	227	227	0	148096	148096
ECON	353	507	860	118140	485461	603601
ED	37	565	602	2050	416232	418282
EDADM	0	42	42	0	39329	39329
EDPSY	434	39	473	150817	10457	161274
EE	418	1386	1804	26571	669521	696092
ENGADM	0	665	665	0	187815	187815
ENGOST	0	1135	1135	0	543740	543740
ENGH	76	0	76	8874	0	8874
ENGLISH	0	59	59	0	66557	66557
ENGRDV	0	2	2	0	354	354
EXDC	0	3	3	0	1515	1515
FIDEL	0	23	23	0	7869	7869
FIN	207	92	299	170341	61667	232008
FOR	0	10	10	0	2657	2657
FR	0	11	11	0	2606	2606
FT	0	38	38	0	18000	18000
GENE	2533	76	2609	281271	51325	332596
GEOS	0	166	175	530	59007	59537
IBL	307	270	577	182816	171345	354161
IOCL	0	47	47	0	16195	16195
GSA	0	5	5	0	7088	7088
HFC	0	27	27	0	26880	26880
HFD	0	8	8	0	9478	9478
HONORS	0	6	6	0	1428	1428
HORT	0	76	76	0	33075	33075

ICR	24	552	576	10186	296872	307058
IE	34	41	75	10179	42203	52386
IFCI	0	2	2	0	1120	1120
ILLUMI	0	4	4	0	3630	3630
ILR	176	278	454	216210	155105	371315
IREC	0	33	33	0	7264	7264
LAW	0	98	98	0	68847	68847
LIRS	0	70	70	0	67791	67791
LING	13	0	13	445	0	445
LIP	0	5	5	0	453	453
MATH	61	170	231	7094	43601	50785
MATRL	0	797	797	0	365528	365528
MCRIO	0	5	5	0	980	980
ME	1182	1260	2442	238147	384037	672184
MMPE	0	127	127	0	15999	15999
MUSIC	203	233	441	111208	113294	224502
NHS	0	200	200	0	46992	46992
NUCE	191	611	802	90993	305191	396184
OAC	0	3	3	0	1247	1247
OAS	0	88	88	0	75334	75334
OIR	0	580	580	0	627493	627493
PEM	186	110	296	43769	27500	71269
PEW	0	32	32	0	11927	11927
PHVR	0	140	140	0	41720	41720
PHYCS	91	485	576	14290	250016	264306
PHVSL	0	39	39	0	7752	7752
PHYX	0	340	340	0	263429	263429
POLS	356	445	801	142373	202973	345351
PROVST	0	31	31	0	5793	5793
PSYCH	748	2681	3420	361233	1492750	1853983
REC	52	17	69	39794	17634	57428
SCBMS	0	92	92	0	46843	46843
SGS	0	18	18	0	19319	19319
SGS	0	632	632	0	501315	501315
SIC	87	436	523	16023	256443	272471
SOCW	41	78	119	31208	53484	84692
SPCH	0	46	46	0	10443	10443
SPED	0	7	7	0	1364	1364
SRL	0	403	403	0	655493	655493
SWS	0	35	35	0	5311	5311
TAM	432	844	1276	179036	329064	508100
UICOM	0	33	33	0	14393	14393
UDSCP	0	97	97	0	97569	97569
URPLAN	2	0	2	77	0	77
USGS	0	1	1	0	112	112
VRH	0	12	12	0	10001	10001
VPP	0	7	7	0	1618	1618
VTFD	0	45	45	0	50123	50123
WPGH	0	2	2	0	1273	1273
ZUNIL	0	279	279	0	134923	134923

SUBTOTAL	29434	26114	55548	5642692	14704258	20346950
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DCSSYS 3	0	9566	9566	0	3917502	3917502
OVERHD 4	0	2657	2657	0	53501	53501
REFUND 5	0	564	564	0	481492	481492

UADP 6	0	98	98	0	9167	9167
CS 7	0	519	519	0	50466	50466
MAINT 8	0	416	416	0	93479	93479
XSSS 9	0	1578	1578	0	222877	222877

TOTAL	29434	41512	70946	5642692	19532832	25175524
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- 1 See list of departmental codes following
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TABLE III THIRD QTR 1970

CARDS PUNCHED--LOCAL

DEPT ¹	NUMBER OF RUNS			NUMBER OF UNITS		
	CLASS ²	RES	TOTAL	CLASS ²	RES	TOTAL
AAE	25	29	54	2097	2105	4202
ACCY	4	11	15	826	1288	2114
ADV	0	4	4	0	459	459
AGE	0	42	42	0	15152	15152
AGFC	0	77	77	0	21376	21376
AGRON	35	43	78	8047	20219	28266
ANS	0	68	68	0	17323	17323
ARCH	3	0	3	320	0	320
ASTP	14	70	84	10482	35233	45715
AVI	0	16	16	0	5036	5036
BADM	25	49	74	24010	10234	34244
BECPSP	0	13	13	0	1120	1120
CF	180	206	386	19972	57513	77485
CEUSA	0	1	1	0	4984	4984
CHE	0	550	550	0	130350	130350
CIRCF	0	14	14	0	9219	9219
CRC	0	12	12	0	8329	8329
DATLOG	0	1	1	0	254	254
DCS	153	139	292	37711	24947	62651
DS	0	3	3	0	3077	3077
ECON	47	54	101	9021	42249	51270
ED	0	34	34	0	15302	15302
EDADM	0	1	1	0	197	197
EDPSY	36	1	37	16835	902	17737
EE	1	153	154	111	60180	60291
ENGADM	0	11	11	0	5050	5050
ENGOST	0	134	134	0	10162	10162
ENGH	1	0	1	227	0	227
ENGLISH	0	8	8	0	3411	3411
FIN	5	8	13	1990	3662	5652
GENE	29	2	31	3541	189	3730
GEOG	0	18	18	0	3453	3453
GEOI	15	51	66	4086	30440	34526
GRDCPL	0	15	15	0	898	898
HDBT	0	9	9	0	3090	3090
ICR	6	111	117	268	27652	27920
ILR	15	30	46	17694	7623	25317
IREC	0	2	2	0	560	560
LAW	0	13	13	0	2223	2223
MATH	2	7	9	249	1339	1588
MATRL	0	260	260	0	34081	34081
ME	122	19	141	26786	3181	29967
MUSIC	0	11	11	0	1886	1886
NHS	0	10	10	0	1521	1521
NUCE	15	115	130	5538	20541	26079
OAS	0	2	2	0	488	488
DIR	0	78	78	0	42563	42563
PEM	9	0	9	718	0	718
PEM	0	11	11	0	2924	2924
PHVP	0	5	5	0	1392	1392
PHYCS	6	216	222	9177	52153	61335
PHYSI	0	11	11	0	4447	4447
PHYX	0	71	71	0	18615	18615

POLS	21	28	49	7367	14111	21478
PROVST	0	4	4	0	254	254
PSYCH	98	601	699	32235	169372	200607
REC	19	2	21	7562	382	7944
SCONS	0	29	29	0	5676	5676
SCS	0	10	10	0	2163	2163
SGS	0	35	35	0	28831	28831
SOC	3	14	17	5061	5152	10213
SOCW	2	0	2	177	0	177
SPCH	0	4	4	0	2060	2060
SPED	0	1	1	0	366	366
SRL	0	53	53	0	26113	26113
SWS	0	9	9	0	2495	2495
TAM	45	75	120	80922	12654	93574
UDSCP	0	14	14	0	13461	13461
VPP	5	2	7	155	455	610
ZOOL	0	4	4	0	257	257

SUBTOTAL	942	3704	4646	333183	1053901	1387084
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DCSSYS ³	0	586	586	0	233739	233739
REFUND ⁴	0	82	82	0	39977	39977
UADP ⁵	0	5	5	0	1431	1431
XDCS ⁶	0	6	6	0	2938	2938
XMAINT ⁷	0	17	17	0	4870	4370
XSSS ⁸	0	174	174	0	13591	13591

TOTAL	942	4574	5516	333183	1350447	1633630
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- 1 See list of departmental codes following
 2 Training and Education
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 7 System Maintenance
 8 Special Short Shots

TABLE III THIRD QTR 1970

LINES PRINTED--LOCAL

DEPT ¹	NUMBER OF RUNS			NUMBER OF UNITS		
	CLASS ²	RES	TOTAL	CLASS ²	RES	TOTAL
AAF	876	704	1580	855485	807239	1662724
ACCY	559	29	588	473005	138353	611358
ADV	0	27	27	0	58860	58860
AGE	7	307	314	2548	316993	319541
AGEC	0	1184	1184	0	1352543	1352543
AGFNT	0	10	10	0	10417	10417
AGRIC	0	9	9	0	35435	35435
AGPOM	138	316	454	213624	360705	574329
ANS	0	677	677	0	552176	552176
ANTH	0	16	16	0	38215	38215
ARCH	275	1	276	394988	131	395119
ARL	0	56	56	0	32209	32209
ASTR	49	310	359	34969	285301	320270
AVI	0	146	146	0	85041	85041
BADM	3934	232	4166	1160211	382826	1552037
BEGRSP	0	90	90	0	159217	159217
BIOPH	0	26	26	0	9375	9375
CAS	0	2	2	0	1175	1175
CE	2008	1847	3855	1436553	2920809	4407362
CEUSA	0	2	2	0	61	61
CHF	26	758	784	58828	1574224	1633052
CIRCE	0	161	161	0	489924	489924
COMM	21	0	21	21595	0	21595
CRC	0	227	227	0	286595	286595
CSL	0	307	307	0	328821	328821
DATLOG	0	37	37	0	19124	19124
DOS	13707	1674	15381	6227261	2109503	8336854
DS	0	222	222	0	337062	337062
ECON	351	496	847	611721	480189	1091910
ED	38	601	639	18073	572920	591093
EDADM	0	41	41	0	194382	194382
EDPSY	439	36	475	166591	14245	180836
EE	414	1443	1857	118100	1569310	1687499
ENGADM	0	804	804	0	889027	889027
ENGOST	0	1106	1106	0	1507042	1507042
ENGH	76	0	76	58114	0	58114
ENGLISH	0	59	59	0	61955	61955
ENGROV	0	1	1	0	494	494
EXDC	0	3	3	0	15516	15516
FIDEL	0	26	26	0	36893	36893
FIN	209	94	303	562307	164699	727006
FDR	0	10	10	0	10732	10732
FR	0	11	11	0	6248	6248
FT	0	38	38	0	38370	38370
GENE	2516	76	2592	1017108	192055	1209163
GEOS	0	165	174	6251	134028	141179
GEOL	304	270	574	360219	254921	615140
GROCOL	0	47	47	0	70132	70132
GSA	0	5	5	0	1323	1323
HFC	0	27	27	0	7573	7573
HFO	0	8	8	0	1838	1838
HONORS	0	6	6	0	1782	1782
HORT	0	76	76	0	42251	42251

