PRELIMINARY 6180 HARDWARE PERFORMANCE MEASUREMENTS

by D. K. Gifford

I. Introduction

From software measurements made last Spring it was clear
that the Honeywell 6180 was not performing as expected. Professor
Saltzer's measurements reported in Request for Comments Number 19
indicated that 6180 hardware performance was degraded from first
estimates.

To provide more insight into the performance of the 6180 I
conducted hardware measurements on the MIT Information Processing
Center's Multics System during November 1973. Test points of
interest were identified in advance by Honeywell and MAC personnel,
and sampled while operating under normal service conditions.

A six digit counter was used to gather the data. For the
measurements that involved taking ratios of two things (eg indirect
cycles to instructions) the higher frequency test point was used
as an external clock in a digital frequency meter. In this manner
ratio measurements were relatively easy to make.

II. Analysis of Results

Careful analysis of the results reported here are to the subject
of a later report. I would appreciate comments on the possible
significance that could be attached to these measurements.

III. Analysis of Error

As all of these measurements were done under uncontrolled
conditions, the results must be suspect. Memory interference
and atypical instruction mixes could prejudice the results reported
to a significant extent.

Identifying test points proved to be extremely difficult in
some cases. For example, the 6180 does not have one point that
goes high on every instruction execution; such a point is not
necessary to make the processor functional. Thus, approximations
were made, and in some cases, the hardware was modified to provide
closer estimates.

IV. Further Work

Comparisons of a 6180 running in 6080 mode vs. a 6080 under controlled conditions should be extremely interesting. Measurements of this kind are planned, along with more extensive measurements of the 6180 to pin point difficulties. Suggestions for interesting points to examine are welcome.

V. Configuration Notes

All tests were made using the non bootload highest port priority processor in a dual processor, 3 SCU, 384K, 2MW bulk store system running Multics version 21-2 unless otherwise noted. SCU C is the high order SCU containing pagable core. SCU A contains the perm wired segments. The bulk store has a higher port priority that either processor. Under system 21-2 the idle process consisted of a DIS instruction.

The GCOS measurements were made on the non bootload highest port priority processor in a dual 6080 256K system at the Ford Motor Company, in Dearborn, Michigan.

The GCOS system was running with two fully interlaced SCU's while the MIT system does not run with port interlace.

VI. Acknowledgements

John Zona of Honeywell provided invaluable assistance in locating the test points and making the measurements. The MIT Information Processing Center was very cooperative throughout the tests. Helpful discussions were provided by Dr. David Clark, Professors J. Saltzer and M. Schroeder, and Steve Webber of Honeywell.

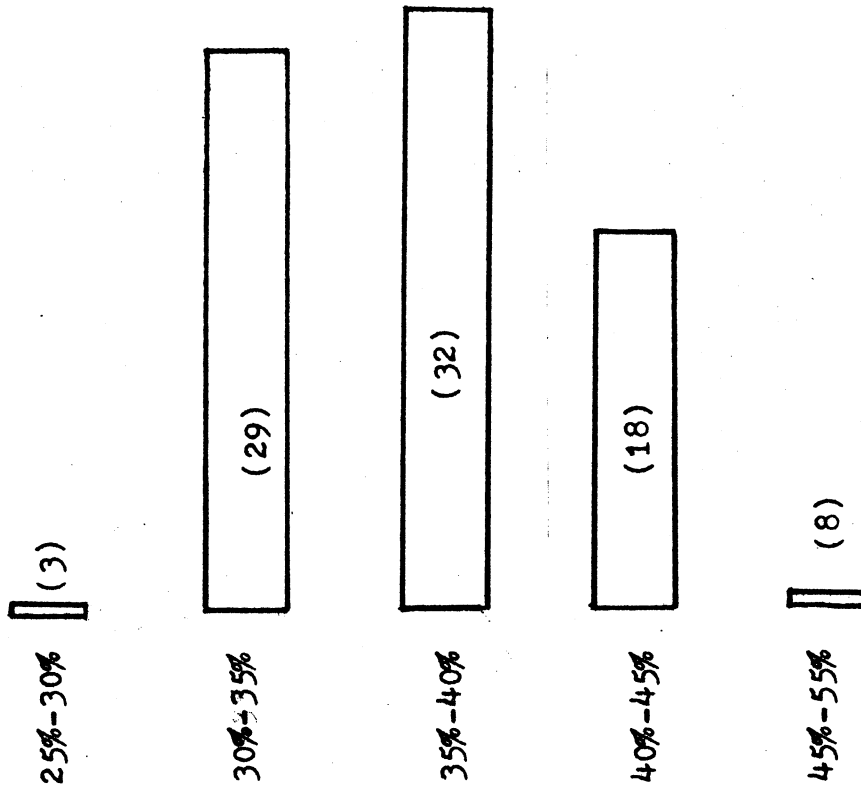November 6, 1973   15:38   30 Load Units

Measurement: store instructions / instructions

Intent: Measure percentage of instructions that modify a
        storage location

