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Demonstrating the Applicability of Simulation Modeling to Resource Allocation in the 63W10 Course

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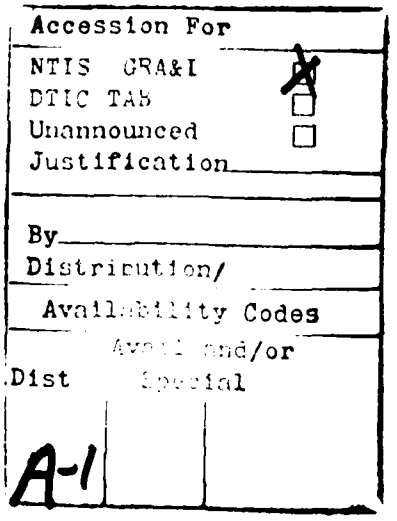

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This report describes a preliminary effort to apply simulation modeling software to resource allocation in the 63W10 (Wheel Vehicle Repairer) training course. The effort was conducted as part of the Training Technology Field Activity (TTFA) program. Two preliminary models of course operation were built using Micro SAINT software. The report concludes that the complexity of scheduling equipment, instructors, and classes would be significantly eased by software such as Micro SAINT and that improvement in resource allocation depends on scheduling capability. Micro SAINT, however, was seen to lack the input/output interface needed for interactive model operation.

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DEMONSTRATING THE APPLICABILITY OF SIMULATION MODELING TO RESOURCE ALLOCATION IN THE 63W10 COURSE

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Introduction:

This report is one of a series produced for the Training Technology Field Activity at the U.S. Army Ordnance Center and School (TTFA-USAOC&S). TTFAs have the goal of infusing Army training with advanced technological capability. The TTFAs are also testbeds dedicated to ensuring that whatever technological innovations are adopted by the Army are proven cost-effective improvements. TTFA-USAOC&S results from the partnership of the U.S. Army Research Institute (ARI), the Training and Doctrine Command's Technology Transfer Agency (TTA), and USAOC&S.

The report summarizes a preliminary effort to determine how resource allocation modeling might increase the efficiency of 63W10 training at USAOC&S. The outcome of the effort is the demonstration of how a particular software package called Micro SAINT might be used to model the resources and requirements of the course. The two models which are discussed demonstrate the feasibility and desirability of simulation modeling as a means to achieve better resource allocation and better training. They are, however, preliminary models, not operational models. Recommendations are offered as to the additional development necessary to produce an operational model.

Background:

ARI observation (Ramsay, et al, 1988, in preparation) of Phase 2 of the 63W course disclosed the following circumstances which suggested that development of a model might be useful:

a) Phase 2 training employs a large amount of actual equipment, approximately 60 vehicles. At any given time with a normal classload, about half of this equipment is not being used.

b) The annexes of Phase 2 are independent of each other. As far as content is concerned, it doesn't matter in what order they are taught. Currently classes are scheduled as if sequence were a factor. (Teaching the use of publications before equipment is handled is the sole exception to the independence observed.)

c) The "sequence immaterial" quality of the annexes appears to apply to the most of the lessons within annexes.

d) Training tasks are done once. Students do not practice in the sense of repeating a procedure until individual mastery is achieved.

e) Many students barely participate in a number of the training tasks. The current system of resource allocation appears to be as responsible for this problem as the personalities of the students. Typically, however many students are in a class are evenly spread to the available equipment for a task, e.g., if there are 32 students and four transmissions, there will be eight students at each. Although instructors watch for students who either take over or shirk the task, class size often determines the quality of the training experience.

The foregoing observations indicate that training resources could be used more efficiently. But to do so would require simulation modeling and computerized scheduling because of the numerous variables and constraints which must be manipulated. Even without the benefits achievable through simulation, computerized scheduling would reduce the workload of course schedulers who now use manual techniques.

Preliminary Developments:

While the TTFA-USAOC&S team was considering these observations, TTFA-Ft. Rucker produced a report (Sprunger and Tremont, 1987) for publication concerning a resource allocation model developed for the Aviator Qualification Course (AQC). The report showed that there were some similarities in the problems faced by the two courses. Both require actual equipment, require instructors in conjunction with the equipment, have a finite length of time in which to cover the POI, and have several classes going on simultaneously.