ICR	42	758	800	25286	383454	408740
IE	32	36	68	47287	241386	288673
IFCL	0	2	2	0	34449	34449
ILLUMI	0	4	4	0	18358	18358
ILR	174	279	453	130865	248116	378981
IREF	0	33	33	0	44834	44834
LAW	0	97	97	0	77033	77033
LIRS	0	70	70	0	59843	59843
LING	13	0	13	59158	0	59158
LIR	0	5	5	0	1847	1847
MATH	78	170	248	23323	168027	191350
MATRL	0	930	930	0	1203040	1203040
MCBIO	0	17	17	0	11921	11921
ME	1189	1299	2488	808680	1152662	1961342
MMPF	0	127	127	0	86516	86516
MUSIC	203	239	442	124192	549476	673668
NHS	0	197	197	0	116904	116904
NUCF	192	600	792	253238	829810	1083048
OAC	0	3	3	0	1246	1246
OAS	0	85	85	0	41755	41755
OIR	0	582	582	0	1114145	1114145
PEM	180	109	289	140196	81365	221561
PEW	0	29	29	0	29335	29335
PHYR	0	150	150	0	116299	116299
PHYCS	91	644	735	45365	778460	823825
PHYSI	0	74	74	0	47796	47796
PHYX	0	449	449	0	1744209	1744209
POLS	354	443	797	434608	466629	911237
PROVST	0	31	31	0	14632	14632
PSYCH	727	2691	3418	1005627	3407154	4412781
REC	45	17	62	40705	22499	63204
SCONS	0	91	91	0	173047	173047
SCS	0	18	18	0	31200	31200
SGS	0	619	619	0	768445	768445
SJC	82	431	513	50530	253910	304440
SJCM	41	76	117	42542	518771	561313
SPCH	0	46	46	0	11226	11226
SPEO	0	7	7	0	4508	4508
SRL	0	395	395	0	2160305	2160305
SWS	0	68	68	0	93903	93903
TAM	432	930	1362	351170	981017	1322187
UICOMM	0	33	33	0	32270	32270
UNSCB	0	93	93	0	65011	65011
URPIAN	2	0	2	445	0	445
USGS	0	1	1	0	1691	1691
VPH	0	12	12	0	13195	13195
VPP	82	75	157	45427	30145	75572
VTEO	0	42	42	0	33534	33534
WPGU	0	3	3	0	2223	2223
ZOOL	0	288	288	0	270621	270621

SUBTOTAL	29915	28224	58139	17486175	37499380	54985555
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DCSSYS 3	0	11508	11508	0	17475561	17475561
QVPHED 4	0	2871	2871	0	23111	23111
REFUND 5	0	588	588	0	726472	726472

UADP6	0	97	97	0	145137	145137
XDCS7	0	502	502	0	734550	734550
XMAINT 8	0	409	409	0	1642281	1642281
XSSS9	0	1647	1647	0	364650	364650

TOTAL	29915	45846	75761	17486175	58611242	76097417
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- 1 See list of departmental codes following
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 - 9 Special Short Shots

TABLE III THIRD QTR 1970

COVER CHARGE--HASP

DEPT ¹	NUMBER OF RUNS			NUMBER OF UNITS		
	CLASS ²	RES	TOTAL	CLASS ²	RES	TOTAL
AAE	882	702	1584	882	702	1584
ACCY	1453	137	1590	1453	137	1590
ADV	0	35	35	0	35	35
AGE	7	316	323	7	316	323
AGEC	0	1415	1415	0	1415	1415
AGENT	0	10	10	0	10	10
AGRIC	0	10	10	0	10	10
AGRON	141	316	457	141	316	457
ANS	0	686	686	0	686	686
ANTH	0	17	17	0	17	17
ARCH	292	2	294	292	2	294
ARL	0	57	57	0	57	57
ASTR	49	309	358	49	309	358
AVI	0	147	147	0	147	147
BADM	4986	373	5359	4986	373	5359
RECBSR	0	111	111	0	111	111
BIOPH	0	116	116	0	116	116
CAS	0	2	2	0	2	2
CE	2935	4608	7543	2935	4608	7543
CEUSA	0	2	2	0	2	2
CHE	97	4326	4423	97	4326	4423
CIRCE	0	176	176	0	176	176
COMM	21	0	21	21	0	21
CRC	0	233	233	0	233	233
CSL	0	306	306	0	306	306
DATLOG	0	37	37	0	37	37
DOS	14013	1752	15765	14013	1752	15765
DS	0	227	227	0	227	227
ECON	584	645	1229	584	645	1229
ED	62	627	689	62	627	689
EDADM	0	42	42	0	42	42
EDPSY	671	39	710	671	39	710
EE	418	1496	1914	418	1496	1914
ENGADM	0	820	820	0	820	820
ENGOST	0	1138	1138	0	1138	1138
ENGH	76	0	76	76	0	76
ENGLISH	0	59	59	0	59	59
ENGROV	0	2	2	0	2	2
EXDC	0	3	3	0	3	3
FIDEI	0	23	23	0	23	23
FIN	388	191	579	388	191	579
FOR	0	10	10	0	10	10
FR	0	11	11	0	11	11
FT	0	39	39	0	39	39
GENE	2532	76	2608	2532	76	2608
GEOG	9	169	178	9	169	178
EOL	306	270	576	306	270	576
GRDCOL	0	47	47	0	47	47
GSA	0	5	5	0	5	5
HFC	0	27	27	0	27	27
HFD	0	8	8	0	8	8
HONORS	0	6	6	0	6	6
HORT	0	76	76	0	76	76

ICR	46	925	971	46	925	971
IE	33	41	74	33	41	74
IFCL	0	2	2	0	2	2
ILLUMI	0	6	6	0	6	6
ILR	176	283	459	176	283	459
IREC	0	33	33	0	33	33
LAW	0	104	104	0	104	104
LIBS	0	103	103	0	103	103
LING	13	0	13	13	0	13
LIR	0	5	5	0	5	5
MATH	84	170	254	84	170	254
MATRL	0	3173	3173	0	3173	3173
MCRIG	0	17	17	0	17	17
ME	1193	1304	2497	1193	1304	2497
MMPE	0	127	127	0	127	127
MUSIC	203	244	447	203	244	447
NHS	0	200	200	0	200	200
NUCE	216	612	828	216	612	828
OAC	0	3	3	0	3	3
OAS	0	88	88	0	88	88
DIR	0	699	699	0	699	699
PEM	186	110	296	186	110	296
PEW	0	32	32	0	32	32
PHYR	0	156	156	0	156	156
PHYCS	142	2960	3102	142	2960	3102
PHYSL	0	107	107	0	107	107
PHYX	0	762	762	0	762	762
POLS	361	446	807	361	446	807
PROVST	0	31	31	0	31	31
PSYCH	751	2757	3508	751	2757	3508
REC	52	17	69	52	17	69
SCONS	0	92	92	0	92	92
SCS	0	18	18	0	18	18
SGS	0	633	633	0	633	633
SDC	93	453	546	93	453	546
SDCH	41	78	119	41	78	119
SPCH	0	48	48	0	48	48
SPEC	0	9	9	0	9	9
SRL	0	454	454	0	454	454
SWS	0	2100	2100	0	2100	2100
TAM	432	931	1363	432	931	1363
UICOMM	0	33	33	0	33	33
USCOP	0	97	97	0	97	97
URPLAN	2	0	2	2	0	2
USGS	0	1	1	0	1	1
VPH	0	12	12	0	12	12
VPP	82	78	160	82	78	160
VTED	0	45	45	0	45	45
WPGU	0	4	4	0	4	4
ZOOL	0	291	291	0	291	291

SUBTOTAL	34028	43151	77179	34028	43151	77179
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DCSSYS ³	0	12111	12111	0	12111	12111
OVERHD ⁴	0	3818	3818	0	3818	3818
REFUND ⁵	0	790	790	0	790	790

UADP ⁶	0	100	100	0	100	100
S ⁷	0	537	537	0	537	537
INT ⁸	0	761	761	0	761	761
XSS ⁹	0	1826	1826	0	1826	1826

TOTAL	34028	63094	97122	34028	63094	97122
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- 1 See list of departmental codes following
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 - 4 System Use of Excess of User Estimated Usage
 - 5 Rerun of User Jobs Due to Machine or System Error
 - 6 University Overhead Administrative Use
 - 7 System Updating
 - 8 System Maintenance
 - 9 Special Short Shots

TABLE III THIRD QTR 1970
COVER CHARGE--XPRESS BATCH

DEPT ¹	NUMBER OF RUNS			NUMBER OF UNITS		
	CLASS ²	RES	TOTAL	CLASS ²	RES	TOTAL
AAF	174	70	244	174	70	244
ACCY	8	0	8	8	0	8
AGE	0	26	26	0	26	26
AGEC	0	148	148	0	148	148
AGRON	77	7	84	77	7	84
ANS	0	16	16	0	16	16
ANTH	0	6	6	0	6	6
ARCH	85	0	85	85	0	85
ARL	0	2	2	0	2	2
ASTR	14	36	50	14	36	50
AVI	0	19	19	0	19	19
BADM	493	2	495	493	2	495
CE	354	180	534	354	180	534
CHE	0	51	51	0	51	51
COMM	1	0	1	1	0	1
CRC	0	77	77	0	77	77
CSL	0	1	1	0	1	1
DATLOG	0	2	2	0	2	2
DCS	8478	399	8877	8478	399	8877
DS	0	14	14	0	14	14
ECON	14	25	39	14	25	39
ED	21	14	35	21	14	35
EDPSY	56	0	56	56	0	56
EE	211	117	328	211	117	328
ENGADM	0	4	4	0	4	4
ENGCS	0	32	32	0	32	32
ENGH	4	0	4	4	0	4
EXOC	0	47	47	0	47	47
FIN	15	2	17	15	2	17
FOR	0	2	2	0	2	2
FT	0	1	1	0	1	1
GENE	454	46	500	454	46	500
GEOL	33	5	38	33	5	38
HORT	0	21	21	0	21	21
ICK	0	34	34	0	34	34
IE	22	0	22	22	0	22
ILR	2	5	7	2	5	7
LAW	0	46	46	0	46	46
LIBS	0	2	2	0	2	2
LING	1	0	1	1	0	1
MATH	46	82	128	46	82	128
MATRI	0	125	125	0	125	125
ME	449	236	685	449	236	685
MMPE	0	2	2	0	2	2
MUSIC	74	8	82	74	8	82
NUCE	42	90	132	42	90	132
OIR	0	4	4	0	4	4
PEM	4	0	4	4	0	4
PEW	0	1	1	0	1	1
PHYB	0	25	25	0	25	25
PHYCS	49	98	147	49	98	147
PHYSL	0	33	33	0	33	33
PHYX	0	8	8	0	8	8

POLS	9	4	13	9	4	13
PSYCH	143	154	297	143	154	297
C	0	1	1	0	1	1
SCONS	0	30	30	0	30	30
SPCH	0	1	1	0	1	1
SRL	0	90	90	0	90	90
SWS	0	20	20	0	20	20
TAM	68	83	151	68	83	151
UICOMM	0	2	2	0	2	2
UOSCP	0	1	1	0	1	1
URPLAN	8	0	8	8	0	8
VPP	0	2	2	0	2	2
VTED	0	6	6	0	6	6
ZOOL	0	45	45	0	45	45

SUBTOTAL	11409	2610	14019	11409	2610	14019
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DCSSYS ³	0	1772	1772	0	1772	1772
QVRHED ⁴	0	703	703	0	703	703
REFUND ⁵	0	17	17	0	17	17
UAOP ⁶	0	81	81	0	81	81
XDCS ⁷	0	110	110	0	110	110
XMAINT ⁸	0	29	29	0	29	29
XSSS ⁹	0	183	183	0	183	183

TOTAL	11409	5505	16914	11409	5505	16914
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- 1 See list of departmental codes following
 2 Training and Education
 3 System Improvement and Modifications
 4 System Use of Excess of User Estimated Usage
 5 Rerun of User Jobs Due to Machine or System Error
 6 University Overhead Administrative Use
 7 System Updating
 8 System Maintenance
 9 Special Short Shots

LIST OF DEPARTMENT CODES

The following list of codes are those codes for which the Department of Computer Science has on file one or more authorized signatures. If your department or office does not appear on this list, please write its full name in the department field on the Problem Specification Form even though it may require more than 6 characters.

