85700 JOB MANAGEMENT WORKING SET
(AUTOMATIC JOB SUSPENSION)
B5700 Job Management Working Set

(Automatic Job Suspension)

Introduction

One advantage of a multiprocessing environment is that it permits several jobs to be run simultaneously in a period of time which is less than the total time required to run the jobs serially (one job at a time, in sequence). However, if a number of jobs are running simultaneously, there is a good chance that the total system performance has been greatly degraded. This is because the operating system is spending so much time managing memory (i.e., continuously overlaying code and data segments to obtain sufficient core memory for each job).

The job management working set (automatic job suspension) has been implemented to eliminate the degradation of system performance and to assure that the amount of time required to run the jobs simultaneously is not longer than the time required to run them serially.

When the operating system is spending so much time trying to manage memory demands that the total system performance is degraded, the system is said to be "thrashing." The B5700 working set is designed to detect "thrashing" and to temporarily suspend one or more of the jobs in the mix when it occurs. This permits the remaining jobs to be run to completion in a non-thrashing environment, greatly reducing the total time required to run all of the jobs, including those which are temporarily suspended.

The primary cause of thrashing is insufficient core memory for the jobs in the mix. This happens because of 1) poor core estimates for a given job; 2) inappropriate use of the "Xs" key (or 3) setting the core factor too high.

The Workset routine is primarily based on the detection of thrashing by a comparison of the overlay overhead time and the actual processor time. Therefore, when "Workset" is compiled into the MCP, the option "Newlogging" should also be compiled in. If the Newlogging option is not compiled in, erratic results may occur.
THREE NEW PROCEDURES: PROCEDURE WORKSET AND PROCEDURE WORKSETREQUESTS.

HAVE BEEN INCORPORATED IN ORDER TO IMPLEMENT THE 65700 MANAGEMENT WORKING SET. ALSO, A NEW OPTION, WORKSET MONITOR HAS BEEN ADDED.

PROCEDURE WORKSET IS RESPONSIBLE FOR DETERMINING 1) WHEN A JOB SHOULD BE SUSPENDED, AND 2) WHICH JOB SHOULD BE SUSPENDED. PROCEDURE WORKSETREQUESTS IS CALLED TO HANDLE ALL KEYBOARD INPUT REQUESTS PERTAINING TO THE MANAGEMENT WORKING SET. THE WORKSET MONITOR COMPILATION TIME OPTION MONITORS THE WORKSET PARAMETER VALUES (DISCUSSED LATER).

PROCEDURE WORKSET

WHEN A DATA OR CODE SEGMENT IS OVERLAPPED, A SMALL AMOUNT OF OVERHEAD IS INCURRED BY THE JOB. THIS OVERHEAD IS PERIODICALLY COMPARED, BY

PROCEDURE WORKSET, TO THE ACTUAL AMOUNT OF PROCESSING TIME FOR ALL JOBS IN THE MIX. WHEN THE AMOUNT OF OVERHEAD EXCEEDS "MAXIMUM" (DISCUSSED LATER), ONE OR MORE OF THE JOBS IN THE MIX WILL BE SUSPENDED TO REDUCE THE OVERHEAD FOR THE REMAINING JOBS. A JOB WILL NOT BE SUSPENDED WITHIN 5 SECONDS AFTER AN EMERGENCY RE-START. ALSO, "LOCATE/DISK", "MAIN/DISK", AND "PRINTER/DISK" ARE NEVER SUSPENDED BY PROCEDURE WORKSET. NEITHER ARE THEY COUNTED INTO THE NUMBER OF JOBS IN THE MIX. IF ONLY ONE JOB IS RUNNING WHEN THE THRESHOLD POINT IS REACHED, IT WILL NOT BE SUSPENDED (NOTICE: REMEMBER THAT THE SYSTEM JOB, "LIBMAIN" ETC., WILL NOT BE COUNTED AS JOBS).

WHEN PROCEDURE WORKSET SUSPENDS A JOB, OR MAKES THE OVERLAY OVERHEAD TIME IS 95% OF "MAXIMUM" PROCEDURE SELECTRUN WILL NOT ALLOW ANY ADDITIONAL JOBS TO ENTER THE MIX EXCEPT SYSTEM JOBS (E.G., LIBMAIN). THE "AS" KEYIN MAY BE USED TO FORCIBLY SEND A JOB INTO THE MIX.

WHEN PROCEDURE WORKSET SUSPENDS A JOB, THE MESSAGE:

```
#AUTO-STOP <FID> <INDEX> = <INDEX INDEX>
```

IS DISPLAYED AT THE SP. AN INDEX TO THE JOB IS PLACED IN A QUEUE FOR SUSPENDED JOBS. WHEN ANOTHER JOB GOES TO EMERGENCY THE FIRST JOB SUSPENDED IS RE-ENTERED INTO THE MIX AND THE MESSAGE:

```
#AUTO-OK <FID> <INDEX> = <INDEX INDEX>
```

IS DISPLAYED. A JOB MAY BE FORCED FROM THE QUEUE BY AN "OK" KEYIN. WHEN THIS OCCURS, THE AMOUNT OF OVERLAY OVERHEAD FOR THE JOB IS SET BACK TO 95% OF ITS FORMER VALUE SO THAT THE JOB WILL NOT BE IMMEDIATELY RESUSPENDED.