However a demonstration of the model at Ft. Rucker showed that the modeling problem in the AQC was quite different from that of 63W and that the model was not appropriate to 63W[1]. Another model, not complete, called the Skill-driven Resource Assignment Model was also described. This model requires detailed, frequently-collected performance data on each student and the flexibility to schedule individual students. Although neither of these is feasible in the 63W10 course, the Micro SAINT software which was used as the basis for model development at Ft. Rucker does seem to be useful for scheduling students and resources in Phase 2 of the 63W course. It was decided that the purposes of TTFA-USAOC&S would be better served by either developing a new model or elaborating one of the Micro SAINT sample models to a point where it simulates the conditions of the course rather than attempting to adapt the Ft.Rucker AQC models.

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[1]The AQC is highly sequence-dependent, the 63W is not. The AQC is critically concerned with weather, 63W is not.

Purpose:

To demonstrate that simulation modeling can be used to allocate resources more efficiently in the 63W course given the following constraints: current course length (15 weeks), program of instruction (POI), training equipment, number of instructors, and student throughput of 1500/year.

Model-Building Objectives:

After the lengthy period of familiarization required by the powerful but user-unfriendly software of Micro SAINT, the first objective was to adapt one of the sample models provided to create a basic model which would serve the purpose of this effort. The sample model is called "Jobshop". It models the scheduling of work through the various machines of a jobshop for the purpose of determining where queues result. The classes entering Phase 2 of the 63W course were seen as analagous to the unfinished parts entering the jobshop; the annexes of the course were seen as analagous to the machines. The constraint that only one part can be worked on by a machine at a time was similar to 63W constraint that only one class can occupy one lesson at a time.

Given that a basic model could be produced, a secondary model-building objective was to increase its level of fidelity so that it might be applied to real-world problems such as determining how fast classes can be fed into Phase 2 from Phase 1 without Phase 2 overload. Progress made toward this objective is described below.

Approach:

Class schedules for the week 1-5 FEB 1988 were obtained. The basic information provided in them is the following:

a) The lessons which comprise Phase 2, number and length, are given.
b) Normal procedure is that once in an annex, a class completes all lessons within that annex before moving to another annex.
c) The first annex after leaving Phase 1 is always "H" (recovery).
d) The annex H to annex I movement of classes is a consistent sequence.
e) Within some annexes, lesson sequence could vary; within others, it was maintained.
f) With the exception of "L", annexes are scheduled in alphabetic order.
g) On Monday all classes in Phase 2 cease after 11:20. Phase 2 shuts down for "Administrative Time".
h) There are a total of forty lessons in Phase 2, each of which appears to be equipped to handle one class at any given time.

Initial Modeling Efforts:

A diagram of the basic model is shown in Figure 1. Classes enter Phase 2, arrive at a distribution point, and are sent to either the annex with the next alphabetic designation or the annex with the shortest queue. Upon completion of an annex, a class returns to the distribution point for assignment to the next annex. The model is programmed so that it keeps track of which annexes have been completed. This process repeats until the program determines that a class has completed all the annexes. The model stops when a predetermined number of classes have all completed all the annexes.

If the period of time required by each annex and the number of classes each annex can accommodate are inserted, this basic model can make a rough determination of how many classes can be fed into the system (Phase 2 of the 63W course) before queues occur. Since this is merely a basic model whose intended use is to demonstrate the viability of the modeling concept, the trial-and-error process of feeding in increasing numbers of classes and running the model until a queue is observed at any annex was not done. The Micro SAINT software permits the insertion of initial conditions.