AAE	Aero. and Astro. Eng.	ECON	Economics
ACCREC	Accounts Receivable	ED	College of Ed.
ACCY	Accountancy	EDADM	Educational Admin. and Super.
ACTGDV	Accounting Division	EDPSY	Educational Psychology
ADV	Advertising	EE	Electrical Eng.
AFS	Air Force Science	ENGADM	Engineering Admin.
AGE	Agricultural Eng.	ENGCS	Engineering College and Station
AGEC	Agricultural Economics	ENGH	Engineering Honors Program
AGED	Agricultural Ed.	ENGLISH	English
AGREXT	Agricultural Extension	ENTOM	Entomology
AGRON	Agronomy	FIN	Finance
ALUMNI	Alumni Assoc.	FOR	Forestry
AMCDEC	Adolf Meyer Center Decatur Ill.	FR	French
ANS	Animal Science	FT	Food Science
ANTH	Anthropology	GENE	General Eng.
ARCH	Architecture	GEOG	Geography
ART	Art	GEOL	Geology
ASTR	Astronomy	GER	Germanic Languages and Lit.
AUDIT	Auditing Division	GRDCOL	Graduate College
AVI	Aviation	GRK	Greek
BADM	Business Admin.	GSA	Graduate Student Assoc.
BAND	Band	HACDMH	Herman Adler Zone Center Champaign
BCMPL	Bureau of Community Planning	HEC	Home Economics
BECBSR	Bureau of Econ. and Bus. Res.	HED	Health Ed.
BED	Business Ed.	HIST	History
BEDRES	Bureau of Ed. Res.	HLTHSV	Health Services
BINRES	Bureau of Institutional Res.	HONORS	Honors Program
BIOPH	Biophysics	HORT	Horticulture
BOT	Botany	HOUDIV	Housing Division
BURSAR	Bursar's Office	HYG	Hygiene
CE	Civil Eng.	ICR	Inst. of Communications Res.
CERE	Ceramic Eng.	IE	Industrial Eng.
CHE	Chemistry and Chemical Eng.	IGPA	Inst. of Government and Public Affair
CICBIO	Comm. Inst. Coop. Bio. Grad. Prog.	ILLCF	Illini Christian Fellowship
CIRCE	Cent. for Instr. Res. and Curr. Ev.	ILLDMH	State of Ill. Dept. of Mental Health
CLASS	Classics	ILR	Inst. of Labor and Industrial Rel.
CMPOL	Comptroller's Office	INSTTV	Instructional TV
COMM	Communications	IREC	Inst. for Res. on Except. Children
CP	City Planning	ISEDAD	Ill. St. U. Dept. of Ed. Admin.
CPUBS	Champaign Public Schools	ITAL	Italian
CRC	Children's Res. Center	JOURN	Journalism
CSL	Coordinated Science Lab.	LA	Landscape Architecture
CURLAB	Curriculum Lab.	IAS	Liberal Arts and Sciences
CZR	Center for Zoonoses Res.	IAT	Latin
DANCE	Division of Dance	LAW	Law
DCS	Dept. of Computer Science	LIBS	Library Science
DGS	Division of General Studies (LAS)	LING	Linguistics
DNSTUD	Dean of Students	MATH	Mathematics
DNW	Dean of Women	MATRL	Materials Res. Lab.
DOW	Division of Waterways	MCBIO	Microbiology
DS	Dairy Science	ME	Mechanical Eng.
DSFA	Dept. of Stud. Fin. Aid	MILS	Military Science
DUE	Division of University Ext.	MKNLY	McKinley Hospital

MMPE	Min. Met. and Petr. Eng.
MUSIC	Music
NHS	Natural History Survey
NS	Naval Science
NUCE	Nuclear Eng.
OAC	Office of Agricultural Comm.
OAS	Office of Admin. Studies
OIR	Office of Instr. Resources
PEM	Phys. Ed. for Men and Grad PE
PERRIF	Pershing Rifles
PEW	Phys. Ed. for Women
PHIL	Philosophy
PHYB	Physics Betatron Lab.
PHYCS	Physics
PHYPLA	Physical Plant
PHYSL	Physiology
PHYX	Physics Project X
PLPA	Plant Pathology
POLS	Political Science
PORT	Portuguese
PROVST	Provost's Office
PSDEC	Spec. Ed. Decatur Public Schools
PSYCH	Psychology
PSYTR	Psychiatry
PUR	Purchasing Division
REC	Recreation
RHET	Rhetoric
RSOC	Rural Sociology
RTV	Radio and Television
RUSHIS	Russian and area Studies
SCONS	Soil Conservation Service
SCS	Student Counseling Service
SGS	State Geological Survey
SHCBRC	Small Homes Council
SLAV	Slavic Languages and Lit.
SOC	Sociology
SOCW	Social Work
SOLS	School of Life Sciences
SPAN	Spanish
SPCH	Speech and Theatre
SPED	Special Ed.
SRL	Survey Research Lab.
SWS	State Water Survey
TAM	Theoretical and Applied Mechanics
UADP	Univ. Admin. Data Processing
UCCTE	U-C Council on Teacher Ed.
UNIHI	Univ. High School
UOSCR	Univ. Off. of School and Coll. Rel.
URPLAN	Urban Planning
USGS	U. S. Geological Survey
VAH	Vet. Anatomy and Histology
VCM	Vet. Clinical Medicine
VMS	Vet. Medical Science
VPH	Vet. Path. and Hygiene
VPP	Vet. Phys. and Pharm.
VTED	Vocational Ed.
WPGU	WPGU Radio Station
ZOOL	Zoology

Chicago Circle

CCARCH	Architecture
CCCHE	Chemistry
CCDME	Materials Engineering
CCENEN	Energy Engineering
CCGEOL	Geology
CCPHCS	Physics
CCPSYC	Psychology
CCSCS	Stud. Counsel. Service
CCSOC	Sociology

Chicago Medical Center

MCCL	Med. Cen. Comp. Lab.
ORME	Off. of Res. in Med. Ed.
OT	Occupational Therapy

Ill. State University, Normal

ISEDAD	Dept. of Ed. Admin.
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Western Ill., Macomb

WIULAB	West. Ill. Univ. Lab School
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10.5 Class Problem Specifications

During the third quarter of 1970, 196 problem specifications were submitted to cover all assigned problems on the System/360 in the following courses.

3994	Computer Science 998.
3995	Educational Psychology 497.
3996	Electrical Engineering 416.
3999	Electrical Engineering 342.
4003	Electrical Engineering 251.
4009	Mathematics 499.
4014	Physical Education 453.
4016	Theoretical and Applied Mechanics 493.
4017	Theoretical and Applied Mechanics 235.
4018	Theoretical and Applied Mechanics 493.
4019	Nuclear Engineering 495.
4023	Sociology 482.

4030 Physics 497.

4032 Educational Psychology 449.

4106 Civil Engineering 220.

4116 Civil Engineering 391.

4145 Educational Psychology 449.

4147 Chemistry and Chemical Engineering 383.

4149 Civil Engineering 416.

4158 Agronomy 340.

4159 Psychology 390.

4160 Industrial Engineering 458.

4161 Accountancy 594.

4162 Civil Engineering 315.

4164 Mechanical Engineering 210.

4165 Mechanical Engineering 263.

4166 Mechanical Engineering 264.

4167 Mechanical Engineering 250.

4174 Secondary Education 356.

4175 Institute of Labor and Industrial Relations 490.

4192 Business Administration 374.

4193 Economics 470.

4195 Mathematics 388.

4196 Business Administration 473.

4206 Aeronautical and Astronautical Engineering 326.

4211 Civil Engineering 458.

4216 Business Administration 351.

4218 Urban Planning 376.

4222 Civil Engineering 391.

4223	Mechanical Engineering 410.
4230	Accountancy 199.
4239	Computer Science 101.
4243	Communications, Radio and Television 490.
4244	Business Administration 533.
4245	Civil Engineering 201.
4250	Computer Science 287.
4254	Political Science 496.
4255	Computer Science 121.
4257	Civil Engineering 497.
4259	Educational Psychology 490.
4260	Educational Psychology 490.
4261	Educational Psychology 490.
4262	Economics 173.

4263	Engineering Honors 297.
4264	Educational Psychology 390.
4265	Architecture 347.
4266	Computer Science 393.
4267	Agricultural Economics 220.
4268	Physics 341.
4269	Physics 303.
4271	Mechanical Engineering 403.
4273	Mechanical Engineering 250.
4276	General Engineering 103.
4278	General Engineering 393.
4279	Business Administration 373.
4282	Economics 294.
4284	Agronomy 365.

4286	Mechanical Engineering 323.
4287	Mechanical Engineering 421.
4290	Mechanical Engineering 271.
4291	Nuclear Engineering 495.
4292	General Engineering 288.
4293	Chemistry and Chemical Engineering 344.
4294	Computer Science 290.
4295	Computer Science 441.
4296	Linguistics 403.
4300	Computer Science 201.
4302	Geology 479.
4303	Chemistry and Chemical Engineering 383.
4305	Communications 490.
4306	Geology 335.

4307 Geology 331.

4311 Economics 410.

4312 Computer Science 199.

4313 Electrical Engineering 272.

4314 Architecture 358.

4315 Economics 467.

4316 Computer Science 287.

4318 Business Administration 552.

4321 Psychology 409.

4323 Finance 350.

4325 Psychology 292.

4326 Industrial Engineering 458.

4327 Computer Science 101, 103, 105, 107, 121, 400.

4329 Biophysics 410.

4330 Economics 172.
4331 Economics 476.
4332 Psychology 332.
4334 Electrical Engineering 271.
4335 Chemistry and Chemical Engineering 466.
4336 Theoretical and Applied Mechanics 428.
4337 Nuclear Engineering 347.
4338 Chemistry and Chemical Engineering 394.
4341 Civil Engineering 478.
4342 Civil Engineering 473.
4348 Theoretical and Applied Mechanics 493.
4349 Computer Science 457.
4350 Mathematics 490.
4352 Theoretical and Applied Mechanics 451.

