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Optimizing a Law School's Course Schedule

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I. INTRODUCTION

If you have ever attempted to prepare a law school class schedule—juggling curricular needs, classroom sizes, professorial whims—you will know how hard a task is involved. If you bother the person in charge of the schedule too much, he or she might unleash the powers of the scheduler upon you. Next year you may find yourself teaching “Legal Spelling” on Saturday mornings at 8:00 A.M.¹

Just like other educational institutions, law schools must schedule courses by taking into consideration student needs, faculty resources, and logistical support such as classroom size and equipment needs. Course

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1. Douglas J. Whaley, *Teaching Law: Advice for the New Professor*, 43 Ohio St. L.J. 125, 126 (1982).

scheduling is an administrative function, typically handled by an Assistant Dean or an Associate Dean, who works with the faculty and the registrar to balance these considerations in advance of the registration process. Usually, the entire academic year is scheduled in advance, although the spring semester may be labeled tentative until registration begins for that semester. It's hard to imagine, but some schools even publish a two-year schedule of upper-division courses so that students can plan their entire law school career in advance.

In order to give assistance to those academics involved for the first time in the scheduling process, this article discusses the law school scheduling process and how a scheduling software package has worked to successfully automate what has been seen as one of the most abysmal administrative tasks of an Associate Dean. We first provide a background to course scheduling at a typical law school. We then present a review of the tools for, and literature on, course scheduling, followed by a discussion of how technology can be applied to course scheduling in general, and our outcomes of applying this technology in a law school environment. We close with a brief summary.

II. COURSE SCHEDULING

A. Curricular Offerings & Scheduling Patterns

At many law schools, the first year curriculum is identical for all students and the entering class is broken into three sections with the same course offerings in each section. Students may be required to take additional upper-division courses during their second or third year and these courses should be offered each semester without overlap or conflict with each other. Class periods are generally fifty or sixty minutes in length with a ten or fifteen-minute passing break between each period. In a sixty-minute class length scheduling, the first period may begin at 8:00 A.M., with the fourth period ending at 12:30 P.M. If classes are not typically scheduled during the lunch hour, the fifth period would begin at 1:30 P.M. Times other than lunch, such as a Tuesday afternoon, may also be reserved for regular functions such as faculty meetings. Generally, not many classes are scheduled towards the end of the day, such as during the seventh and last period from 3:50 to 4:50 P.M. However, some upper-division elective courses may be offered in the evening, Monday through Thursday, say, between 6:00 and 9:00 P.M. Indeed, some schools run extensive night programs to provide opportunities for mid-career and part-time students.

The first year courses are typically taught in one-hour segments for two to three hours a week based on the number of units. They are sched-

uled throughout the week without much regard to any particular pattern. Upper-division courses, on the other hand, can be scheduled Monday-Wednesday-Friday (MWF), Tuesday-Thursday (TTH), or one day a week in a two to three hour segment. Four-unit courses can be scheduled on MWF with class times of eighty minutes. Most of the three-unit courses are scheduled either on MWF for sixty minutes each day or on TTH or MW for ninety minutes each day. Whenever courses are scheduled to meet for more than sixty minutes, but for less than two hours, two class periods must be used to accommodate the scheduling. Therefore, two of these courses can be scheduled back-to-back, using three class periods, rather than separately, using four class periods. Another way to deal with these extra-long classes is to overlap them into either the 8:00 A.M. time slot (which isn't used as much) or into the lunch period (which also is generally not used). Dealing specifically with these overlaps is necessary to prevent inefficiency in course and classroom scheduling.