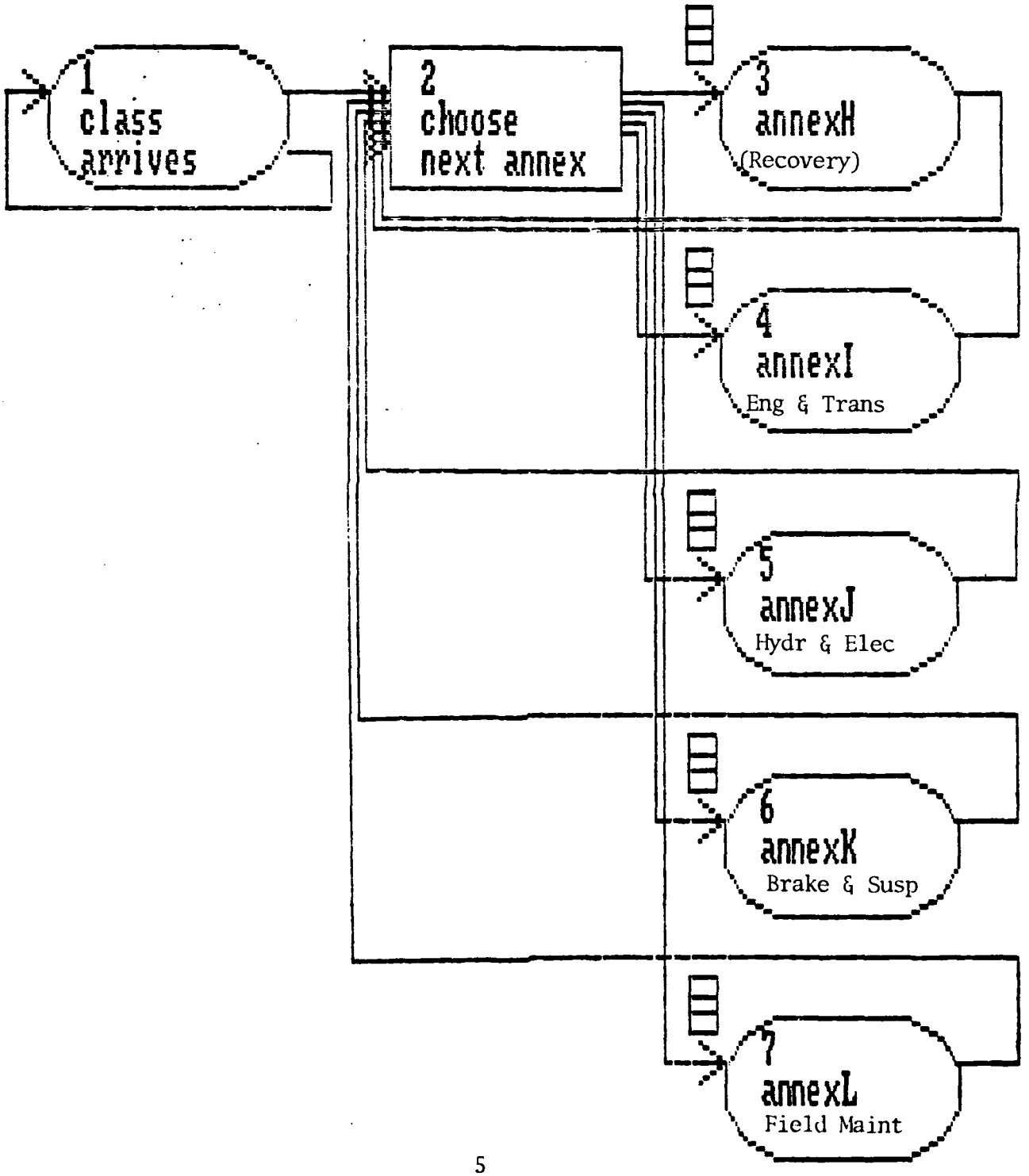
Elaboration of Basic Model:

The basic model was elaborated by inserting each annex's lessons and their scheduled time periods. (The basic model dealt only with annexes. The elaborated model functions at the lesson-level of detail.) The resulting model was put through a test run using parameters which closely approximate the current scheduling configuration, i.e., 48 classes fed in at the rate of one every 40 hours. This elaborated model incorporates the existing constraint that a class completes all the lessons within an annex before moving to the next annex. A complete run of the model represents a year in the operation of the 63W course.