PROCEDURE WORKSETREQUESTS
PROCEDURE WORKSETREQUESTS HANDLES ALL KEYBOARD INPUT REQUESTS PERTAINING TO THE MANAGEMENT WORKSET. THE BASIC FORM OF THE WORKSET KEYIN IS "WK", WHEN "WK" IS KEYED-IN, THE VALUE ASSOCIATED WITH THE WORKSET PARAMETERS ARE PRINTED AS WELL AS ALL OF THE WORKSET OPTIONS WHICH ARE SET. THE RESPONSE TO THE "WK" KEYIN IS IN THE FOLLOWING FORMAT:

WK SET CYCLE=<N>, ULAY=<N>, TOL=<N>, OPTIONS: <O> <O> ...<O>

WHEN AN INCORRECT "WK" KEYIN IS ENTERED, AN ERROR MESSAGE WILL BE PRINTED AT THE SPU AS FOR ALL INCORRECT KEYIN REQUESTS. HOWEVER, IN THE CASE OF THE "WK" KEYIN, A PORTION OF THE REQUEST MAY BE EXECUTED PRIOR TO FINDING THE ERROR. FOR EXAMPLE:

WK CYCLE=25, ULAY=13, TIL=14
("TIL" SHOULD BE "TOL")

WOULD BE RECOGNIZED AS A VALID REQUEST EXCEPT FOR THE "TIL". THE SYSTEM WILL RESPOND:

WK: ERROR: TIL=14 CYCLE=25, ULAY=13

WHICH INDICATES THAT THE REQUEST WAS ABORTED WHEN "TIL" WAS ENCOUNTERED AND ALL PORTIONS PRECEDING THE "TIL" WERE ACCEPTED.

WORKSETMONITOR
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THE WORKSETMONITOR MONITORS THE WORKSET PARAMETER VALUES. THE MONITOR MAY BE SET OR RESET BY THE FOLLOWING (WHEN WORKSETMONITOR IS COMPILED INTO THE MPU):

WK MONITOR = 1

OR

WK MONITOR = 0

A VALUE OF 1 SETS THE MONITOR AND A VALUE OF 0 RESETS IT. WHEN THE MONITOR IS SET, EACH TIME PROCEDURE WORKSET SUSPENDS A JOB, THE VALUES FOR THE WORKSET OPTIONS ARE PRINTED AT THE SPU FOR EACH JOB IN THE MIX. ALSO, EACH TIME A JOB GOES TO EOJ, THE AMOUNT OF PROCESSOR, I/O, AND ELAPSED TIME IS PRINTED AT THE SPU. THIS INFORMATION IS HELPFUL WHEN CHOOSING PARAMETERS.
SUSPENSION OF ONE OR MORE OF THE JOBS IN THE MIX IS A RELATIVELY

STRAIGHT FORWARD PROBLEM FOR IMPASING. HOWEVER, THE FACTORS REGARDING
WHEN TO SUSPEND A JOB AND WHICH JOB TO SUSPEND CAN BE COMPLEX AND MAY
CHANGE DRAMATICALLY DEPENDING ON THE NATURE OF THE JOBS IN THE MIX.

THEREFORE, WORKING SET HAS BEEN MADE AS FLEXIBLE AS POSSIBLE, SO THAT IT
MAY BE TUNED TO THE NEEDS OF THE SYSTEM UTILIZING IT. THIS FLEXIBILITY
IS PROVIDED BY SPECIAL WORKSET OPTIONS AND WORKSET PARAMETERS.

WORKSET OPTIONS

PROCEDURE WORKSET USES 5 OPTIONS TO DECIDE WHICH JOB SHOULD BE
SUSPENDED. THESE OPTIONS ARE:

1) OLAY RATE (THE OVERLAY OVERHEAD TIME EXPRESSED AS A PERCENTAGE
OF THE PROCESS TIME), DEFINED AS

\[
\text{\% of \text{Actual Processor Time}} \times 100
\]

2) PRIORITY (THE SYSTEM PRIORITY ASSOCIATED WITH THE JOB)

3) TIME (THE ELAPSED TIME FOR THE JOB)

4) CORE (THE AMOUNT OF OVERLAYABLE CORE USED BY THE JOB)

5) SAVECORE (THE AMOUNT OF NON-OVERLAYABLE CORE FOR THE JOB)

THE WORKSET OPTIONS MAY BE SET FROM THE SCOPE BY USE OF THE "WK" KEY
THE FORMAT IS:

\[
\text{WK USE } \text{<D>_<D>_<D>_<D>_<D>_<D>}
\]

FOR EXAMPLE:

WK USE 000000

THE EXAMPLE WILL SET THE WORKSET OPTIONS TO OVEARLAY OVERHEAD TIME,
ELAPSED TIME, AND OVERLAYABLE CORE IN THAT ORDER, AND THE SYSTEM
WILL RESPOND WITH:

WKSET OPTIONS: OLY TIME CORE

PROCEDURE WORKSET REQUESTS LOOKS ONLY AT THE FIRST 3 LETTERS OF THE
OPTION NAME. THEREFORE, EACH OPTION MAY BE AbbREVIATED TO 3 LETTERs.