Mean: 37.6%

Test Points: Store instructions: PM-6R03
             Instructions: CV-2B09

( ) indicates number of samples observed.   Each sample was
    averaged over 10^6 instructions.
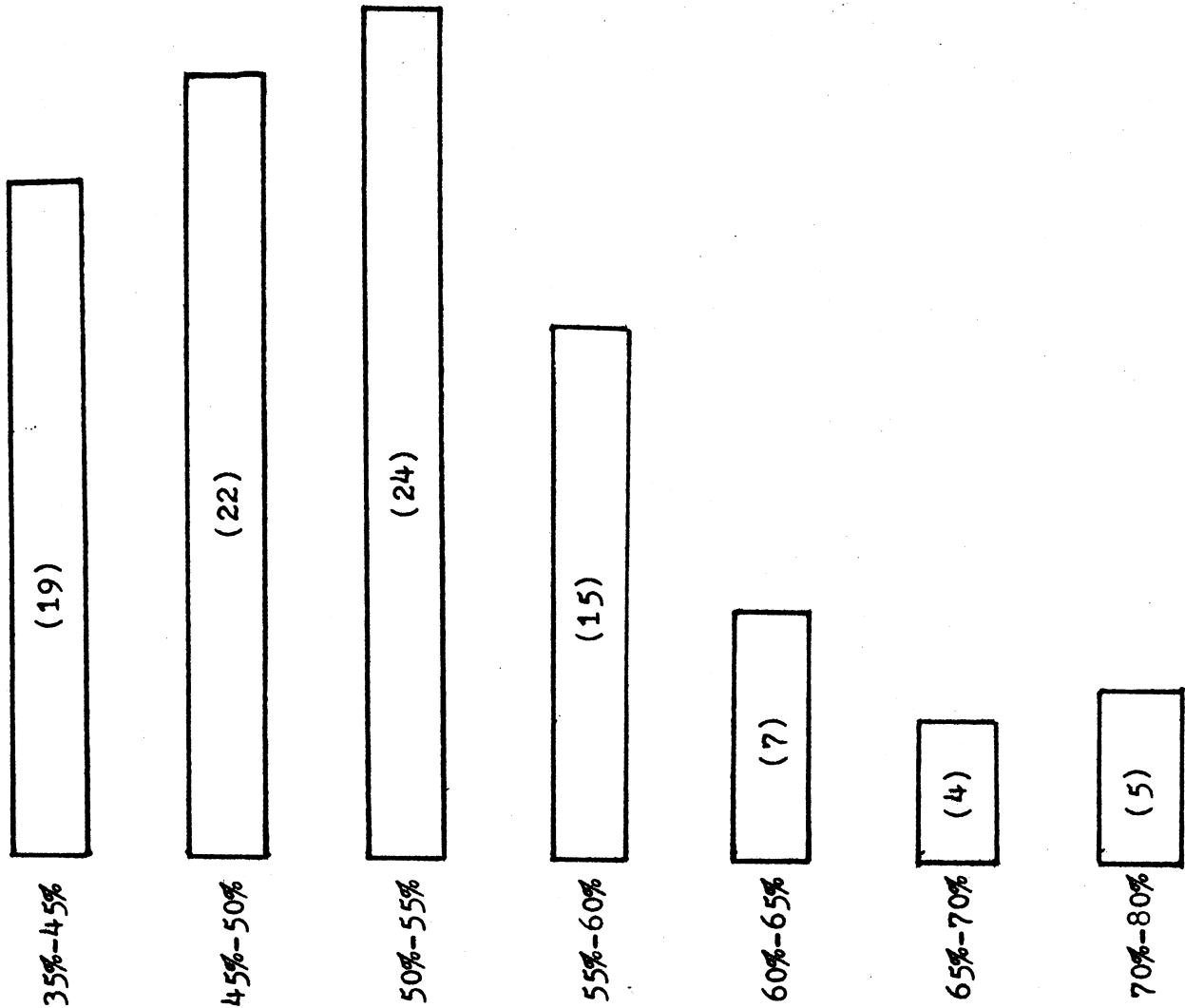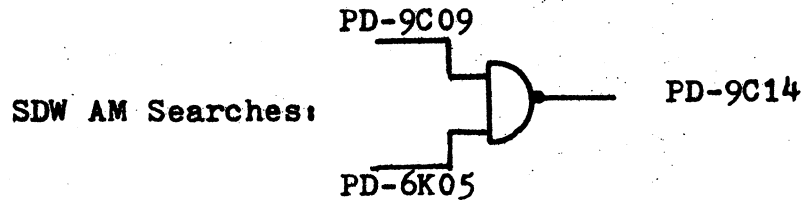
November 20, 1973   16:04-16:12   65 Load Units