The elaborated model functions in the same way as the basic model. With the added detail of individual lesson times, each annex has a "lesson selector" distribution point where classes can be scheduled to the lessons which most efficiently get them through the course. (At the current stage of model development the existing scheduling procedure is replicated. Further effort is required to develop algorithms for insertion into the "lesson selectors" which would improve efficiency.)

1. A run of a Micro SAINT model results in a trace file (**modelname**.TRC) which contains the beginning and end of every event executed during the run. In the case of the elaborated 63W model, the trace file contains the beginning and end of every

Figure 1. Diagram of basic model



lesson for every class as well as all of the model's management events. A sample of what a trace file looks like is provided in appendix A. The "clock" column states the time in model hours. The "tag" column indicates the class number. "Trigger" means that beginning ("Beg") or "End" of the particular "Job" caused the event to register on the trace. The complete trace for a year would occupy about 150 pages.

2. To illustrate the process by which the raw and cumbersome output of a Micro SAINT run might be transformed into operational schedules, some additional data processing was done. First to produce a file which contains only information pertaining to classes and lessons, the trace (.TRC) file was edited. This was accomplished using the DOS command FIND and the DOS editing capability EDLIN to remove the model's management events. The resultant file was named DATA. A sample of this file is provided in appendix B.

3. Next the DATA file was operated on by a program in BASIC which extracted the complete schedule for any given class. This operation produced a file called ZZ. A sample of the ZZ file is provided in appendix C. The function of the BASIC program is that if the number 20 is entered in response to the prompt, CLASS NUMBER?, ZZ will contain the schedule for the 20th class to enter the model. The schedule times are clock hours since the start of the model when the first class began the first lesson. (Example. The file ZZ indicates a class is to begin a lesson at the time 578.5. If there are eight working hours in a school day, then 578.5/8 or 72.3 school days after the model's start, the lesson would begin.)

4. A ZZ file, about two pages in hard copy, could be produced for every class. If overlaid on an actual calendar, a ZZ file could be transformed into a close approximation of the operational schedule for a class. It falls short of being a viable schedule because the model does not take into account the interaction between the calendar and scheduling requirements, e.g., Annex L requires three full contiguous workdays without interruption by weekends or special duties. The model also does not allow for the possibility that the same physical space may be occupied for different lessons. While it insures that a lesson is empty before routing a class to it, it does not check for instances where the same vehicles are used for different lessons, e.g., brakes and electrical systems lessons might compete for access to the same training equipment.

Discussion:

The foregoing has demonstrated that the modeling of Phase 2 of the 63W is readily accomplished using the Micro SAINT software package. Although the modeling concept and its applicability are evident, the elaborated model requires considerable development in two areas before it could be considered a useful tool. One area concerns development within the capability of the Micro SAINT software. This area contains two interrelated parts: 1) modeling the interaction between real time and lesson scheduling, and 2) inserting the algorithms which are needed to achieve optimization of resource allocation. An example of the first of these is taking into account the fact that some lessons can be interrupted (left overnight or over a weekend) and easily resumed while others must be completed within the workday. In the second case it needs to be remembered that the current state of the model assumes enough instructors to staff each lesson at any time. If, however, the number of classes is significantly increased through improved scheduling, the number and capability of instructors will need to be captured in an algorithm. While such developments are not simple or without pitfalls, they appear to be things which a person well-versed in Micro SAINT and with some knowledge of queueing theory could accomplish.

More difficult from the point of view of delivering a turnkey product is the second area. Here the problem is that there is no viable interface for a user of a model produced with Micro SAINT. On the input side, the insertion of any change (e.g., in the Program of Instruction or schedulable special events) is a complex and tedious effort. The model cannot be handed off without virtually training up the recipient to the same level as the developer. On the output side, Micro SAINT does not produce anything resembling a usable class schedule. The procedure used to produce the ZZ files described above involved many more steps than a user-scheduler could reasonably be expected to follow.