4353 Electrical Engineering 497.

4355 Music 446.

4356 Electrical Engineering 350.

4358 Computer Science 397B.

4360 Social Work 491.

4361 Chemistry and Chemical Engineering 383.

4363 Mechanical Engineering 443.

4364 Mechanical Engineering 341.

4365 Mechanical Engineering 448.

4366 Mechanical Engineering 220.

4367 Accountancy 101.

4370 Civil Engineering 221.

4371 Civil Engineering 307.

4372 Electrical Engineering 251.

4374 Civil Engineering 304.

4376 Geography 463.

4377 Mechanical Engineering 428.

4378 Chemistry and Chemical Engineering 348.

4379 Electrical Engineering 324.

4381 Electrical Engineering 451.

4385 Civil Engineering 352.

4386 Nuclear Engineering 441.

4387 General Engineering 232.

4389 Educational Psychology 496.

4390 Theoretical and Applied Mechanics 438.

4391 Theoretical and Applied Mechanics 493.

4392 Electrical Engineering 416.

4394 Educational Psychology 390.

4395 Architecture 236.

4396	Electrical Engineering 389.
4397	Theoretical and Applied Mechanics 493.
4398	Theoretical and Applied Mechanics 431.
4399	Theoretical and Applied Mechanics 392.
4403	Psychology 455.
4405	Secondary Education 490.
4406	Electrical Engineering 382.
4408	Computer Science 387.
4409	Psychology 306.
4410	Business Administration 370.
4411	Electrical Engineering 454.
4412	Electrical Engineering 386.
4413	Industrial Engineering 288.
4416	Music 343.

4417 Geology 455.

4418 Mechanical Engineering 185.

4419 Chemistry and Chemical Engineering 406.

4421 Aeronautical and Astronautical Engineering 391.

4422 Aeronautical and Astronautical Engineering 493.

4423 Industrial Engineering 386.

4424 Theoretical and Applied Mechanics 493.

4425 Civil Engineering 461.

4427 General Engineering 241.

4428 Civil Engineering 261.

4429 Architecture 493.

4432 Theoretical and Applied Mechanics 321.

4433 Mechanical Engineering 306.

4434 Mechanical Engineering 259.

4435 Chemistry and Chemical Engineering 421.

4436 Aeronautical and Astronautical Engineering 241.

4437 Civil Engineering 361.

4439 Computer Science 209.

4441 Psychology 332.

4442 General Engineering 242.

4443 Economics 272.

4444 Aeronautical and Astronautical Engineering 391.

4445 Electrical Engineering 357.

4449 Aeronautical and Astronautical Engineering 213.

4450 Aeronautical and Astronautical Engineering 263.

4451 Business Administration 578.

4453 Agricultural Engineering 281.

4454 Agricultural Engineering 126.

4455	Agricultural Economics 325.
4456	Civil Engineering 471.
4457	Political Science 326.
4459	Business Administration 573.
4461	Computer Science 999.
4463	Civil Engineering 369.
4465	Political Science 425.
4466	Civil Engineering 264.
4467	Economics 172.
4471	Chemistry and Chemical Engineering 367.
4472	Nuclear Engineering 451.
4473	Music 320.
4475	Plant Pathology 302.
4476	Mechanical Engineering 224.

4477 Aeronautical and Astronautical Engineering 260.

4478 Aeronautical and Astronautical Engineering 438.

10.6 Research Problem Specifications

During the third quarter of 1970, 293 problem specifications were submitted to the Department for computation on the System/360. The following brief descriptions of these problems have been prepared for inclusion in this report by those submitting them. T indicates a calculation associated with a thesis.

3993 Psychology. Adult, Child Objective Test Battery. Standardizing of adult and child objective test battery measuring the entire personality sphere. Application of this battery in an extensive genetics research project with the aim to find estimates for the contributions of heredity and environment to the basic personality source traits. (R. Cattell)

3997 T Agricultural Economics. Adequacy of Financial Intermed. Evaluate the adequacy of financing firms and markets available to farmers in terms of their competitive position in securing funds, other investment opportunities, and alternative solutions. (C. Baker)

3998 Agricultural Economics. Composd Assisted Planning System. Develop planning systems for farm operation and finance. (C. Baker)

4000 T Sociology. Thesis Research on Burglars. Ph.D. Dissertation research on types of burglary offenders and their careers in crime. (N. Shover)

4001 Electrical Engineering. Loaded Dipole Antennas.
Analysis and synthesis of impedance of wire antennas with discrete loading.
(1) Adapt existing computer programs to compute the input impedance of
wire antennas with lumped circuit elements in series with the wire. (2)
Evaluate the effects of various patterns of resistive and reactive loading
on the input impedance and efficiency. (3) Investigate various optimization
routines for synthesizing prescribed impedance verses frequency characteristics.
(P. Mayes)

4002 T Psychology. Markhov Model of Decision-Making. This
research is designed to provide a test of a mathematical model of decision-
making in a setting in which persons are operating under informational and
normative social influences. (J. Hornik)

4004 Agricultural Economics. Impact of Industry on Rural Social
Systems. Analyze impacts of industrial development occasioned by the location
of a large scale steel manufacturing complex on the family, economic, religious,
and interest organizations and on attitudes and values of rural residents
living in immediate area. (C. Folse)

4005 Agricultural Economics. Market Production Adjusted to
Technological Changes, Grain. Assess the changes occurring in the grain industry
due to rapid increase in harvesting shelled corn at high moisture levels
and to predict the effects of these and other technological changes occurring
in the grain industry. (J. Scott)

4006 Agricultural Economics. Adjustments in the Grain Industry. Evaluate the effects of alternative government policies and technological changes on the market structure in the grain industry. (L. Hill)

4007 T Geography. Diffusion Soybean Production. The problem is concerned with a statistical analysis of soybean production in Illinois over time and space. It will require the running of multiple regression programs, CalComp programs, as well as supporting key punching work, and general program writing. (L. Powell)

4008 Sociology. Sociology of Education Survey. National survey of sociology of education manpower with focus on training programs and research activities. (G. Summers)

4010 T Physical Education for Men and Graduate Physical Education. Effects of Beginning Lacrosse. Lacrosse was taught to a beginning class of ninth-grade girls at Jefferson Junior High School. To determine any physiological effects of lacrosse on these girls, the following tests were administered: step test (heart rate), 600 yard walk-run, and skinfold measures were taken. Pre and post tests were administered. (J. Markert)

4011 T Economics. Filtering in Housing Markets. The thesis is based on a statistical analysis of the theory of filtering in urban housing markets. (D. Guy)

4012 Aeronautical and Astronautical Engineering. 70 Aero Astro Summer. Undergraduate instructional award. (W. Van Tassell)

- 4013 Psychology. Organization in Memory. Investigates organizational variables and interference in human verbal memory. The data from a series of experiments is to be analyzed. (W. Montague)
- 4015 Recreation. Long Range Planning and Policy Analysis. Long range planning and policy analysis for the Illinois Department of Conservation. (G. Carls)
- 4020 T Education. Special Education Division in Illinois 1965-1970. A survey to determine the rate of change and the factors impeding development of special education programs and services in Illinois 1965-1970. (E. Smith)
- 4021 T Theoretical and Applied Mechanics. Large Dynamic Beam Deflection. Numerical computer investigation of a class of large dynamic beam deflections problems. (M. Critchfield)
- 4022 Springfield Public Schools. Pupil Data Project District 186. Storing and updating of student information for computerized vocational information system. (G. Hagerman)
- 4024 T Theoretical and Applied Mechanics. Composites, Adhesive Joints. Stress analysis of composite materials and adhesive joints. (F. Lin)
- 4025 Agronomy. Agronomy Statistical Laboratory. Statistical analysis of Agronomic research data. (S. Carmer)
- 4026 Recreation. Systems Plan for Waterfowl Refuge. Systems plan for waterfowl refuges--recreation areas for the State of Illinois. (G. Carls)

4027 Agricultural Economics. Agricultural Economics Computer Problems. General agricultural economics computer problems that may tie in with various research projects. (S. Sanderson)

4028 Agricultural Economics. Price Analysis. Formulate alternative economic models which simulate short-run demand and supply and, thereby, fluctuations in the price and quantity of live hogs. (R. Leuthold)

4029 T Psychology. Lubitz Dissertation. The experiment attempts to test several theories which describe how human subjects revise subjective probability estimates in a problem solving task. In particular I plan to manipulate two variables: the number of hypotheses being tested, and the number of tenable hypotheses. (R. Lubitz)

4031 T Computer Science. Memory System Simulation. Simulation study of interleaved memory systems. (E. Davis)

4033 T Electrical Engineering. Remote Probing Optical Radar. A major impasse in the use of optical radar for remote probing of pollutants is the discrimination of Mie scattering off pollutant particulates from Rayleigh scattering off of atmospheric molecular constituents. Analytical studies indicate the feasibility of such discrimination thru the observation of coherent verses incoherent backscatter. However, optimal conditions for coherent detection can only be deduced by calling upon numerical integration techniques. Thus, one hour's computation time is being requested to carry out integrations resulting from simulation of both time averaged and pulsed optical radar operation. (R. Nittra)

4034 Computer Science. Sybalski Test for Primality. For Mersenne numbers, a decision method using far fewer operations than the Lucas test, has been devised by John Sybalski. It works correctly up to exponent 17 (hand calculation), and he feels he almost has a proof that it is correct. By a modest amount of experimental mathematics, it can either be disproved or be used to uncover new Mersenne primes. (D. Gillies)

4035 Agricultural Economics. United States Department of Interior Project BO 52. Fidelity of information transmission in local campaigns of water issues. (F. Fliegel)

4036 Agricultural Economics. United States Department of Interior Project BO 49. Economic evaluation of the effect of selected crop practices of non-agricultural uses of water. (E. Swanson)

4037 State Water Survey. Rain Enhancement. The causes for rainfall enhancement over small-scale topographic features in one small sector (the center) of the Shawnee Hills of southern Illinois will be investigated. Factors to be investigated are: (1) a hill-effect insolation increase, (2) hill-effect mechanical turbulence increase, and (3) a hill-produced moisture increase from the heavily-forested hills. (D. Jones)

4038 T Theoretical and Applied Mechanics. Time Dependent Anisotropy. Time effect upon stress and strain relationship produced by a prior plastic strain for a medium carbon steel. Data reduction program. (K. Johnson)

4039 State Water Survey. Dual Wavelength Radar. This research project is to develop and evaluate a dual wavelength radar for the detection of incipient hail. (E. Mueller)

- 4040 Natural History Survey. Soybean Insect Data. Process data on insects found on soybeans. (M. Kogan)
- 4041 Natural History Survey. Pheasant Behavior Studies. Ethological and ecological studies of pheasant populations in Illinois. (R. Labisky)
- 4042 Electrical Engineering. Ionosphere Prediction Model. To develop an ionospheric model for predicting and hence correcting for the errors caused by propagation group delay of navigation satellite signals penetrating the ionosphere. (K. Yeh)
- 4043 Anthropology. HAC. Attribute cluster analysis for hammerstones from prehistoric site in Colorado. (M. Smith)
- 4044 T Economics. Adaptive Portfolio Selection Problems. Dissertation research is intended as programming and simulation approach to portfolio selections. Computer time is needed to plot graphs and solve programming problems. (H. Tsang)
- 4045 Social Work. SOCW 491. SOCW 491 is the master's research project, our equivalent of thesis research. Students this summer are collecting data and beginning analysis. (R. Anderson)
- 4046 Natural History Survey. Pheasant Physiology Studies. Investigating physiological parameters, mineral status, and pesticide levels in pheasants, taking into consideration sex, age, season, activity, and geographic region. (W. Anderson)