Most of the two-unit courses can be scheduled either on TTH or on MW for sixty minutes each day. Courses taught by adjuncts should be scheduled on one day a week, Monday through Thursday, typically in the evenings for two or three hours based on the number of units. By scheduling the upper-division courses on a MWF or TTH pattern, the students have greater flexibility in arranging externships, which may occur quite a distance from the campus. However, because the American Bar Association rules require that students not work more than twenty hours per week on outside work, care must be taken to make sure the schedule encourages a full-time student level of commitment to the campus community.²

B. Faculty Resources

The scheduling process usually begins by asking full-time faculty members which courses they would like to teach, on what days, and at which times. Most faculty members will hopefully understand the preferred pattern of scheduling and should agree to conform to the pattern in order to meet student needs. The faculty is also generally aware of the courses that must be offered regularly as well as the faculty resources currently available to the law school. In terms of faculty resources, it is wise

2. See ABA Standard 304(f) (One of the ways this rule is enforced is by requiring schools to schedule classes such that students have no choice but to comply with the rules.); ABA Interpretation 304-7 (August 1996) ("A law school shall demonstrate that it has adopted and enforces policies insuring that individual students satisfy the requirements of this Standard, including the implementation of policies relating to class scheduling, attendance, limitation on employment, and time devoted to job interviewing. The law school also shall take steps to control absenteeism by students involved in placement interviewing.").

to maintain four professors capable and willing to teach each of the first year courses which are offered in three sections. The school should also strive to have three professors available to teach any of the upper-division courses which are offered twice a year. This allows the school to rotate professors into teaching special seminars in their scholarship areas, taking sabbaticals, reducing teaching loads to allow for writing, and sometimes, offering an extra section of a particular course to reduce the number of students in each class. For example, most second year students want to take Evidence in the fall, which puts an extra load on the faculty member teaching in the fall. Therefore, two sections of Evidence can be scheduled in the fall, while a spring section may be offered as well.

When determining the first-year class section composition of professors, several factors influence the selection process. First, the scheduler might attempt to achieve an equal mix of male and female professors in each section. Since there is generally a smaller percentage of female professors teaching outside the clinical area in most law schools, it may only be possible to include one or two female professors in each section of six courses. Second, the scheduler should try not to put all of the new or inexperienced professors in the same section and should attempt to mix the levels of teaching experience in each section. Third, even in those schools with a renowned teaching faculty, there will always be a few who stand out as the "most popular" professors and every effort should be made to interperse these professors among the sections.³

Some of the more challenging considerations in putting together the first-year sections include determining which professors are willing to teach in the unpopular time slots such as at 8:00 A.M. or after 3:00 P.M. Generally, there are at least three who enjoy teaching early and these professors should be assigned to different sections so that each section will have an early morning class. Because first year students cannot choose their classes, it is better to utilize classroom facilities efficiently by scheduling the first year students in the unpopular times and offering the second and third year courses in the more favorable time slots. This may help avoid under enrollment in valuable upper-division courses because of undesirable class meeting times. It has even been suggested that the legal theory leanings of the individual professors be considered so that those interested in theories such as critical legal studies or law and economics would be scattered throughout the sections to expose students to a variety of legal approaches.

3. One scheduler was approached by a professor who specifically asked not to be placed in the same section with another more popular professor because of the desire to avoid competition for the students' favor.

C. Scheduling to Avoid Conflicts and to Facilitate Student Needs.

Once the school determines which professors will be teaching which courses to meet curricular needs, the scheduling of classes begins. First, any upper-division required courses should be scheduled, along with any other courses most students choose in order to prepare for a state bar exam. For example, Community Property is tested on the California State Bar Exam and may be a popular course for those students studying in California. These required or popular courses should be scheduled so that a student can take any combination of these courses in any semester without conflict. Upper-division elective courses should be dispersed throughout the schedule so that there are no more than three competing elective courses in any time slot. Every attempt should be made to schedule these electives such that similar subjects or similar majors do not conflict with each other.

Finally, three sections of first year courses are scheduled to meet throughout the week, Monday through Friday. Here, the pattern of classes is not as critical as with the upper-division courses since first year students are discouraged from working and are not allowed to participate in the externship program. The schedule should be equitable across the three sections such that each section has its fair share of both early morning classes and late afternoon classes. Whenever possible, Friday classes can be scheduled to meet earlier in the day so that students are not required to be on campus Friday afternoon. Ideally, courses should be dispersed so that study time is allowed throughout the day and students are not required to sit through back-to-back classes.