Two types of software appear to be needed to deal with the lack of interface. The first would be a small customized spreadsheet application which would enable the user to easily input changes as well as initial conditions. The model could then be run using data derived from the spreadsheet. The second type of software would integrate the model output with that of a wordprocessor. This would enable the rapid generation of operational class schedules which optimize resource allocation at any given point in time.

Conclusion:

The Micro SAINT software can be used to develop a model of the operation of Phase 2 of the 63W course. To be a useful product, however, a considerable amount of development is needed to

produce a user input/output interface. (The current class scheduling workload, even without any attempt to improve resource allocation, would be significantly helped by computerization.) The preliminary models described in this report show that more training (in the form of more classes) could be done given the resources available. Thus these models reflect what can be seen in the current course schedules and training facilities. However without a simulation model produced with Micro SAINT or some other appropriate software, it would be virtually impossible to improve resource allocation because of unmanageable scheduling complexities.

The models described in this report are demonstrations of the feasibility and potential of simulation modeling. They are several developmental steps away from being turnkey products. Recommended steps to achieve the turnkey goal must include: 1) Update and refine the existing model so that it captures all the considerations of the class schedulers, e.g., instructor capability/availability, extracurricular events which cause schedule aberrations, POI changes, etc.; 2) Build the input/output interface which will enable the revision of all class schedules automatically when changes occur; and 3) Develop the model algorithms which make it possible to deal with questions such as what happens if the annual number classes is increased by 50 or 100 per cent.

The immediate payoff of a fully-developed turnkey product would be to improve training in the 63W10 Course by substantially reducing course scheduling labor and the idle time of training equipment and instructors. The long term payoff would be the adaptation of this technology to other Army courses requiring the management of numerous lessons, classes, and resources.

References

Ramsay, D. A., Kessler, J. J., Mirabella, A., and Thoreson, R. W. (1988, in preparation). Preliminary review of the 63W10 course at the Aberdeen Proving Ground (ARI Research Note 88-110). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Sprunger, C. A. W., and Tremont, P. J. (1987). Simulating the AH1S Aviator Qualification Course: Resource allocation model (ARI Research Product 87-30). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (AD B121 262)