TO INQUIRE AS TO WHICH OPTIONS ARE SET, THE INPUT:
WK OPTIONS

MAY BE ENTERED. THE SYSTEM WILL RESPOND WITH:

WKSET OPTIONS: <0> <0> <0> <0>

EXAMPLE

WK USE OILAY TIME CORE

WHEN THE ABOVE KEYS HAVE BEEN ENTERED AND THE SYSTEM IS THRASHING,
PROCEDURE WKSET WILL SELECT A CANDIDATE FOR SUSPENSION BASED ON
THE OVERLAY OVERHEAD TIME, THE ELAPSED TIME, AND THE AMOUNT OF
OVERLAYABLE CORE, IN THAT ORDER.

PROCEDURE WKSET WILL EXAMINE ALL JOBS IN THE MIX TO DETERMINE
WHICH JOB HAS THE MAXIMUM OVERLAY TIME, THEN ALL JOBS WHICH HAVE
AN OVERLAY TIME WHICH IS WITHIN A FIXED PERCENTAGE OF THE MAXIMUM
OVERLAY TIME ARE RETAINED FOR FURTHER EXAMINATION. (THE PERCENTAGE
IS SPECIFIED BY "TOLERANCE" WHICH IS DISCUSSED WITH THE PARAMETERS.)
THE REMAINING JOBS IN THE MIX ARE ELIMINATED FROM FURTHER
CONSIDERATION.

NEXT, PROCEDURE WKSET EXAMINES THE RETAINED JOBS TO DETERMINE
WHICH JOB HAS BEEN RUNNING FOR THE SHORTEST PERIOD OF TIME. THEN
ALL JOBS WHICH HAVE AN ELAPSED TIME WHICH IS WITHIN A FIXED
PERCENTAGE OF THE MINIMUM ELAPSED TIME ARE RETAINED FOR FURTHER
EXAMINATION. (THE PERCENTAGE IS SPECIFIED BY "TOLERANCE" WHICH IS
DISCUSSED WITH THE PARAMETERS.) THE REMAINING JOBS IN THE MIX ARE
ELIMINATED FROM FURTHER CONSIDERATION.

FINALLY, PROCEDURE WKSET EXAMINES THE RETAINED JOBS TO DETERMINE
WHICH JOB IS USING THE MOST OVERLAYABLE CORE. THE JOB USING THE
MOST CORE (SINCE THIS IS THE LAST OPTION) IS SELECTED FOR SUSPENSION.

WKSET PARAMETERS

PROCEDURE WKSET HAS THREE PARAMETERS WHICH IT USES FOR EVALUATING
THE OPTIONS. THESE PARAMETERS ARE:

1. CYCLE (INTERVAL IN SECONDS AT WHICH WKSET SHOULD RUN)
2) **OILMAX** (TOTAL OVERLAY OVERHEAD PERMITTED, EXPRESSED AS A PERCENT)

\[
\text{PERCENT} = \left( \frac{\text{TOTAL AMOUNT OF OVERHEAD TIME FOR OVERLAY}}{\text{TOTAL AMOUNT OF ACTUAL PROCESSOR TIME USED}} \right) \times 100
\]

3) **TOLERANCE** (VARIANCE PERMITTED FROM MAXIMUM OR MINIMUM VALUE, EXPRESSED AS A PERCENT)

VALUES MAY BE ASSIGNED TO THESE PARAMETERS BY A "WK" KEYIN FROM THE SPDS. THE FORMAT OF THE MESSAGE IS:

\[
\text{WK} <\text{PARAMETER}> = <\text{NN}>
\]

PROCEDURE WORKSET LOOKS AT ONLY THE FIRST THREE LETTERS OF THE PARAMETER NAME. THEREFORE, EACH PARAMETER MAY BE ABBREVIATED TO THREE LETTERS.

THE VALUES CURRENTLY ASSIGNED TO THE PARAMETERS MAY BE INTERROGATED BY A:

\[
\text{WK} <\text{PARAMETER}>
\]

MESSAGE: THE SYSTEM WILL RESPOND WITH:

\[
\text{WKSET} <\text{PARAMETER}>=<\text{NN}>, <\text{PARAMETER}>=<\text{NN}>, \ldots, <\text{PARAMETER}>=<\text{NN}>
\]

ASSIGNMENT AND INQUIRY REQUESTS MAY BE INTERMIXED IN THE SAME "WK" KEYIN. FOR EXAMPLE:

\[
\text{WK CYCLE}=30, \text{OILMAX}=15, \text{TOLERANCE}=15
\]

WOULD BE INTERPRETED AS: 1) SET CYCLE TO 30 SECONDS; 2) PRINT OUT THE CURRENT VALUE OF OILMAX AND 3) SET TOLERANCE TO 15 PERCENT. THE SYSTEM WILL RESPOND WITH:

\[
\text{WKSET CYCLE}=30, \text{OILMAX}=<\text{NN}>, \text{TOLERANCE}=15
\]

WORKSET OPTIONS AND WORKSET PARAMETERS MAY BE INTERMIXED IN THE SAME "WK" KEYIN. FOR EXAMPLE:

\[
\text{WK CYCLE}=15, \text{OIL}=50, \text{USE PRIOR}, \text{OIL}, \text{CORE}, \text{TOL}=20
\]

WOULD BE INTERPRETED AS: 1) SET CYCLE TO 15 SECONDS; 2) SET OILMAX TO 50; 3) SET WORKSET OPTIONS: PRIORITY, OIL, AND CORE; IN THAT ORDER; AND 4) SET TOLERANCE TO 20. THE SYSTEM WILL RESPOND WITH:

\[
\text{WKSET CYCLE}=15, \text{OIL}=50, \text{TOL}=20, \text{OPTIONS=} \text{PRIORITY}, \text{OIL}, \text{CORE}
\]
**CYCLE PARAMETER**

CYCLE IS THE INTERVAL OF TIME, IN SECONDS, AT WHICH PROCEDURE WORKSET SHOULD BE RUN. IF CYCLE = 30, PROCEDURE WORKSET WILL FIRE UP EVERY 30 SECONDS TO CHECK FOR THRESHOLD. PROCEDURE WORKSET WILL NOT FIRE UP IF CYCLE IS EQUAL TO A NEGATIVE VALUE OR ZERO.