Measurement: PTW AM Searches / SDW AM Searches

Intent: Measure percentage of time Multics runs in paged memory

Mean: 52.5%

Test Points: PTW AM Searches: PD-3L12

PD-9C09

SDW AM Searches: PD-9C14

PD-6K05

(19)	(22)	(24)	(15)	(7)	(4)	(5)
35%-45%	45%-50%	50%-55%	55%-60%	60%-65%	65%-70%	70%-80%

SPG "user time" aprox 47%
( ) Number of samples observed at indicated range. Each sample
    was averaged over 10^6 SDW AM searches.

November 8, 1973   13:15-13:20   45 Load Units
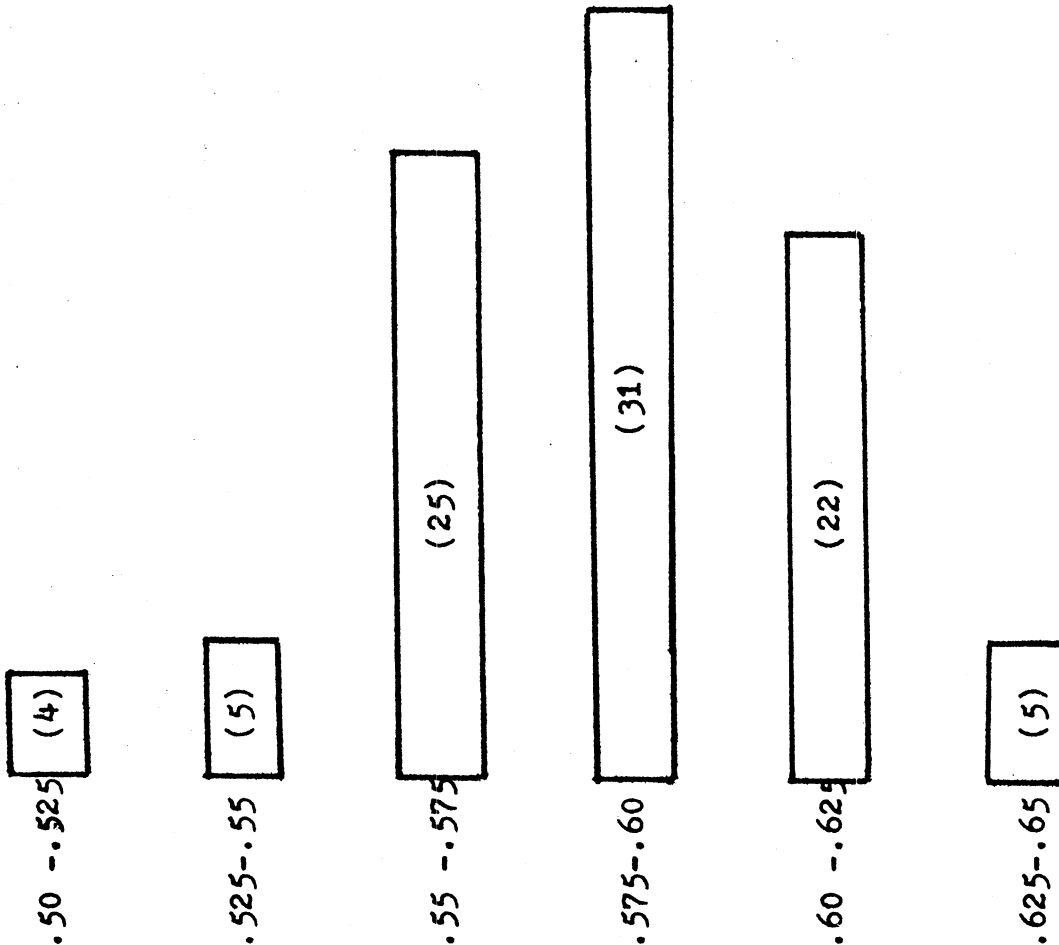
Measurement: Instructions executed / one second

Intent: Find speed of 6180 processor

Mean: .582 Million Instructions per Second (MIPS) $\sim$ 1.7 μsec/instr.