APPENDIX A

Sample of the Execution Trace Produced by Micro SAINT

```
"clock" "tag" "Trigger:" "Jobs:"
0.000000 0 "Beg" "1" "class arrives"
40.000000 1 "End" "1" "class arrives"
40.000000 1 "Beg" "999" "select annex"
40.000000 1 "Beg" "1" "class arrives"
40.000000 1 "End" "999" "select annex"
40.000000 1 "Beg" "301.1" "select group"
40.000000 1 "End" "301.1" "select group"
40.000000 1 "Beg" "301.2" "select lesson"
40.000000 1 "End" "301.2" "select lesson"
40.000000 1 "Beg" "3" "lesson H1"
43.000000 1 "End" "3" "lesson H1"
43.000000 1 "Beg" "301.1" "select group"
43.000000 1 "End" "301.1" "select group"
43.000000 1 "Beg" "301.2" "select lesson"
43.000000 1 "End" "301.2" "select lesson"
43.000000 1 "Beg" "4" "lesson H2"
47.500000 1 "End" "4" "lesson H2"
47.500000 1 "Beg" "301.1" "select group"
47.500000 1 "End" "301.1" "select group"
47.500000 1 "Beg" "301.2" "select lesson"
47.500000 1 "End" "301.2" "select lesson"
47.500000 1 "Beg" "5" "lesson H3"
54.500000 1 "End" "5" "lesson H3"
54.500000 1 "Beg" "301.1" "select group"
54.500000 1 "End" "301.1" "select group"
54.500000 1 "Beg" "301.2" "select lesson"
54.500000 1 "End" "301.2" "select lesson"
54.500000 1 "Beg" "6" "lesson H4"
58.500000 1 "End" "6" "lesson H4"
58.500000 1 "Beg" "301.1" "select group"
58.500000 1 "End" "301.1" "select group"
58.500000 1 "Beg" "301.2" "select lesson"
58.500000 1 "End" "301.2" "select lesson"
58.500000 1 "Beg" "7" "lesson H5"
66.000000 1 "End" "7" "lesson H5"
66.000000 1 "Beg" "301.1" "select group"
66.000000 1 "End" "301.1" "select group"
66.000000 1 "Beg" "301.2" "select lesson"
66.000000 1 "End" "301.2" "select lesson"
66.000000 1 "Beg" "8" "lesson H6"
69.500000 1 "End" "8" "lesson H6"
69.500000 1 "Beg" "301.1" "select group"
69.500000 1 "End" "301.1" "select group"
```

```
69.500000 1 "Beg" "301.3" "select lesson"
69.500000 1 "End" "301.3" "select lesson"
69.500000 1 "Beg" "9" "lesson H7"
74.000000 1 "End" "9" "lesson H7"
74.000000 1 "Beg" "301.1" "select group"
74.000000 1 "End" "301.1" "select group"
74.000000 1 "Beg" "301.3" "select lesson"
74.000000 1 "End" "301.3" "select lesson"
74.000000 1 "Beg" "10" "lesson H8"
75.500000 1 "End" "10" "lesson H8"
75.500000 1 "Beg" "301.1" "select group"
75.500000 1 "End" "301.1" "select group"
75.500000 1 "Beg" "301.4" "done with annex H"
75.500000 1 "End" "301.4" "done with annex H"
75.500000 1 "Beg" "999" "select annex"
75.500000 1 "End" "999" "select annex"
75.500000 1 "Beg" "401.1" "select group"
75.500000 1 "End" "401.1" "select group"
75.500000 1 "Beg" "401.2" "select lesson"
75.500000 1 "End" "401.2" "select lesson"
75.500000 1 "Beg" "11" "lesson I1"
76.500000 1 "End" "11" "lesson I1"
76.500000 1 "Beg" "401.1" "select group"
76.500000 1 "End" "401.1" "select group"
76.500000 1 "Beg" "401.2" "select lesson"
76.500000 1 "End" "401.2" "select lesson"
76.500000 1 "Beg" "12" "lesson I2"
77.500000 1 "End" "12" "lesson I2"
77.500000 1 "Beg" "401.1" "select group"
77.500000 1 "End" "401.1" "select group"
77.500000 1 "Beg" "401.2" "select lesson"
77.500000 1 "End" "401.2" "select lesson"
77.500000 1 "Beg" "13" "lesson I3"
80.000000 2 "End" "1" "class arrives"
80.000000 2 "Beg" "999" "select annex"
80.000000 2 "Beg" "1" "class arrives"
80.000000 2 "End" "999" "select annex"
80.000000 2 "Beg" "301.1" "select group"
80.000000 2 "End" "301.1" "select group"
80.000000 2 "Beg" "301.2" "select lesson"
80.000000 2 "End" "301.2" "select lesson"
80.000000 2 "Beg" "3" "lesson H1"
83.000000 2 "End" "3" "lesson H1"
83.000000 2 "Beg" "301.1" "select group"
83.000000 2 "End" "301.1" "select group"
83.000000 2 "Beg" "301.2" "select lesson"
83.000000 2 "End" "301.2" "select lesson"
83.000000 2 "Beg" "4" "lesson H2"
87.500000 1 "End" "13" "lesson I3"
87.500000 1 "Beg" "401.1" "select group"
87.500000 2 "End" "4" "lesson H2"
87.500000 2 "Beg" "301.1" "select group"
```

APPENDIX B

Sample of "DATA" File
(Extracted from the Micro SAINT Execution Trace)

Column 1: Classroom clock hours since model started.
Column 2: Class number.
Column 3: Beginning/End
Column 4: Micro SAINT task number.
Column 5: Lesson title.