- 4047 Zoology. Vertebrate Social Behavior. Social dynamics of Macaca fascicularis troop. (E. Banks)
- 4048 Education. The Role of the English Education. Comparison of attitude between high school and college teachers concerning the teaching of English. (E. Wingler)
- 4049 Engineering College and Station. Research Theory of Simulation. Research to test the ability of the simulation method for analyzing large systems. (J. Serage)
- 4050 State Water Survey. Hydraulic Geometry. This research project would develop information to allow the quantitative evaluation of the capacity of a stream to assimilate wastes and to determine the tendency of a stream toward the dispersion of a slug of contaminant material that might be introduced into the Kaskaskia river in Illinois. (R. Yang)
- 4051 T Civil Engineering. III-Dimensional Finite Element. Replaces PS Number 3246. (B. Karlson)
- 4052 Civil Engineering. Heat Transfer in Pavements. This research project will be concerned with the placement of insulation materials in highway pavement systems. (B. Dempsey)
- 4053 T Civil Engineering. Sludge Thickening. Replaces PS Number 3257. (R. Dick)
- 4054 T Civil Engineering. Welding Residual Stresses. Determine the residual stresses in a thin plate due to welding. Parameters are X, Y, and Time. Elastic constants and yield stress depend on temperature. (R. Eubanks)

4055 T Civil Engineering. Damage Spectra-Quakes. Develop a new approach for determination of earthquake response. Procedure will involve damage spectra with time information included. Extensive computation of spectra will be required. (R. Eubanks)

4056 Civil Engineering. Reinforced Concrete Arches.
Replaces PS Number 3228. (G. Gurfinkel)

4057 T Civil Engineering. Construction Vibrations. Application of response spectra and Fourier amplitude techniques to the analysis of construction vibrations. (C. Dowding)

4058 T Civil Engineering. Nonmetric Camera. Study of the photogrammetric potentials of non-metric cameras. (Y. Abdel-Aziz)

4059 Civil Engineering. Post. Replaces PS Number 3232. (P. Homan)

4060 Civil Engineering. Water Quality System Optimization. Using operations research, the management of water quality in a closed river system will be studied. Stochastic aspects of the system will be taken into consideration. (C. Yin)

4061 Civil Engineering. Consolidation Mechanisms. Investigation of the mechanisms controlling the consolidation characteristics of soils.
(G. Mesri)

4062 T Civil Engineering. Water Resource Planning System. CE 499-D: Investigation into planning scheme in water resource projects, involving techniques of operations research: Replaces PS Number 3236. (E. Cetwinski)

4063 T Civil Engineering. Isoparametric Finite Element. Development of two and three dimensional isoparametric finite element with elasto-plastic material behavior. (A. Gupta)

4064 T Civil Engineering. Slabs with Irregular Columns. Replaces PS Number 3250. (C. Hofmayer)

4065 T Civil Engineering. Deep Beams on Elastic Foundations. Finite element analysis of deep beams on elastic foundations applied to the study of masonry walls, dams, and machine parts. (M. Stetson)

4066 Civil Engineering. Risk Analysis in Civil Engineering. Replaces PS Number 3247. (W. Tang)

4067 T Civil Engineering. Finite Element Bridge Dynamic. Replaces PS Number 3239. (A. Eberhardt)

4068 T Civil Engineering. Spatially Varied Flow. Replaces PS Number 3230. (K. Chang)

4069 T Civil Engineering. Systems Model Simulation. Development of facilities for the simulation of certain types of complex systems. (A. Thesen)

4070 T Civil Engineering. Thin Walled Beam Analysis. Generalization of thinwalled beam formulation to tapered, skewed, and curved forms. (R. Wright).

4071 Civil Engineering. Unitgraph and Backwater Curve.
Replaces PS Number 3241. (B. Yen)

4072 Civil Engineering. Constraint Processing. Trial
implementation of the topological concepts of ingredience and dependence
for data in structural design. (R. Wright)

4073 Civil Engineering. Network Synthesis Simulation. CPM
network model for industrialized building. Design and construction
process. (T. Nakajima)

4074 Civil Engineering. Television Mapping System. Geometric
calibration of a closed-circuit television system; and mapping for stereo
TV-imageries. (K. Wong)

4075 T Civil Engineering. Effect of Raindrop Impact.
The effect of Rainfall on spatially varied sheet flow is being studied.
Tubulence and mean velocites are measured as well as the boundary shear.
(Y. Yoon)

4076 T Civil Engineering. Soil Study Aerial Photographs.
Quantitative differentiation of soil association areas using aerial
photographs. (M. Phillips)

4077 Civil Engineering. Wave Pressures. Replaces PS Number
3244. (R. Weggel)

- 4078 T Civil Engineering. Stability of Stiff Clay Slope.
Calculation of factor of safety of several well documented and instrumented
slopes that failed during construction of freeway in stiff clays in Seattle;
evaluation of present methods of predicting stability. (R. Peck)
- 4079 T Civil Engineering. Dynamics of Framed Structures.
Study of the dynamic behavior of simple steel frames subjected to earthquake
motions - experimental investigation and analytical prediction of response.
(R. Srinivasan)
- 4080 Civil Engineering. Flood Control Systems Analysis. To
investigate the application of systems engineering in the design and
operation of flood control structures. (G. Cortes)
- 4081 Civil Engineering. Photo Block Adjustment. Modify, implement
and test the photogrammetric analytical aerotriangulation block adjustment
program of the United States Coast and Geodetic Survey. Using the program,
study the correlation between ground control density and photogrammetric
control accuracy. (W. Marks)
- 4082 Civil Engineering. Translator Generators. Replaces PS
Number 3234. (L. Lopez)
- 4083 T Civil Engineering. Stereometric System. Replaces PS
Number 3263. (R. Malhotra)
- 4084 Civil Engineering. Image Refinement Routine. Develop an
efficient image refinement routine and algorithm to handle single and double
projector comparitors. (G. Elphingstone)

4085 T Civil Engineering. Rail Contact Stress Investigation. This investigation involves the determination of rail stresses due to wheel-rail contact. (G. Martin)

4086 T Civil Engineering. Prestressed Column Strength. Examination of the loading history to failure of prestressed concrete columns within the P-M interaction diagram for various cross-sections, slenderness ratios and end-fixity conditions. (L. Pleimann)

4087 T Civil Engineering. Sludge Conditioning. Specific resistance and compression coefficient values will be computed from laboratory vacuum filtration test leaf data. (R. Dick)

4088 T Civil Engineering. Diesel Pile Driving Hammer. Dynamic analysis of impact and combustion in a diesel pile driving hammer. (D. Rempe)

4089 T Civil Engineering. Conventional Pile Driving. Replaces PS Number 3231. (J. Parola)

4090 Civil Engineering. Hydrosystems Models. Formulation of stochastic hydrologic systems and one and two dimensional hydrodynamic distributed systems models. (S. Kareltotis)

4091 T Civil Engineering. Seismic Analysis of Structures. Replaces PS Number 3229. (I. Gungor)

4092 Civil Engineering. Analysis of Safety. Replaces PS Number 3233. (M. Amin)

- 4093 T Civil Engineering. Finite Difference Models. Lumped-parameter models for static stress analysis and dynamic wave propagation problems will be investigated. Replaces PS Number 3252. (Y. Uckan)
- 4094 T Civil Engineering. Structure-Soil Interaction. Replaces PS Number 3226. (E. Tabujara)
- 4095 T Computer Science. Image Processing Experiments. PL/1 programs will be written to process abstract list or graph representations of pictures. Hierarchical picture structures will be built by heuristic techniques for composite formation. Preprocessing will be done on the ILLIAC III system. (J. Schwebel)
- 4096 T Civil Engineering. Project Management. Civil engineering project management systems are being studied. (D. Anastasiu)
- 4097 T Civil Engineering. Soil-Structure Interaction. The effect of various models on soil-structure-interaction will be studied. (T. Abe)
- 4098 T Civil Engineering. Discrete Element Methods. Development of lumped parameter elements for analysis of shells. Replaces PS Number 3576. (B. Mohraz)
- 4099 T Civil Engineering. Three Dimensional Wave Prop. This study is designed to show the effects of a nuclear burst on a buried silo. The problem requires the solution of a large number of hyperbolic partial differential equations. (T. Jackson)

4100 T Civil Engineering. Surface Runoff. To investigate the hydrodynamics of runoff on impervious surface. (Y. Shen)

4101 T Civil Engineering. Effects of Vertical Accelerogram. This study is to determine if vertical accelerogram are important in design for seismic loads. (C. Chiou)

4102 T Civil Engineering. Finite Element Shearwall Frame. Approach for shearwall interaction. (O. Yuzugullu)

4103 T Civil Engineering. PCRN Analysis. Lumped-parameter analysis of prestressed concrete reactor vessels. Replaces PS Number 3237. (R. Higashimura)

4104 Sociology. Auto Accident Victim Insurance Study. Our target population is Illinois residents who were involved in automobile accidents in 1967 and 1968 and who received \$100 or over in payment for their personal injury losses. We are attempting to ascertain their attitude toward "pain and suffering" payments and the present procedures of settlement for personal injury losses. (R. Simon)

4105 Geography. Sedimentation Patterns. Mapping the distribution of flood plain sediments using the SYMAP program. (C. Alexander)

4107 T Civil Engineering. Dynamic Analysis. Influence of degrading stiffness on dynamic response of multistory buildings. (N. Nielsen)

4108 T Physical Education for Men and Graduate Physical Education. Body Density vs. Acquisition Beginning Swimming Skills. Correlational analysis-body density and anthropometric measures verses acquisition of swimming skills. (R. Stallman)

4109 T Business Administration. Three-Mode Factor Analysis. An investigation of the effectiveness of advertisements using three-mode factor analysis. (T. Vavra)

4110 T Education. Thesis. Selection of applicants for group counseling. (A. Walker)

4111 Special Education. Encounter Group Studies. This research project is titled: Leader Empathy and Group Compatibility as Variables Affecting Group Process and Outcome. It concerns itself with the level of encounter group leader empathy and the degree of compatibility among group members on outcomes such as empathy, depth of self-exploration, and group cohesion. (E. Schultz)

4112 T Agronomy. PHS Computer Science-Agronomy. Statistical analysis of agronomic thesis research data. (S. Carmer)

4113 T Business Administration. Prediction of Purchases. "Prediction of purchases on durable goods from intentions data: An application of multivariate statistical techniques." Objectives of the study are to find out the underlying dimensions of buying intentions and improve the predictability of purchases. Use of factor, discriminant and regression analyses. (R. Suh)

4114 Geography. Information and Migration. Will examine a set of migration flows from a 100 county area of the Southern United States to major cities in the Northeast. A statistical model will be employed to control for distance and size factors, thus isolating salient migration flows which are attributable to spatial biases of information flow. Other statistical analyses will be employed to relate socio-economic characteristics of migrants to their responses to the various channels of information flow. Results of the research will contribute to an understanding of the overall process of migration by isolating the role of information flows as they influence migration destination choices. (C. Roseman)

4115 Survey Research Laboratory. Study 073 All Work. Police training institute survey. (R. Ferber)

4117 T Law. Mental Health Practices. Analysis of mental patient's civil rights. (T. Engelmann)

4118 Sociology. Significant Other Project. The interaction of students, peers, and significant others in the attitude formation process. (J. Woelfel)

4119 Vocational and Technical Education. Illinois Junior College Cost Analysis. Exploration study to determine program costs in community colleges. (T. Tomlinson)