Test Point: Instructions: CV-2B09

Note: DIS time was not factored out. SPG indicated that the processor
      was in DIS about one percent of the time.

( ) indicates number of samples observed within indicated range.
    Each sample was for one second.

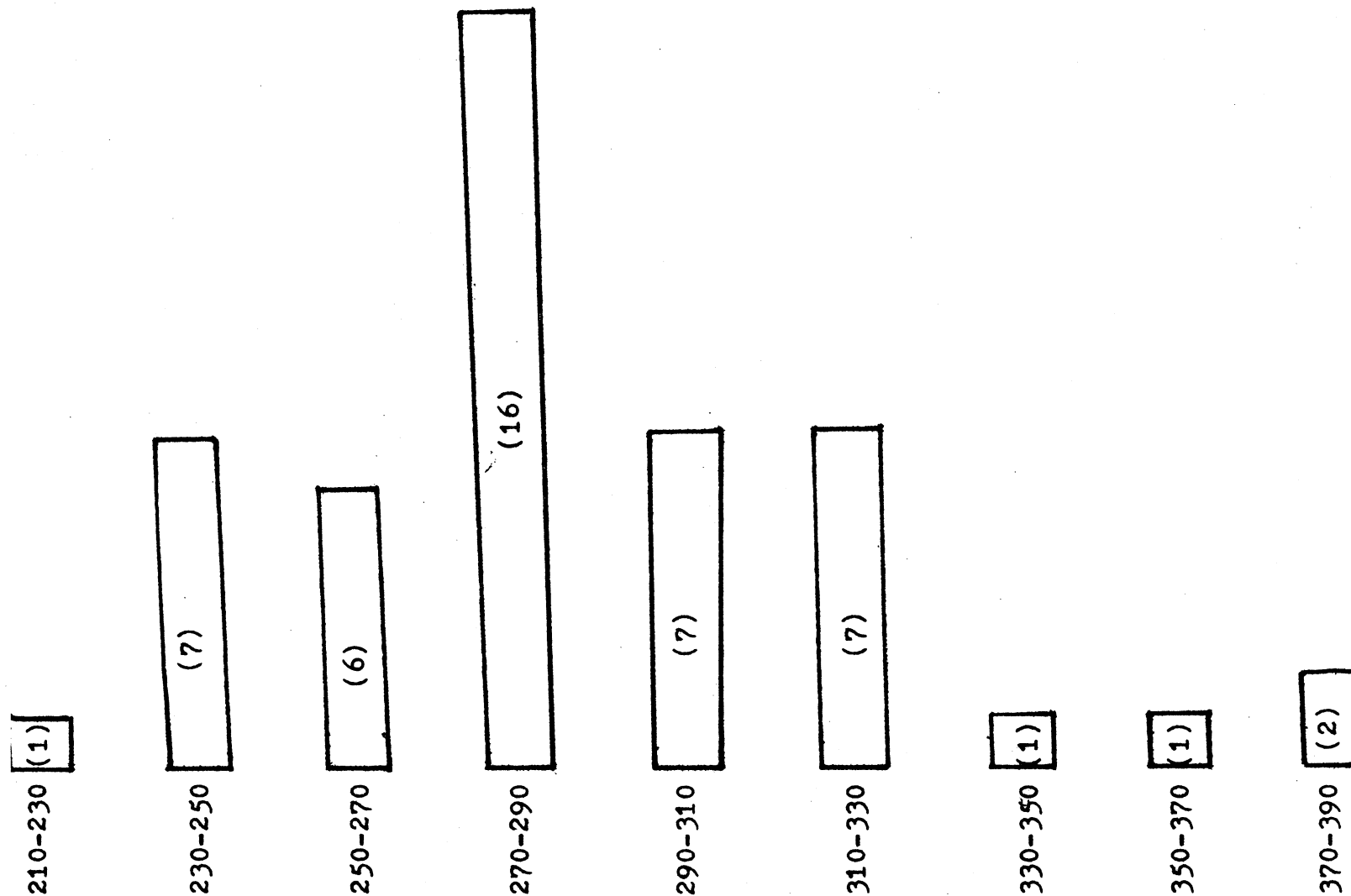November 6, 1973   14:09-14:30   50 Load Units

Measurement: RTCD Instructions / Instructions

Intent: Approximate the average number of instructions executed
        per procedure call

Mean: 281 instructions / RTCD instruction

Test Points: RTCD Instructions: PX-OHO5
             Instructions: CV-2B09

Note: PX-OHO5 is a very shaky test point

Instructions / RTCD Instruction

( ) Number of samples observed within indicated range.
    Each sample averaged over 10^7 instructions.