1	2	3	4	5
560.000000	14	"Beg"	"3"	"lesson H1"
562.500000	10	"End"	"27"	"lesson J8"
562.500000	10	"Beg"	"28"	"lesson J9"
563.000000	14	"End"	"3"	"lesson H1"
563.000000	14	"Beg"	"4"	"lesson H2"
563.500000	7	"End"	"41"	"lesson M3"
563.500000	11	"End"	"20"	"lesson J1"
563.500000	7	"Beg"	"42"	"lesson M4"
563.500000	11	"Beg"	"21"	"lesson J2"
566.500000	9	"End"	"34"	"lesson K2"
566.500000	9	"Beg"	"35"	"lesson K3"
567.500000	13	"End"	"13"	"lesson I3"
567.500000	14	"End"	"4"	"lesson H2"
567.500000	11	"End"	"21"	"lesson J2"
567.500000	13	"Beg"	"14"	"lesson I4"
567.500000	14	"Beg"	"5"	"lesson H3"
567.500000	11	"Beg"	"22"	"lesson J3"
569.500000	10	"End"	"28"	"lesson J9"
569.500000	7	"End"	"42"	"lesson M4"
569.500000	7	"Beg"	"43"	"lesson M5"
569.500000	10	"Beg"	"29"	"lesson J10"
570.500000	12	"End"	"16"	"lesson I7"
570.500000	11	"End"	"22"	"lesson J3"
570.500000	12	"Beg"	"17"	"lesson I8"
570.500000	11	"Beg"	"23"	"lesson J4"
571.500000	8	"End"	"38"	"lesson L"
571.500000	8	"Beg"	"39"	"lesson M1"
573.500000	10	"End"	"29"	"lesson J10"
573.500000	10	"Beg"	"30"	"lesson J11"
574.500000	9	"End"	"35"	"lesson K3"
574.500000	14	"End"	"5"	"lesson H3"
574.500000	9	"Beg"	"36"	"lesson K4"
574.500000	14	"Beg"	"6"	"lesson H4"
575.500000	7	"End"	"43"	"lesson M5"
575.500000	7	"Beg"	"44"	"lesson M6"

1	2	3	4	5
577.500000	8	"End"	"39"	"lesson M1"
577.500000	8	"Beg"	"40"	"lesson M2"
578.500000	11	"End"	"23"	"lesson J4"
578.500000	14	"End"	"6"	"lesson H4"
578.500000	11	"Beg"	"24"	"lesson J5"
578.500000	14	"Beg"	"7"	"lesson H5"
579.500000	10	"End"	"30"	"lesson J11"
579.500000	10	"Beg"	"31"	"lesson J12"
580.500000	12	"End"	"17"	"lesson I8"
580.500000	7	"End"	"44"	"lesson M6"
580.500000	12	"Beg"	"18"	"lesson I10"
582.500000	9	"End"	"36"	"lesson K4"
582.500000	9	"Beg"	"37"	"lesson K5"
583.500000	8	"End"	"40"	"lesson M2"
583.500000	8	"Beg"	"41"	"lesson M3"
586.000000	14	"End"	"7"	"lesson H5"
586.000000	14	"Beg"	"8"	"lesson H6"
586.500000	10	"End"	"31"	"lesson J12"
586.500000	10	"Beg"	"32"	"lesson J13"
587.500000	9	"End"	"37"	"lesson K5"
587.500000	9	"Beg"	"38"	"lesson L"
589.500000	13	"End"	"14"	"lesson I4"
589.500000	11	"End"	"24"	"lesson J5"
589.500000	14	"End"	"8"	"lesson H6"
589.500000	13	"Beg"	"15"	"lesson I5"
589.500000	11	"Beg"	"25"	"lesson J6"
589.500000	14	"Beg"	"9"	"lesson H7"
590.500000	10	"End"	"32"	"lesson J13"
590.500000	10	"Beg"	"33"	"lesson K1"
591.500000	11	"End"	"25"	"lesson J6"
591.500000	11	"Beg"	"26"	"lesson J7"
594.000000	14	"End"	"9"	"lesson H7"
594.000000	14	"Beg"	"10"	"lesson H8"
595.500000	12	"End"	"18"	"lesson I10"
595.500000	11	"End"	"26"	"lesson J7"
595.500000	14	"End"	"10"	"lesson H8"
595.500000	12	"Beg"	"19"	"lesson I11"
595.500000	11	"Beg"	"27"	"lesson J8"
595.500000	14	"Beg"	"11"	"lesson I1"
596.500000	14	"End"	"11"	"lesson I1"
596.500000	14	"Beg"	"12"	"lesson I2"
597.500000	14	"End"	"12"	"lesson I2"
597.500000	14	"Beg"	"13"	"lesson I3"
598.500000	13	"End"	"15"	"lesson I5"
598.500000	10	"End"	"33"	"lesson K1"
598.500000	12	"End"	"19"	"lesson I11"
598.500000	13	"Beg"	"16"	"lesson I7"
598.500000	10	"Beg"	"34"	"lesson K2"
598.500000	12	"Beg"	"20"	"lesson J1"
600.000000	15	"Beg"	"3"	"lesson H1"
602.500000	11	"End"	"27"	"lesson J8"