**CLAYMAX PARAMETER**

CLAYMAX IS USED BY PROCEDURE WORKSET TO DETERMINE WHETHER OR NOT A JOB SHOULD BE SUSPENDED. CLAYMAX IS A PERCENTAGE WHICH IS THE MAXIMUM PERCENTAGE OF OVERLAY TIME PERMITTED.

EACH TIME PROCEDURE WORKSET CYCLES, IT CHECKS THE CLAYMAX PERCENTAGE AGAINST THE TOTAL OVERLAY PERCENTAGE INCURRED BY THE SYSTEM. THE TOTAL OVERLAY PERCENTAGE IS CALCULATED BY DIVIDING THE TOTAL PROCESSOR TIME USED BY THE SYSTEM INTO THE TOTAL OVERLAY OVERHEAD TIME INCURRED BY THE SYSTEM AND MULTIPLYING THE RESULT BY 100. IF THE TOTAL OVERLAY PERCENTAGE IS GREATER THAN CLAYMAX, A JOB WILL BE SUSPENDED BY THE PROCESS OUTLINED WITHIN THE OPTIONS SECTION. ALSO, IF THE CLAY RATE FOR ANY JOB IN THE MIX IS GREATER THAN 4 TIMES THE VALUE OF CLAYMAX, A JOB WILL BE SUSPENDED BY THE PROCESS OUTLINED IN THE OPTIONS SECTION.

**TOLERANCE PARAMETER**

TOLERANCE IS THE VARIANCE PERMITTED FROM THE MAXIMUM OR MINIMUM VALUE, EXPRESSED AS A PERCENT. IF TOLERANCE = 10, PROCEDURE WORKSET WILL LOOK FOR A CANDIDATE FOR SUSPENSION USING A 10% LEEWAY FROM THE OPTIONS. THIS MEANS, IF THE MAXIMUM OVERLAYABLE CORE (OPTION CORE) IS 12,000, THEN ALL JOBS HAVING AN AMOUNT OF OVERLAYABLE CORE WITHIN 10% OF 12,000 WORDS WILL BE RETAINED AS WELL AS THE ONE HAVING THE 12,000 WORDS. THE TOLERANCE LEVEL APPLIES TO ALL OF THE OPTION.

The following example further illustrates TOLERANCE:

**EXAMPLE**

To further illustrate the use of the tolerance value, assume that there are four jobs in the mix and the WORKSET options are CLAY, TIME, and CORE, in that order.

<table>
<thead>
<tr>
<th>MIX</th>
<th>CLAY RATE</th>
<th>ELAPSED TIME</th>
<th>OVERLAYABLE CORE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(PERCENT)</td>
<td>(SECONDS)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
PROCEDURE WORKSET WOULD FIRST SELECT <mix 3> SINCE IT HAS THE
HIGHEST OVERLAY TIME (88% OF ITS PHASE TIME). THEN, ALL JOBS
WHICH ARE WITHIN THE TOLERANCE (10%) ARE RETAINED. THE TOLERANCE IS
EQUAL TO 81 X 0.1 = 8.1%. THEREFORE, <mix 1> IS RETAINED AND <mix
2> AND <mix 4> ARE ELIMINATED.

NEXT, <mix 1> AND <mix 3> ARE EXAMINED FOR ELAPSED TIME, AND SINCE
THE ELAPSED TIME FOR <mix 1> IS 33% WHICH IS WITHIN THE TOLERANCE
LIMIT FOR THE ELAPSED TIME (23 X 0.1 = 2.3%), BOTH JOBS ARE RETAINED
FOR FURTHER EXAMINATION.

FINALLY, <mix 1> AND <mix 3> ARE EXAMINED TO DETERMINE WHICH JOB IS
USING THE MOST OVERLAPABLE CORE. PROCEDURE WORKSET WOULD THEN
SELECT <mix 1> AS THE JOB TO BE SUSPENDED.

THE WORKSET ROUTINE MAY BE INHIBITED BY SETTING CYCLE TO ZERO OR A
NEGATIVE VALUE, BUT THIS LOSES THE PREVIOUS VALUE OF CYCLE. THEREFORE,
NEW CONSTRUCTS, "WK ON" AND "WK OFF" HAVE BEEN ADDED TO THE WORKSET
ROUTINE.