4120 Economics. Pricing of Legal Services. Investigation of pricing practices of legal professions. (R. Arnould)

- 4121 T Business Administration. Organizational Effectiveness.
Correlates of organizational behavior. (K. Rowland)
- 4122 Fidelis League. Fidelis League Data Processing.
Electronic data processing of organization membership and mailing lists
to prepare listings, mailing labels, and letters. (J. Conway)
- 4123 Engineering Administration. Circsystem. Development
of automated circulation system for the undergraduate library. (J. Divilbiss)
- 4124 Agricultural Engineering. Drainage and Irrigation Research.
Using weather data to plan drainage and irrigation systems. (W. Lembke)
- 4125 Agricultural Engineering. Modeling Machinery Systems.
The activity of field machinery is to modeled with a time generator. Monte
Carlo methods are to be used to generate probabilities for field work
completion. Weather models and plant growth models are to be included.
(D. Hunt)
- 4126 Institute of Labor and Industrial Relations. Governors
Manpower Report. Analysis of manpower data. (W. Franke)
- 4127 T Education. Attitude Survey: Good English. A survey of
randomly selected Illinois English teachers regarding their attitudes
toward the concept of "good English." (D. Preston)
- 4128 Business Administration. Consumer Product Relationship.
Consumer behavior model. (J. Cohen)

- 4129 T Sociology. Predicting the Future. Predicting the effects of significant other influence upon aspiration attitudes. (C. Mettlin)
- 4130 T Aeronautical and Astronautical Engineering. Vibrations of Beam. Solution of non-integer ultraharmonic vibrations of a fixed end beam. To plot the results, a system of six nonlinear algebraic equations must be solved simultaneously using the Newton iteration scheme. (R. Rinkel)
- 4131 Physical Education for Men and Graduate Physical Education. Body Composition and Physical Fitness in Boys. Effects of an 8-week program of sport activity on the physical fitness of young boys, and the relationship of body strength to body composition in young boys ages 7-12 years. (R. Boileau)
- 4132 Anthropology. GEORGE. Attribute analysis of archaeological surface collection. (J. Gatewood)
- 4133 Astronomy. Theory Gaseous Nebulae. Theoretical study of gaseous nebulae. In particular, models will be constructed for the orion nebula and comparisons made with observations. (R. Rubin)
- 4134 T Civil Engineering. Plastic Analysis Shells. Develop and apply lumped parameter method to determine plastic behaviour of shell structures constructed from orthotropic materials. (W. Schnobrich)
- 4135 T Sociology. Occupation and Child Rearing. A study attempting to relate data on differences in occupational setting to variations in child rearing attitudes. (H. Hofmann)

- 4136 Business Administration. WCIA WMBD FCC Study. Federal Communications Commission study for television stations WCIA/WMBD. (P. Winn)
- 4137 Sociology. Police Encounters with Juveniles. Analysis of Chicago police records to determine those factors which affect police decision-making. (L. Goldberg)
- 4138 Education. Financing Higher Education. Doctoral study on opinions of financial aid recipients toward current and proposed financial aid practices and programs. (D. Edwards)
- 4139 T Educational Administration and Supervision. Completion of Dissertation. Arrange for the completion of work begun on a dissertation using the computer. (D. Williams)
- 4140 T Theoretical and Applied Mechanics. Composites, Adhesive Joints. Stress analysis of composite materials and adhesive joints. (F. Lin)
- 4141 Library Science. General Faculty Research. Library research problems including opinion survey, automation and user studies. (C. Kronus)
- 4142 T Computer Science. Image Processing Experiments. Develop programs to interpret photomicrographs of cervical smears; develop systems programs to support the use of Illiac III for this purpose. (J. Read)

4143 Educational Administration and Supervision. Ecology-
Structure-Innovation. Multiple regression analysis of ten interrelated
environmental indicators, eight organizational attributes including
differentiation and integration, and the extent to which these
characteristics determine innovativeness, the dependent variable, in
Illinois public schools. (R. Burnham)

4144 T Physical Education for Men and Graduate Physical Education.
The Goals of Physical Education. The purpose of this investigation is to
determine the extent to which certain societal sub-publics perceived certain
goals to be significant functions of physical education in elementary
and secondary public schools relative to what "ought to be" and what "are
the practices." (F. Grebner)

4146 Electrical Engineering. Analysis of Arbitrary Grating.
A new numerical method has been developed for the analysis of the diffraction
by the gratings with arbitrary profile. Numerical methods include the
calculation of Bessel functions, matrix inversion, plot of the output data,
etc. Complex double precision arithmetic is required. (R. Mittra)

4148 Survey Research Laboratory. Cleaning of Study 065.
Study of student finances at University of Illinois. (R. Ferber)

4150 Electrical Engineering. Liquid Density Instruments.
Studies of instrumentation for liquid density measurements. Measurements
to be made in-situ. (C. Hendricks)

4151 T Education. Stability of ICC Parameters. Analysis will be made of the stability of the item characteristic curve parameters across groups of different abilities. 100 items will be examined for 12 groups of approximately 3200 subjects in each group. (E. Williams)

4152 Political Science. Congress Power and Defense Expense. The research is an analysis of the relationship of economic capability and Congressional seniority and committee assignments to the distribution of prime military contracts among U.S. counties in fiscal year 1960. (B. Rundquist)

4153 Chemistry and Chemical Engineering. Roll Waves. Roll wave profiles in two phase flow. (S. Zanelli)

4154 T Economics. Commodity Speculation Model. A model of commodity trading based on speculative behavior. (S. Stevens)

4155 T Geography. Ecology of Nematodes. Correlation of nematode species with soil properties. (J. Schiel)

4156 T Physics Betatron Laboratory. Compute HE^4 Cross Sections. Cross section calculations including angular distribution fits. (J. Murphy)

4157 Survey Research Laboratory. Tabulations on Study 065. Study of student finances at University of Illinois. (R. Ferber)

4163 Education. Use of Student Appraisal Information. A state wide survey of counselor practices in the release of student personnel information. (R. Boyd)

4168 T Chemistry and Chemical Engineering. X-Ray Analysis Single Crystal. Calculations are made to determine the mean square displacements and average positions of atoms in solids. Single crystals are used. (G. Stucky)

4169 T Psychology. Differences in Human Judgement. An investigation of the relations between multidimensional (similarity) judgements and various types of unidimensional judgements of multiple cue profiles. (T. Stewart).

4170 T Education. Teacher Opinion of Social Studies. An empirical survey and analysis of data to try to determine if social studies teachers perceive themselves implementing the methods and "theories" of the new Social Studies. (G. Burgess)

4171 T Mathematics. Numerical Solution of a PDE. The proposal is to check a numerical scheme for solving a partial differential equation by applying the scheme on a collection of points and checking these results with the known solution. (W. Ford)

4172 Veterinary Pathology and Hygiene. Holmes County Health Project. The project is a study of health problems in Holmes County, Mississippi. The computer will be used for data reduction and statistical analyses. (K. Todd)

4173 T Physical Education for Men and Graduate Physical Education. Exercise Studies. Active versus passive recuperation from exercise. (P. Richter)

4176 Materials Research Laboratory. Potential Calculation.
The potential seen by a He^4 atom on top of a substrate (argon). This
potential is calculated via lattice summation. (C. Woo)

4177 Political Science. Pol of Womens Liberation Project.
Study of the status of women in the historical profession, and comparison
with the status of women in other academic professions, specifically in
the social sciences. (B. Carroll)

4178 Institute of Labor and Industrial Relations. Union-
Management Accommodation Process. Thesis examining process between unions
and management. Thesis builds on twenty years of previous survey work
of Illinois union-management relationships. Variables examined include
economic factors, personality and motivation structures, and attitudes
and satisfactions. (J. Mitchell)

4179 Civil Engineering. Design of Tunnel Liners. The project
is intended to improve the methods of supporting tunnels. (A. Rokhsar)

4180 Electrical Engineering. Plasma Diagnostics. Calibrating
microwave cavity. (M. Fein)

4181 T Psychology. Behavioral Intentions. Black and white subjects
from Illinois and Virginia are used to show the effects of race or beliefs
on interpersonal behaviors. (T. Tyler)

4182 Education. Attitudes Toward Lovaas. Attitude change study Solomon four groups design with experimental treatment of Smith University and French "reinforcement" therapy. (D. Bosshart)

4183 T Astronomy. Dynamical Models of Nebulae. This project consists of the development and study of radiation plasma dynamical models of gaseous envelopes or shells which are ejected from certain types of stars. (P. Lavender)

4184 Agronomy. Tetraploid Simulation. This project is a study of inheritance of a quantitative character in an autotetraploid random mating population. (M. Swanson)

4185 Institute of Labor and Industrial Relations. Instrumentality. Analysis of the relationship between perceived contingencies, expectancies and performance feedback and role performance within complex interdependent situations. Quantitative analyses include complex correlational and mean difference techniques. (G. Graen)

4186 T Psychology. Norm Conflict Resolution. This research examines the resolution of norm conflict by one or two persons as a function of the distance between the norms and the norms' ranges of tolerable behavior. (K. Rissman)

4187 Civil Engineering. Diffusion Pattern Synthesis. Technique for simulation of diffusion patterns and full systems will be developed. A simulated plan will be used to examine option patterns. (W. Maxwell)

4188 T Theoretical and Applied Mechanics. Fracture Toughness - Adhesives. Fracture toughness of adhesive joints under combined mode loading. (G. Trantina)

4189 T Civil Engineering. Optimal Sample Intervals for WQ MON. The problem will involve the analysis of a long series of water quality data to describe trends, oscillations, and random variations followed by reanalysis of successively smaller samples of the data to determine how frequently measurements would be needed in order to satisfy particular purposes. (W. Betchart)

4190 T Theoretical and Applied Mechanics. Analysis of Oscillating Flows. Analysis of pulsatile flow in the vicinity of wall obstacles in plane conduits. (L. Cheng)

4191 Sociology. Self and Parolee Behavior. Relationship between M. H. Kuhn's T.S.T. and variables from parolee work behavior. (J. Gillham)

4194 Education. Predicting Creative Abilities. This research will involve the formulation of a model for the prediction of the creative abilities in elementary school children, the cross-validation of this model, and its application to a set of data. In addition, analyses will be done for a study dealing with some of the affective variables in the learning situation. (S. Thomas)

- 4197 Education. Evaluation of Workshop Course Instruction Development. 1) analysis of data of a campus workshop. 2) development of instruction to measure concepts stated by micro-teaching model. 3) re-evaluation of a project of rule-disadvantaged children. (H. Thomas)
- 4198 Sociology. Police Processing of Juvenile. Multivariate analysis will be performed on official police statistics on juvenile delinquents for the cities of Detroit and Chicago. Emphasis in the analysis will be upon isolations of delinquent referral patterns by police. (D. Bordua)
- 4199 T Education. Organizational Climate Bolivia. Organizational climate of public schools in Bolivia. (D. Good)
- 4200 Business Administration. Management Control. Determination of optimal strategies for controlling a group of activities using MPS. (H. Hinomoto)
- 4201 T Psychology. Delay of Reward on Problem Solving. Different levels of delay of reward are assessed for effects on learning. Delay of reinforcement is combined and contrasted with other response time intervals. (C. Wood)
- 4202 Psychology. Comparative Rehabilitation of Chronic Hospital Patients. Assessing comparative effectiveness of three treatment programs with "hard-core" chronically hospitalized mental patients; substudies on reliability and validity of instruments, effects of drugs, staff training and performance, etc. (G. Paul)