APPENDIX C

Example of file "ZZ"
(extracted from the file "DATA")

Column 1: Class number.
Column 2: Line number.
Column 3: Classroom clock since model start.
Column 4: Lesson title.

1	2	3	4
48	1	1880	lesson H1
48	2	1883	lesson H1
48	3	1883	lesson H2
48	4	1887.5	lesson H2
48	5	1887.5	lesson H3
48	6	1894.5	lesson H3
48	7	1894.5	lesson H4
48	8	1898.5	lesson H4
48	9	1898.5	lesson H5
48	10	1906	lesson H5
48	11	1906	lesson H6
48	12	1909.5	lesson H6
48	13	1909.5	lesson H7
48	14	1914	lesson H7
48	15	1914	lesson H8
48	16	1915.5	lesson H8
48	17	1915.5	lesson I1
48	18	1916.5	lesson I1
48	19	1916.5	lesson I2
48	20	1917.5	lesson I2
48	21	1917.5	lesson I3
48	22	1927.5	lesson I3
48	23	1927.5	lesson I4
48	24	1949.5	lesson I4
48	25	1949.5	lesson I5
48	26	1958.5	lesson I5
48	27	1958.5	lesson I7
48	28	1970.5	lesson I7
48	29	1970.5	lesson I8
48	30	1980.5	lesson I8
48	31	1980.5	lesson I10
48	32	1995.5	lesson I10
48	33	1995.5	lesson I11
48	34	1998.5	lesson I11
48	35	1998.5	lesson J1
48	36	2003.5	lesson J1
48	37	2003.5	lesson J2

1	2	3	4
48	38	2007.5	lesson J2
48	39	2007.5	lesson J3
48	40	2010.5	lesson J3
48	41	2010.5	lesson J4
48	42	2018.5	lesson J4
48	43	2018.5	lesson J5
48	44	2029.5	lesson J5
48	45	2029.5	lesson J6
48	46	2031.5	lesson J6
48	47	2031.5	lesson J7
48	48	2035.5	lesson J7
48	49	2035.5	lesson J8
48	50	2042.5	lesson J8
48	51	2042.5	lesson J9
48	52	2049.5	lesson J9
48	53	2049.5	lesson J10
48	54	2053.5	lesson J10
48	55	2053.5	lesson J11
48	56	2059.5	lesson J11
48	57	2059.5	lesson J12
48	58	2066.5	lesson J12
48	59	2066.5	lesson J13
48	60	2070.5	lesson J13
48	61	2070.5	lesson K1
48	62	2078.5	lesson K1
48	63	2078.5	lesson K2
48	64	2086.5	lesson K2
48	65	2086.5	lesson K3
48	66	2094.5	lesson K3
48	67	2094.5	lesson K4
48	68	2102.5	lesson K4
48	69	2102.5	lesson K5
48	70	2107.5	lesson K5
48	71	2107.5	lesson L
48	72	2131.5	lesson L
48	73	2131.5	lesson M1
48	74	2137.5	lesson M1
48	75	2137.5	lesson M2
48	76	2143.5	lesson M2
48	77	2143.5	lesson M3
48	78	2163.5	lesson M3
48	79	2163.5	lesson M4
48	80	2169.5	lesson M4
48	81	2169.5	lesson M5
48	82	2175.5	lesson M5
48	83	2175.5	lesson M6
48	84	2180.5	lesson M6