A "WK ON" KEYPIN FORCED WORKSET TO EXAMINE ALL OF THE WORKSET
PARAMETERS AND OPTIONS. IF ANY OF THESE DO NOT CONTAIN A VALUE (FROM A
PREVIOUS "WK" KEYPIN), A DEFAULT VALUE IS ASSIGNED TO IT. THE DEFAULT
VALUES ARE:

CYCLE = 20 SECONDS
OILAYMAX = 40 PERCENT
TOLERANCE = 10 PERCENT
OPTIONS = PRIORITY, OILAY, CORE, TIME, SAVECORE

THE SYSTEM WILL RESPOND WITH:

WKSET CYCLE=20,OILAY=40,TOL=10,OPTIONS=PRIORITY,OILAY,CORE,TIME,SAVECORE

A "WK OFF" KEYPIN CONVERTS THE CYCLE TIME TO A NEGATIVE VALUE, WHICH
STOPS WORKSET. ALL OF THE PARAMETER AND OPTION VALUES ARE RETAINED.
THE SYSTEM WILL RESPOND WITH:

WKSET CYCLE=20,OILAY=40,TOL=10,OPTIONS=PRIORITY,OILAY,CORE,TIME,SAVECORE

WHEN THE NEXT "WK ON" IS ENTERED, THE CYCLE TIME WILL BE RECONVERTED
TO A POSITIVE VALUE (ITS FORMER VALUE) AND ALL OF THE PARAMETERS AND
OPTIONS WILL RETAIN THEIR FORMER VALUES.

THE "WK ON" AND "WK OFF" KEYS MAY BE INTERMIXED WITH "WK"
ASSIGNMENT AND INQUIRY KEYS, FOR EXAMPLE:

WK ON OLAY=20

WILL RESTORE ALL PREVIOUS WORKSET PARAMETERS AND OPTIONS TO THEIR
PREVIOUS (OR DEFAULT) VALUES EXCEPT FOR CLAYMAX WHICH IS ASSIGNED
THE VALUE OF 20.
SUGGESTIONS FOR OPTIMA SELECTION

THE "PRIORITY" ASSIGNED TO EACH JOB HAS HISTORICALLY BEEN USED TO DETERMINE WHICH JOBS SHOULD BE PLACED IN THE MIX FIRST, FOR SITES WHICH RUN USER JOBS WITH DIFFERENT PRIORITIES. THIS OPTION SHOULD PROBABLY BE THE FIRST ONE USED WHEN SELECTING A CANDIDATE FOR SUSPENSION.

THE REMAINING OPTIONS WILL HAVE TO BE SELECTED EMPIRICALLY BY THE SITE SETTING THEM. JOBS WHICH USE A GREAT DEAL OF NON-OVERLAYABLE CURE SHOULD NOT BE SUSPENDED SINCE THAT CURE WILL BE TIED UP ANYWAY (WHICH IS WHY THE WORKSET ROUTINE LOOKS FOR A MINIMUM VALUE OF NON-OVERLAYABLE CURE DURING ITS SELECTION). THEREFORE, IF THE MIX CONTAINS MANY JOBS WHICH USE A LARGE QUANTITY OF NON-OVERLAYABLE CURE, THE SAVETORE OPTION SHOULD BE PLACED NEAR THE FRONT OF THE WORKSET OPTIONS LIST.

THE CURE RATE WILL USUALLY BE RELATED TO THE AMOUNT OF OVERLAYABLE CURE USED BY A JOB, BUT NOT NECESSARILY SO. THEREFORE, THESE OPTIONS MAY HAVE TO BE JUGGLED TO FIND THE BEST COMPROMISE.

IT WOULD SEEM TO BE UNFAIR TO PLACE THE ELAPSED TIME AT THE END OF THE WORKSET OPTIONS LIST, SINCE ONE CAN VISUALIZE THAT A JOB WHICH HAS BEEN RUNNING FOR A RELATIVELY LONG TIME COULD BE BUMPED OUT BY A JOB WHICH HAS ONLY RECENTLY ENTERED THE MIX. HOWEVER, IT COULD WELL BE THAT THE MOST EFFICIENT WAY TO RUN BOTH JOBS IS TO DO JUST THAT.

SUGGESTIONS FOR PARAMETER SETTINGS

VALUE OF THE TOLERANCE CAN AFFECT THE SELECTION OF A JOB CONSIDERABLY. FOR EXAMPLE, IF ONE WISHES TO USE ALL OF THE WORKSET OPTIONS WITHOUT PLACING VERY MUCH WEIGHT ON ANY SINGLE ONE OF THEM, A RELATIVELY LARGE TOLERANCE VALUE SHOULD BE USED. A 20% TOLERANCE WILL REMOVE THE DISTINCTION BETWEEN A JOB PRIORITY OF 5 AND A JOB PRIORITY OF 4. ON THE OTHER HAND, IF ONE WISHES TO EMPHASIZE THE EFFECT OF ONE PARTICULAR WORKSET OPTION, A VERY SMALL TOLERANCE LEVEL CAN BE USED OR ONLY ONE WORKSET OPTION SPECIFIED.

THE WORKSET CYCLE TIME SHOULD ALSO BE SET TO A VALUE COMmensurate WITH THE TYPE OF JOBS BEING RUN, WHEN A SITE IS RUNNING MANY SMALL JOBS THROUGH THE SYSTEM, A SHORT CYCLE TIME SHOULD BE USED. FOR UNUSUALLY LONG JOBS, THE REVERSE IS TRUE. HOWEVER, THE MINIMUM CYCLE TIME USED SHOULD NOT BE LESS THAN 5 SECONDS TO AVOID SYSTEM INSTABILITY.