4203 Psychology. Academic Ability Non-Academic. Accomplishments and ideational productivity in high risk and regularly admitted college students. (R. Menges)

4204 T Agricultural Engineering. Service Impact on Feed Firms. To determine what customer services are offered by Illinois livestock feed distributors and the relationship between these services and the changes that have occurred in the individual businesses and the industry. (B. Brooks)

4205 T Agricultural Economics. Analysis of Illinois Land Values. This project centers around the development of a multiple regression model to investigate factors which will explain the changes in Illinois farmland values from 1950-70. (A. Mueller)

4207 Geography. TOFC Haulage Concept. Description and analysis of commodity movements in the northern United States via TOFC (trailer-on-Flatcar). (W. Walcott)

4208 Sociology. Crowd Formation. An examination of the relationship between exposure to designating and prescribing behaviors, social relationships, and crowd formation. (C. McPhail)

4209 T Agricultural Engineering. Dynamics of Tillage. Similitude studies of soil machine systems-correlation of soil strength measurements with tillage tool forces. (J. Panwar)

- 4210 Institute of Labor and Industrial Relations. Job Mobility. Employee job changes as studied by regression analysis. (H. Folk)
- 4212 Psychology. Training Culture. Studies of the induction of culturally disadvantaged persons in job situations. Will involve responses of both black and white subjects to a variety of psychological measures. (H. Triandis)
- 4213 T Chemistry and Chemical Engineering. Flow Over Solid Wavy Surfaces. Solution of Orr-Somerfeld equation. (P. Morrisroe)
- 4214 Agricultural Engineering. Properties of Soybeans. The project involves a study of the physical properties of soybeans. The computer will be used for statistical analysis of the data and for analysis of the dynamic response of the plants by matrix formulation of the equations of motion. (D. Hoag)
- 4215 T Accountancy. The Brain Drain from the Arab World. Motivations and conditions of the migration of scientists and engineers from the Arab World into the United States. (F. Shaaban)
- 4217 T Psychology. Desensitization Outcome Study. Comparison of four experimental groups in order to evaluate effectiveness of desensitization therapy technique. (E. Craighead)
- 4219 Laboratory of Atmospheric Research. Wave Mixing. The manner in which atmospheric wave structures interact with molecular diffusion will be investigated. (M. Geller)

- 4220 Physical Education for Men and Graduate Physical Education.
Perceptual Motor Learning and Perfection. Investigations dealing with
perceptual-motor learning. (O. Young)
- 4221 Civil Engineering. Heat Transfer in Pavements. This project
is concerned with the study of temperature effects on pavement systems
using insulating materials. (B. Dempsey)
- 4224 Natural History Survey. Aquatic Communities. Comparing
benthic communities from flood plain pools and river, using numbers of
species, weights per area, weights and numbers per volume of flow.
(R. Larimore)
- 4225 Survey Research Laboratory. Cleaning on Study 061.
Cleaning and checking on the Chicago Circle Sociology practium. (R. Ferber)
- 4226 Survey Research Laboratory. Cleaning on Study 264.
Cleaning and checking on the model cities (phase 2) study. (R. Ferber)
- 4227 Survey Research Laboratory. Tabulations on Study 264.
Tabulations and analysis on the model cities (phase 2) study. (R. Ferber)
- 4228 Survey Research Laboratory. Cleaning on Study 056.
Cleaning and checking on the health center study. (R. Ferber)
- 4229 Survey Research Laboratory. Tabulations on Study 056.
Tabulations and analysis on the health center study. (R. Ferber)

4230 T Institute of Labor and Industrial Relations. Private Employment Agencies. Employers' evaluation of private employment agencies in four Illinois labor markets. (M. Reynolds)

4231 T Sociology.. Significant Other Research. An analysis of the relationship between location in social structure and value integration, value stability, and selected personality characteristics. (J. Saltiel)

4232 Physical Education for Men and Graduate Physical Education. Human Physical Performance Appraisal. Reaction of individuals to exercise stress measured by metabolic cost circulo-respiratory parameters and neuromuscular performance measures. (B. Massey)

4233 Physical Education for Men and Graduate Physical Education. Physical Education Administrative Research. Sociological and administrative research related to physical education. (J. Razor)

4234 Physical Education for Men and Graduate Physical Education. Sport Psychology. Continuing investigation of environmental, perceptual, and neuromuscular factors underlying skilled and unskilled human motor performance. (A. Hubbard)

4235 Physical Education for Men and Graduate Physical Education. Research on Technology Instructions. Instructional technology dealing with curriculum development, administrative theory and practice, and teaching methods. (R. Wright)

- 4237 Education. General Departmental Use. Problems involve studies of teacher characteristics and classroom environments and their effects on student motivation. (M. Maehr)
- 4238 Sociology. School Social Work. Statistical description (tabulation) of Illinois school social worker's annual reports. (R. Anderson)
- 4240 T Psychology. The Language of Personality. Research on the relationship between the semantic structure of personality trait words and the structure of personality trait ratings. (B. Baldridge)
- 4241 Psychology. Effect of Attractiveness. This study is concerned with the effects of physical attractiveness upon the behavior and personality of teenage girls. (N. Minahan)
- 4242 T Economics. Journey-to-Work Data: Mexico. Compare survey data from Mexico research on Journey-to-Work: CICS Grant; Summer 1969. (M. Conroy)
- 4246 T Agricultural Economics. Optimum Village Organization. Determine allocation of resources between farm sizes; and optimal organization of activities for a Turkish village specialized in cotton production. (L. Fettig)
- 4247 Education. Status of Women. The status (salary and rank) of women on the academic staff will be compared to that of men. Status will be predicted from indices of merit (e.g., publications) and sex. (J. Loeb)

- 4248 Psychology. Fear Assessment Study. Analyses of data from fear questionnaires and related research. (D. Bernstein)
- 4249 Sociology. Migration of Thailand Doctors. First phase of analysis concerns the social and economic factors which explain the decision of doctors to remain in Thailand or travel to the United States. Subsequent analyses will examine patterns of movement and social assimilation within America and subsequent international travel.. (W. Maxwell)
- 4251 T Education. Analysis of Doctoral Students. An analysis of doctoral admissions to the Department of Education and Administration, College of Education, University of Illinois. (R. Snyder)
- 4252 Materials Research Laboratory. David Avigdor Research. Determination of mechanical properties of calcium aluminate glasses. (D. Avigdor)
- 4253 Psychology. Assimilation. Analysis of the relationships between sent roles and accepted roles over time from the frames of reference of the participants.. Quantitative analyses include complex correlational and mean difference techniques. (G. Graen)
- 4256 T Civil Engineering. Earthquake. Same as PS Number 1119. (P. Gulkan)
- 4258 Veterinary Clinical Medicine. Research and Records. New building in final states of completion. Research projects to be developed. Inactive status at onset. (E. Musselman)

- 4270 Mathematics. Numerical Analysis. Preparation of course on numerical analysis to be taught in the future. (H. Benzinger)
- 4272 Business Administration. Multivariate Analysis. Conduct a multivariate analysis of buyer behavior. (J. Sheth)
- 4274 Library Science. Public Library Circulation.. Analyses of the circulation of selected titles from the Champaign and Urbana public libraries, over 6-month periods, resulting from changes in variables relating to browsing. (H. Goldhor)
- 4275 Materials Research Laboratory. Quantum Mechanical Problems. Study of localized electron states in crystals. (A. Baldereschi)
- 4277 T Speech and Theatre. Salient Beliefs. An investigation into the attitude change that results from making specific beliefs salient. (S. Epstein)
- 4280 Chemistry and Chemical Engineering. Simulation of NMR Spectra. Derivation of various physical parameters from actual and simulated NMR spectra. (H. Gutowsky)
- 4281 Computer Science. Illiac IV Research. General calculations for problems not adaptable to project system. (R. Borelli)
- 4283 Military Science. Order of Merit List. Establishment of rank list for branching purposes. (K. Buch)

4285 Advertising. Consumer-Product Typology. A study of the interrelationships between interpersonal response traits, certain demographic components, and subject perception of selected products. Based on sample of 500 Chicago residents. (A. Barban)

4288 Mechanical Engineering. Absorption System Simulation. Steady-state simulation using Newton-Raphson techniques of an absorption refrigeration unit. (W. Stoecker)

4289 T Electrical Engineering. Laser Diagnostics of Plasmas. Solution of equations for electron density and excited state density in gas discharges. (B. Cherrington)

4297 Animal Science. Cattle Growth Study. To study the association of breed type, weight group, hormone treatment and dietary energy level on measures of growth in cattle. (Lohman)

4298 Law. Law and Population Growth. A study of the effect of law upon population growth in Eastern Europe. (P. Maggs)

4299 T Psychology. Assimilation of New Grads. This study explores the social-psychological process whereby a new graduate student is assimilated in his department. Of central interest are the stability, change and influence of role expectations, role demands, role behavior, and role satisfaction over time. (J. Newman)

4301 T Aeronautical and Astronautical Engineering. Solar Wind-Earth Interaction. Interaction of the solar wind with the earth's magnetic field; simple programs involving solutions of algebraic and integral equations. (R. Rensvold)

4304 Economics. SOCECON. Use of multi-dimensional scaling techniques for appraising the existing structure in the communication network underlying (1) economics journals and (2) specialized fields of study within economics. (R. Eagly)

4308 T Aeronautical and Astronautical Engineering. 3 Dimensional Boundary Layer. To study the secondary flow effects due to a 3 dimensional boundary layer on a right circular cylinder in a uniform stream. (T. Payne)

4309 T Psychology. Slot-Car Race Study. A social psychology experiment studying the acceptance of a new member into a previously existing group. The groups are classified according to size and prior success with respect to specific task demands. A masters thesis. (R. Petty)

4310 Horticulture. Survey on Strawberries. Chi-Square of a survey concerning pick-your-own strawberries. (J. Courter)

4317 Physics. Electron-Nucleus Scattering. Comparison with experiment of prediction of the nuclear shell model, using two well-developed programs: nuclear shell model; and partial wave analysis of the Dirac equation. (D. Ravenhall)

4319 Theoretical and Applied Mechanics. Finite Elements Applications. Use of the finite element method in the solution of some problems involving composite materials. (R. Miller)

4320 Psychology. Analyses for Measurement Levels. Data at different levels of measurement will be simulated and different analyses will be applied to determine their appropriateness. (C. Lewis)

4322 Psychology. Quantitative Models-Judgment. Investigation of methods for multivariate analysis and description of psycho physical phenomena. A subproject concerns methods for predicting category judgments using a computer-simulation model. (L. Jones)

4324 Electrical Engineering. Partial Reflections. This project involves the calculation of partial reflections from the D layer, using different types of reflector models, and testing the influence of the reflector model in the value of electron density obtained from partial reflections. (L. Dasilva)

4328 T Biophysics. Biophysics Training. General graduate student use--biophysics research problems. (C. Sybesma)

4333 T Civil Engineering. Dynamic Analysis. Earthquake design of structures. (G. Estrada)

4339 Computer Science. Singular Bases. Explore the use of local global singular bases in the solution of singular integral equations occurring in the kinetic theory of gases. (D. Watanabe)