November 27, 1973   9:30-9:35   63 Users

Measurement: Instructions / one second

Intent: Measure speed of 6080 running GCOS and compare it with
         a 6180 running Multics → *conclusion* ?

Mean: .929 Million Instructions per Second (MIPS)   `

Test Point: Instructions: CV-2B09

Note: DIS time was not factored out. Meters in GCOS indicated the
      processor was in DIS about five percent of the time.

Sample Size: 96   Sample Averaged Over: 1 second

November 6, 1973   11:23   50 Load Units   *Test Nov. 8 ?*

Measurement: Instructions / one second

Intent: Find speed of 6180 processor

Mean: .554 Million Instructions per Second (MIPS)   `· *582*

Test Point: Instructions: GV-2B09

Note: DIS time was not factored out. SPG indicated that the processor
      was in DIS about five percent of the time..

Sample size: 96   Sample Averaged over: 1 second

November 20, 1973   15:50-16:00   60 Load Units

Measurement: SDW AM "found" / SDW AM Searches

Intent: Find effectiveness of 6180 SDW AM

Mean: 98.95% hit

Test Point: SDW AM "found": PD-4G12
            SDW AM searches: PD-9C14 (see page 4)

Sample Size: 96   Sample Averaged Over: 10^6 SDW AM searches

November 8, 1973   13:41-13:54   49 Load Units

Measurement: PTW AM "found" / PTW AM Searches

Intent: Find effectiveness of 6180 PTW AM

Mean: 98.67% hit

Test Points: PTW AM "found" : PD-4H12
             PTW AM Searches: PD-3L12

Sample Size: 96   Each Sample Averaged over: 10^6 PTW AM Searches

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November 8, 1973   15:14   62 Load Units

Measurement: Memory cycles SCU C / Memory cycles SCU A

Intent: Approximate effect of interlacing memories 2

Mean: .401

Test Points: Memory cycles SCU C: TP-19 SCU C
             Memory cycles SCU A: TP-19 SCU A

Sample Size: 48   Each Sample Averaged over: 10^6 SCU A Mem Cycles

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November 8, 1973   14:42-14:47   59 Load Units

Measurement: Bulk store memory cycles SCU C / CPU B Memory
             cycles SCU C

Intent: See how much of a load the bulk store places on
        an SCU in terms of a processor

Mean: .28

Test Points: Bulk store memory cycles SCU C: SCU C TP-12
             CPU B memory cycles SCU C: SCU C TP-16

Sample Size: 24   Each Sample Averaged over: 10^6 SCU B Mem Cycles

November 8, 1973   14:52-14:56   61 Load Units

Measurement: Bulk store memory cycles SCU C / SCU C Memory
             cycles

Intent: Find the load the bulk store places on SCU C

Mean: .22

Test Points: Bulk store memory cycles SCU C: SCU C TP-12
             SCU C Memory cycles   : SCU C TP-19

Sample Size: 24   Sample Averaged Over: 10^6 SCU C Mem Cycles

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November 8, 1973   15:00-   60 Load Units

Measurement: IOM memory cycles SCU C / SCU C memory cycles

Intent: Find the load the IOM presents to SCU C

Mean: .034

Test Points: IOM memory cycles SCU C: SCU C TP-10
             SCU C memory cycles   : SCU C TP-19

Sample Size: 24   Sample Averaged Over: 10^6 SCU C Mem Cycles

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November 8, 1973   15:07   62 Load Units

Measurement: SCU C memory cycles / one second   Sample Size: 48

Intent: Find absolute loading of SCU C

Mean: .273 Million Memory Cycles per Second (MMCPS)   *mem. cycles/instruction*
Test Point: SCU C Memory cycles: TP-19 SCU C   Sample Av. Over: 1 sec

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November 8, 1973   13:30   40 Load Units

Measurement: ITS indirects / indirects

Intent: Find percentage of indirects that are ITS indirects

Mean: .933

Test Points: ITS indirects: PX-WH16
             indirects   : PX-OL07
Sample Size: 48   Sample Averaged Over: 10^6 indirects

November 6, 1973   11:52   50 Load Units

Measurement: ITS indirects / instructions

Intent: Find frequency of ITS indirects on instructions

Mean: .102

Test Points: ITS indirects: PXXWH16
             instructions : CV-2B09

Sample Size: 96   Sample Averaged Over: 10^6 instructions

November 6, 1973   11:30   51 Load Units

Measurement: indirects / instructions

Intent: Find frequency of indirects on instructions

Mean: .112

Test Points: indirects: PX-OL07
             instructions: CV-2B09

Sample Size: 96   Sample Averaged Over: 10^6 instructions