THE OILMAX VALUE, WHICH IS THE DETECTION POINT FOR THRASHING, WILL ALSO NEED TO BE EMPICALLY DETERMINED, SINCE IT DEPENDS UPON THE NATURE OF THE JOBS IN THE MIX. FORTY PERCENT WAS ChoSEN AS THE DEFAULT VALUE. THIS MEANS THAT THE SUM OF THE OVERLAY OVERHEAD TIMES FOR ALL JOBS IN
THE MIX MUST REACH A VALUE WHICH IS GREATER THAN 40 PERCENT OF THE SUM
OF THE ACTUAL PROCESSOR TIMES FOR THE MIX. ROUGHLY SPEAKING, THE SYSTEM
IS SPENDING 40% OF ITS TIME TRYING TO MANAGE MEMORY.

APPLICATION EXAMPLE

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THE FOLLOWING COMPARES THREE JOBS ALL STARTED AT APPROXIMATELY THE SAME
TIME. THE ONLY FACTOR WHICH VARIES IS THE OLABMAX PARAMETER. THE
WORKSET PARAMETER SETTINGS WERE: CYCLE = 20 AND TOLERANCE = 10. THE
WORKSET OPTION LIST WAS AS FOLLOWS: PRIORITY, OLABCORE, TIME, SAVECORE.

THE JOBS IN THE MIX WERE:

MIX=1, AN ESPOL Compilation of a Portion of the MCP
MIX=2, AN ALGOL Compilation of a Portion of the COBOL Compiler
MIX=3, AN ESPOL Compilation of a Portion of the MCP

THE FOLLOWING PAGES SHOW THE EFFECT OF OLABMAX, RANGING FROM 20 PERCENT
TO 60 PERCENT.
OILAYMAX = 20%

<table>
<thead>
<tr>
<th>MIX</th>
<th>OILAY RATE</th>
<th>PRIORITY</th>
<th>TIME</th>
<th>CORE</th>
<th>SAVECORE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>19%</td>
<td>5</td>
<td>30 SEC</td>
<td>6387 MDS</td>
<td>3971 MDS</td>
</tr>
<tr>
<td>2</td>
<td>33%</td>
<td>5</td>
<td>29 SEC</td>
<td>5822 MDS</td>
<td>3423 MDS</td>
</tr>
<tr>
<td>3</td>
<td>22%</td>
<td>5</td>
<td>28 SEC</td>
<td>2295 MDS</td>
<td>3668 MDS</td>
</tr>
<tr>
<td>SYSTEM</td>
<td>25%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#AUTO-STOP ALGOL/COBOL, MIX#2, TOTAL OILAY RATE=25%

NOTE: OILAY RATE IS THE PERCENT OF CPU TIME.

THE FOLLOWING IS THE CPU, I/O, AND ELAPSED TIME FOR EACH JOB AT COMPLETION TIME:

<table>
<thead>
<tr>
<th>TIMES</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIX</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
</tbody>
</table>

NOTE: AUTO-STOPPED JOB WAS RESTARTED AFTER THE FIRST EQU.
\textsc{Olaymax} = 254
\textsc{-------} \textsc{---}

\begin{tabular}{|c|c|c|c|c|c|}
\hline
MIX & Olay Rate & Priority & Time & Core & Savecore \\
\hline
1 & 31\% & 5 & 72 SEC & 5534 WDS & 4015 WDS \\
2 & 41\% & 5 & 71 SEC & 6151 WUS & 3060 WDS \\
3 & 26\% & 5 & 69 SEC & 2523 WDS & 3840 WDS \\
\hline
\textsc{System} & 33\% & & & & \\
\hline
\end{tabular}

\textsc{#Auto-stop Algol/Cobol Mix = 2}

\textsc{Note: Olay rate is the percent of CPU time.}

\textsc{The following is the CPU, I/O, and elapsed time for each job at completion time:}

\begin{tabular}{|c|c|c|c|c|}
\hline
Mix & Job & CPU & I/O & Elapsed \\
\hline
1 & ESPOL DISK & 119 SEC & 31 SEC & 182 SEC \\
2 & ESPOL DISK & 122 SEC & 30 SEC & 183 SEC \\
3 & ALGOL COBOL & 119 SEC & 31 SEC & 289 SEC \\
\hline
\end{tabular}

\textsc{Note: Auto-stopped job was restarted after the first COBOL job.}
```
OLAYMAX = 30%

<table>
<thead>
<tr>
<th>MIX</th>
<th>OILAY RATE</th>
<th>PRIORITY</th>
<th>TIME</th>
<th>CORE</th>
<th>SAVECORE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>27%</td>
<td>5</td>
<td>70 SEC</td>
<td>5623 MDS</td>
<td>3944 MDS</td>
</tr>
<tr>
<td>2</td>
<td>43%</td>
<td>5</td>
<td>69 SEC</td>
<td>5131 MDS</td>
<td>3715 MDS</td>
</tr>
<tr>
<td>3</td>
<td>32%</td>
<td>5</td>
<td>67 SEC</td>
<td>3133 MDS</td>
<td>3842 MDS</td>
</tr>
<tr>
<td>SYSTEM</td>
<td>34%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#AUTO-STOP ALGOL/COBOL,MIX=2

NOTE: OILAY RATE IS THE PERCENT OF CPU TIME.

THE FOLLOWING IS THE CPU, I/O, AND ELAPSED TIME FOR EACH JOB AT COMPLETION TIME:

<table>
<thead>
<tr>
<th>MIX</th>
<th>JOB</th>
<th>CPU</th>
<th>I/O</th>
<th>ELAPSED</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ESPOL DISK</td>
<td>119 SEC</td>
<td>30 SEC</td>
<td>179 SEC</td>
</tr>
<tr>
<td>2</td>
<td>ALGOL COBOL</td>
<td>119 SEC</td>
<td>31 SEC</td>
<td>288 SEC</td>
</tr>
<tr>
<td>3</td>
<td>ESPOL DISK</td>
<td>120 SEC</td>
<td>30 SEC</td>
<td>160 SEC</td>
</tr>
</tbody>
</table>

NOTE: AUTO-STOPPED JOB WAS RESTARTED AFTER THE FIRST EQU.
```
OLAYMAX = 35%