- 4340 T Computer Science. Systems Memory Modeling. This program determines the parameters of various models of memory heirarchies such that both computation time and memory capacity are minimized. (D. Gold)
- 4343 Civil Engineering. Boundary Layer Integration. The problem consists of integration of ordinary differential equations by an initial value procedure when edge or boundary effects are present. (L. Choo)
- 4344 Laboratory for Atmos. Research. Eq. Waves in a Shear Flow. Certain special wave modes can theoretically exist only in the absence of a shear flow. The propagation of these waves from a region of uniform flow to one with shear will be investigated. (M. Mak)
- 4345 Geography. Land Use and Settlement Problems in Illinois. Purpose is to study the application of the seamap program to land use and settlement problems in Illinois. (F. Foster)
- 4346 Theoretical and Applied Mechanics. Inelastic Solids. Strain deplacement will be studied for a class of two dimentional problems. (A. Boresi)
- 4347 T Psychology. Wittig Dissertation. An analysis of the use of hypotheses by children during a probability learning task. (M. Wittig)
- 4351 Computer Science. Strongly Implicit Methods. Experimental studies of strongly implicit procedures for the numerical solution of elliptic boundary value problems. (P. Saylor)

- 4354 Geography.. Phosphate Analysis. Plotting the results of a total phosphate analysis of alluvial samples from the Ohio, Cumberland and Tennessee Rivers. (C. Alexander)
- 4357 Education. Meaningful Verbal Learning. Variables affecting meaningful verbal learning and remembering. (R. Anderson)
- 4359 Communication. FCC Input Study. A study of the academic input into the communications policy-making process. An attempt to discover how much participation in this process there has been by 500 academic "authorities" on broadcasting. (D. Mullally)
- 4362 Recreation. Park Visitor Study. Statistical analysis of the conditions that are associated with park visitor satisfaction. (W. Harris)
- 4368 T Computer Science. Timing Simulation. Simulation of problems associated with large parallel machines in routing networks. Hopefully will develop a timing simulator of such a hypothetical machine using GPSS. (L. Swanson)
4369. T Computer Science. Computational Geometry. Study of efficient algorithms for performing geometric transformations on a computer, with applications to computer graphics. (J. Nievergelt)
- 4373 T Theoretical and Applied Mechanics. Sector Finite Elements. Finite element analysis using sector elements. (R. Danhof)
- 4375 University Press. Mailing Lists. Recording, storage, and recovery of assorted mailing lists to be used in promotion of university press books. (C. Schuetz)

4380 Physical Education for Men. Historical, Philosophical, and Administrative Theory of Physical Education and Sport. Studies will be carried out relative to the historical, philosophical, and comparative aspects of physical education and sport. A further aspect of this work treats administrative theory and practice as related to PE and sport. (E. Zeigler)

4382 Educational Psychology. School Readiness Test Comparison. Pretest-posttest design. Comparison of an experimental and a control group. (M. Atteberry)

4383 Survey Research Laboratory. Cleaning on Study 430. Cleaning checking on the consumer panel (wave 4). (N. Morrison)

4384 Survey Research Laboratory. Tabulations on Study 430. Analysis on the consumer panel (wave 4). (N. Morrison)

4388 T Computer Science. Automatic PDE Solvers. An investigation of the use of stiff integration techniques for initial value problems in partial differential equations. (L. Larsen)

4393 T Theoretical and Applied Mechanics. Fatigue Cycle Counting. Calculations for thesis research on fatigue of metals. (N. Dowling)

4400 T Computer Science. Machine Architecture Study. A study into architectural characteristics of machines and their impact on computational efficiency. (D. Lawrie)

4401 T Computer Science. Compiler for Parallel Machine. Design of a compiler for a parallel machine. (Y. Muraoka)

4402 Computer Science. Exploration of Integration Schemes. Exploration of integration schemes for transistor switching circuits. To explore possibilities of using methods in CS 393 for pedagogical reasons. (D. Hyde)

4404 Psychology. Mediating Processes. Project consists of experimental studies of role of mediating processes (comprehension, counterarguing) in changing attitudes. (A. Eagly)

4407 Aviation. Time Compression Study Performance. Statistical analysis of data on operator signal detection performance using various types of time compressed radar displays. (L. Scanlan)

4414 T Accountancy. Managerial-Attitudes. To analyze the empirical research data to determine the relationship between managerial thinking and organizational factors of the company. (S. Liao)

4415 Physical Education for Men. Measurement of Body Composition. Measurement of body composition. Opinionnaire of physical education's purposes. (L. Huelster)

4420 Provost's Office. CLEP General Exams--Juniors. A comparison of transfer and native students on results of CLEP general examinations. (D. Wermers)

4426 Civil Engineering. Flow Measurement in Sewers. The objective is to develop the optimum geometry for a pipe constriction which can be used to measure both full and part full pipe flow. (H. Wenzel)

4430 Psychology. Multiple Cue Learning In Children. A developmental study of children's ability to use multiple sources of information in making judgments. (D. Montanelli)

4431 T Psychology. Associative Net. Investigation of additional parameters as a means of clarifying some of the conflicting results in studies of the effects of prior attitude on learning of propagandistic material. (D. Weldon)

4438 Finance. Financing Small Firms In Britain. This project involves the compilation and organization of balance sheet, income statement, and other financial data for more than 1,000 small firms financed by the Industrial and Commercial Finance Corporation in Britain. (R. Osborn)

4440 Business Administration. International Airlines. Investigating costs, revenue, and relationships in international airlines. (A. Ilan)

4446 T Psychology. PORNO Study. Ph.D. dissertation. Correlation of 65 variables; analysis of variance (Balanova) on 11 dependent variables (4-way), OR ANOVA on 7 variables and comparable test(s) on final 4 variables (deviation from ANOVA format due to incomplete data for some subjects). (C. Colson)

- 4447 Sociology. Radicalism in the Slum. Completion of analysis of data on the prediction of lower-class leftist extremism collected in slums of Santiago, Chile, during 1968-1969. (A. Portes)
- 4448 Mathematics. Difference Method. Numerical treatments of Dirichlet problem and Navier-Stocks equation by difference method. (H. Mizumoto)
- 4452 Library Science. Illinois School Library Media Survey. Survey to identify and describe the existing media programs in school libraries throughout Illinois. (L. Wert)
- 4458 Business Administration. Markov Systems. Study of algorithms for finding the best from a class of Markov systems. (R. Evans)
- 4460 T Aeronautical and Astronautical Engineering. Eff. Prop. Fracture Gen. Composite. Numerical integration of multifold integrals whose integrands involve the numerical solution to sets of 3 simultaneous partial differential eq. via the method of weighted residuals. (J. Majerus)
- 4462 T Education. Special Education Intern. Step-wise multiple regression on factors relevant to release from a zone center. (H. Altstein)
- 4464 Political Science. Evaluation of CBE in Government. Evaluation of achievement. Attitude change, and concept development among freshmen and sophomore students in experimental political science introductory course. (F. Coombs)

4468 Economics. Cost of Funds to Firms. This project will employ Monte Carlo techniques to determine prices of securities and resulting cost of funds to firms based on various demand functions for securities by individuals and probability density of return to the firm. (R. Resek)

4469 Education. Relation of Maturation to Perform. Analysis of data gathered by Fuzak exploring the role of maturation in determining the ability of junior high school boys to perform complex finger coordinative activities. (L. Clendenhing)

4470 Psychology. Concept Identification on Models. Iterative search for parameter estimate of concept identification models, evaluation of goodness of fit and tests of various restrictions on the parameters. (H. Halff)

4474 Aviation. Simulation-Adaptive Training. A stochastic simulation of an adaptive training model. (J. Gandelman)

4479 T Education. Effects of IPI on School Children. Multivariant analysis to compare self concept of children in IPI with children in traditional classes. (K. Myers)

4480 T Educational Psychology. Medical Student Attitudes. Quantification and qualification of medical student attitudes following exposure to specified course in community medicine. (R. Nelson)

4481 T Aeronautical and Astronautical Engineering. Composite Material Study. Finite element solution in double precision of composite material problems. (E. Wogulis)

11. GENERAL DEPARTMENT INFORMATION

11.1 Personnel

The number of people associated with the Department in various capacities is given in the following table:

	<u>Full-time</u>	<u>Part-time</u>	<u>Full-time Equivalent</u>
Faculty	21	3	22.25
Visiting Faculty	5	0	5.00
Research Associates	0	0	----
Graduate Research Assistants	2	60	32.34
Graduate Teaching Assistants	0	30	14.46
Professional Personnel	22	1	22.75
Administrative and Clerical	29	0	29.00
Nonacademic Personnel (Monthly)	52	0	52.00
Nonacademic Personnel (Hourly)	<u>1</u>	<u>74</u>	<u>17.22</u>
	132	168	195.02*

* This report does not include personnel employed on the ILLIAC IV Project.

The Department Advisory Committee consists of Professor J. N. Snyder, Head of the Department; Professors E. K. Bowdon, D. F. Cudia, K. W. Dickman, H. G. Friedman, C. W. Gear, D. B. Gillies, D. J. Kuck, B. H. McCormick, S. Muroga, T. A. Murrell, J. Nievergelt, J. R. Phillips, W. J. Poppelbaum, S. R. Ray, E. M. Reingold, J. E. Robertson, P. E. Saylor, D. L. Slotnick, and D. S. Watanabe.

11.2 Bibliography

During the third quarter, the following publications were issued by the Laboratory:

File Numbers

- (1) Harms, R. P., "Iterative Array Driver Noise," File No. 844, September 3, 1970
- (2) Stevens, James E. Jr. "A Fast Fourier Transform Subroutine For Illiac IV," File No. 851, July 28, 1970

Report Numbers

- (1) "ILLIAC IV Quarterly Progress Report - April, May, and June 1970," Report No. 408, July 15, 1970

Theses

- (1) Becker, Harold Richard, "Numerical Studies of the Stone Algorithm and Comparisons with Alternating Direction Implicit Methods," (M.S.), Report No. 407, July 1970
- (2) Coombes, Daniel, "SABUMA - SAfe Bundle Machine," (M.S.), Report No. 412, August, 1970
- (3) Levin, Harold, "Local Information Retrieval for the Simulation and Modeling System," (M.S.), Report No. 409, August 1970
- (4) Lin, Chinlon, "Design Factors for a Transition Temperature Pockels Tube," (M.S.), Report No. 413, August, 1970
- (5) Olsen, David Lyman, "Remote Power Supply for the Ape System," (M.S.), Report No. 410, August, 1970

11.3 Colloquia

"The Associative Processor - A New Computer Resource," by Mr. J. A. Rudolph, Goodyear Aerospace Corporation, Akron, Ohio, September 21, 1970.

"Analysis of Digital Fault Behavior," by Professor James W. Gault, Department of Electrical Engineering, North Carolina State University, Raleigh, North Carolina, September 28, 1970.

11.4 Drafting

During the third quarter, a total of 795 drawings were processed by both drafting sections:

	<u>General</u>	<u>Pattern Recognition</u>
Large Drawings	6	127
Medium Drawings	50	53
Small Drawings	207	30
Layouts	5	35
Report Drawings	17	7
Changes	14	93
Miscellaneous	9	142
	<u>308</u>	<u>487</u>

(M. Goebel and S. Zundo)

11.5 Shops' Production

Job orders processed and completed during the third quarter of 1970 are as follows:

	<u>AEC 1018</u>	<u>AEC 1469</u>	<u>Other</u>
Machine Shop	4	12	5
Electronics Shop		58	
Chemical Shop		51	8
Layout Shop		39	5

(F. P. Serio)