<table>
<thead>
<tr>
<th>MIX</th>
<th>OLAY RATE</th>
<th>PRIORITY</th>
<th>TIME</th>
<th>CORE</th>
<th>SAVECORE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>32%</td>
<td>5</td>
<td>A/V Sec</td>
<td>6760 MOS</td>
<td>3966 MOS</td>
</tr>
<tr>
<td>2</td>
<td>52%</td>
<td>5</td>
<td>80 Sec</td>
<td>4251 MOS</td>
<td>4433 MOS</td>
</tr>
<tr>
<td>3</td>
<td>31%</td>
<td>5</td>
<td>85 Sec</td>
<td>3041 MOS</td>
<td>3813 MOS</td>
</tr>
<tr>
<td>SYSTEM</td>
<td>37%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#AUTO-STOP ALGOL/COBOL, MIX=2

NOTE: OLAY RATE IS THE PERCENT OF CPU TIME.

THE FOLLOWING IS THE CPU, I/O, AND ELAPSED TIME FOR EACH JOB AT COMPLETION TIME:

<table>
<thead>
<tr>
<th>MIX</th>
<th>JOB</th>
<th>CPU Time</th>
<th>I/O</th>
<th>ELAPSED</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ESPOL</td>
<td>122 SEC</td>
<td>31 SEC</td>
<td>149 SEC</td>
</tr>
<tr>
<td>2</td>
<td>ALGOL</td>
<td>119 SEC</td>
<td>31 SEC</td>
<td>301 SEC</td>
</tr>
</tbody>
</table>

NOTE: AUTO-STOPPED JOB WAS RESTARTED AFTER THE FIRST EQW.
<table>
<thead>
<tr>
<th>MIX</th>
<th>OLAY RATE</th>
<th>PRIORITY</th>
<th>TIME</th>
<th>CORE</th>
<th>SAVECORE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>34%</td>
<td>5</td>
<td>84 SEC</td>
<td>4508 MB</td>
<td>4037 MB</td>
</tr>
<tr>
<td>2</td>
<td>514%</td>
<td>5</td>
<td>78 SEC</td>
<td>5490 MB</td>
<td>3751 MB</td>
</tr>
<tr>
<td>3</td>
<td>38%</td>
<td>5</td>
<td>77 SEC</td>
<td>3408 MB</td>
<td>3838 MB</td>
</tr>
<tr>
<td>SYSTEM</td>
<td>40%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

AUTO-STOP ALGOL/COBOL MIX=2

NOTE: OLAY RATE IS THE PERCENT OF CPU TIME.

THE FOLLOWING IS THE CPU+I/O+ AND ELAPSED TIME FOR EACH JOB AT COMPLETION TIME:

<table>
<thead>
<tr>
<th>MIX</th>
<th>JOB</th>
<th>CPU</th>
<th>TIME</th>
<th>ELAPSED</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ESPOL 4</td>
<td>120</td>
<td>32 SEC</td>
<td>193 SEC</td>
</tr>
<tr>
<td>2</td>
<td>ESPOL 4</td>
<td>121</td>
<td>31 SEC</td>
<td>194 SEC</td>
</tr>
<tr>
<td>3</td>
<td>ALGOL 4</td>
<td>117</td>
<td>31 SEC</td>
<td>297 SEC</td>
</tr>
</tbody>
</table>

NOTE: AUTO-STOPPED JOB WAS RESTARTED AFTER THE FIRST CPU.
**PLAYMAX = 45%**

<table>
<thead>
<tr>
<th>MIX</th>
<th>OILAY RATE</th>
<th>PRIORITY</th>
<th>TIME</th>
<th>CORE</th>
<th>SAVECORE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>38%</td>
<td>5</td>
<td>133 SEC</td>
<td>5477 MDS</td>
<td>4027 MDS</td>
</tr>
<tr>
<td>2</td>
<td>73%</td>
<td>5</td>
<td>132 SEC</td>
<td>5752 MDS</td>
<td>3690 MDS</td>
</tr>
<tr>
<td>3</td>
<td>41%</td>
<td>5</td>
<td>131 SEC</td>
<td>2901 MDS</td>
<td>3885 MDS</td>
</tr>
<tr>
<td>SYSTEM</td>
<td>49%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#AUTO-STOP ALGOL/COBOL, MIX#2

**NOTE:** OILAY RATE IS THE PERCENT OF CPU TIME.

THE FOLLOWING IS THE CPU, I/O, AND ELAPSED TIME FOR EACH JOB AT COMPLETION TIME:

<table>
<thead>
<tr>
<th>TIME</th>
<th>MIX</th>
<th>JOB</th>
<th>CPU</th>
<th>I-O</th>
<th>ELAESPED</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>ESPOI CISA</td>
<td>147 SEC</td>
<td>30 SEC</td>
<td>235 SEC</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>ALGOL CUBOL</td>
<td>121 SEC</td>
<td>31 SEC</td>
<td>335 SEC</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>ESPOI CISA</td>
<td>127 SEC</td>
<td>30 SEC</td>
<td>236 SEC</td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:** AUTO-STOPPED JOB WAS RESTARTED AFTER THE FIRST EQ.
### CLAYMAX = 50%

<table>
<thead>
<tr>
<th>MIX</th>
<th>CLAY RATE</th>
<th>PRIORITY</th>
<th>TIME</th>
<th>CORE</th>
<th>SAVECORE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>41%</td>
<td>5</td>
<td>238 SEC</td>
<td>5445 MDS</td>
<td>3946 MDS</td>
</tr>
<tr>
<td>2</td>
<td>76%</td>
<td>5</td>
<td>247 SEC</td>
<td>6650 MDS</td>
<td>3734 MDS</td>
</tr>
<tr>
<td>3</td>
<td>40%</td>
<td>5</td>
<td>236 SEC</td>
<td>2013 MDS</td>
<td>3820 MDS</td>
</tr>
<tr>
<td>SYSTEM</td>
<td>50%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#AUTO-STOP ALGOL/COBOL, MIX=2

**NOTE:** CLAY RATE IS THE PERCENT OF CPU TIME.

**THE FOLLOWING IS THE CPU, I/O, AND ELAPSED TIME FOR EACH JOB AT COMPLETION TIME:**

<table>
<thead>
<tr>
<th>MIX</th>
<th>JDB</th>
<th>CPU TIME</th>
<th>I/O</th>
<th>ELAPSED</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ESPOL CISK</td>
<td>122 SEC</td>
<td>32 SEC</td>
<td>314 SEC</td>
</tr>
<tr>
<td>2</td>
<td>ESPOL CISK</td>
<td>129 SEC</td>
<td>31 SEC</td>
<td>317 SEC</td>
</tr>
<tr>
<td>3</td>
<td>ALGOL COBOL</td>
<td>129 SEC</td>
<td>31 SEC</td>
<td>396 SEC</td>
</tr>
</tbody>
</table>

**NOTE:** AUTO-STOPPED JOB WAS RESTARTED AFTER THE FIRST EXEC.
NO JOBS WERE AUTO-STOPPED WHEN THE OILMAX PARAMETER WAS SET TO 60%.

THE FOLLOWING IS THE CPU, I/O, AND ELAPSED TIME FOR EACH JOB AT COMPLETION TIME:

<table>
<thead>
<tr>
<th>MIX</th>
<th>JOB</th>
<th>CPU</th>
<th>I/O</th>
<th>ELAPSED</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ESPOL DISK</td>
<td>114 SEC</td>
<td>31 SEC</td>
<td>445 SEC</td>
</tr>
<tr>
<td>2</td>
<td>ALGOL COBOL</td>
<td>130 SEC</td>
<td>36 SEC</td>
<td>504 SEC</td>
</tr>
</tbody>
</table>

WORKSET NOT RUNNING = SERIAL EXECUTION

THE FOLLOWING IS THE CPU, I/O, AND ELAPSED TIME FOR EACH JOB AT COMPLETION TIME:

<table>
<thead>
<tr>
<th>MIX</th>
<th>JOB</th>
<th>CPU</th>
<th>I/O</th>
<th>ELAPSED</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESPOL DISK</td>
<td>110 SEC</td>
<td>31 SEC</td>
<td>126 SEC</td>
<td></td>
</tr>
<tr>
<td>ESPOL DISK</td>
<td>110 SEC</td>
<td>31 SEC</td>
<td>126 SEC</td>
<td></td>
</tr>
<tr>
<td>ALGOL COBOL</td>
<td>114 SEC</td>
<td>35 SEC</td>
<td>130 SEC</td>
<td></td>
</tr>
</tbody>
</table>

TOTAL ELAPSED TIME IF RUN SERIALLY: 382 SECONDS
THE FOLLOWING GRAPH ILLUSTRATES THE EFFECT OF THE WORKING SET OILAYMAX VALUE ON THE TOTAL (ELAPSED) TIME REQUIRED TO RUN ALL THREE JOBS. AS THE OILAYMAX VALUE IS INCREASED, THE SYSTEM ALLOWS THE JOBS TO MULTIPROCESS FOR A LONGER PERIOD OF TIME BEFORE TAKING ACTION TO SUSPEND ONE OF THE JOBS.

FOR THIS PARTICULAR MIX, IT TAKES JUST AS LONG TO RUN THE JOBS TOGETHER AS IT DOES TO RUN THEM SERIALLY WHEN THE OILAYMAX VALUE IS SET TO APPROXIMATELY 50%. BELOW THIS VALUE, THE JOBS RUN TO COMPLETION FASTER THAN THEY WOULD IF RUN SERIALLY, AND ABOVE THIS VALUE, THE REVERSE IS TRUE.