D. Faculty Needs & Desires

In addition to scheduling these classes to meet student needs, professors' needs must be taken into account. Back-to-back classes on the same day should be avoided, unless the professor requests such a schedule, and there should not be too wide a spread between classes. For example, most professors will not wish to teach a class at 8:00 A.M. and then also at 3:50 P.M. Classes for each professor should be scheduled on no more than three days of the week to allow the faculty larger segments of time for scholarship and class preparation. Professors who travel frequently to speak at conferences or on panels may prefer to have either a Monday or a Friday without classes so that rescheduling a class is not required when they travel for a "long weekend." Some professors are "morning people" willing to teach at 8:00 A.M., while others prefer the later time slots. These particular desires must be matched with the need to schedule courses throughout the

day, rather than just during the most highly desired time slots between 10:00 A.M. and 2:00 P.M.

Those faculty members who make use of technology in the classroom require a classroom outfitted with appropriate equipment. Since many law schools have some, but not all of their classrooms equipped with technology such as built in video projectors, professors using this technology must be given preference in room scheduling to support their use of these teaching tools. Other professors may simply have room preferences and will request the use of a particular classroom in which they feel most comfortable teaching.

Although curricular and student needs are paramount in the scheduling process, faculty members who are treated with consideration and fairness in the scheduling of their classes will likely be happier and more productive members of the law school community. Individual needs and preferences should be taken into account whenever possible, while maintaining academic quality and institutional goals.

E. *Classroom Space Allocation*

Classroom space is typically a scarce resource, which must be managed by proper academic scheduling. Seminars should meet in smaller, more intimate, classrooms while the large first year classes or upper-division required courses must use the largest classrooms. Classrooms should be assigned only after all of the courses have been scheduled as to professor, day, and time. However, with a finite number of classrooms, it is possible that certain classes might require rescheduling if the appropriate mix of large and small classrooms is not available for a particular time slot. Therefore, ideally, classroom assignments should be made concurrently with the day and time assignments to insure availability.

In addition to room size limitations, there are also other physical attributes which may make one classroom particularly appropriate for a certain course or professor. For example, Trial Practice classes may use a special trial courtroom in order to properly emulate a trial setting. Since multiple Trial Practice courses may be offered each semester, the scheduler must ensure that the courses do not meet at the same or overlapping times. Some professors use the chalkboard or whiteboard extensively, while others do not. Some prefer the chalkboard, while others prefer a whiteboard because dust gets on their clothing or they are allergic to it. Since the advent of technology in the classroom, professors using equipment such as ceiling video projectors and computers for multimedia presentations must be scheduled into those classrooms adequately equipped for the particular technology required.

F. *Scheduling Exams*

Once the class schedule has been finalized, examination dates are typically scheduled into a two-week examination period. This examination period may consist of ten examination days, beginning at 8:30 A.M. and ending before 5:00 P.M. on Monday through Friday. Some schools schedule exams on Saturday, but many students and administrative staff resist such scheduling. First year examinations for five courses can be scheduled in the mornings at 8:30 A.M. with at least a day in between each exam, beginning on the first Wednesday and finishing on the last Friday of the two-week period. For proctoring ease and room availability, upper-division required courses may be scheduled in the afternoons beginning at 1:00 P.M. These exams are spread across the examination period with care given to spreading out those classes that are typically taken at the same time (such as in the second year) from each other. Upper-division elective course examinations are scheduled last and may be scheduled either at 8:30 A.M. or at 1:00 P.M.

Although it is impossible to avoid a student having two exams in one day, it is possible to schedule exams such that no student will be precluded from taking a class because of a directly conflicting exam in another class. This direct conflict is avoided by scheduling exams on the same day and time if the course itself conflicts as to day and time such that the student could not take both of the courses because of the course conflict. Therefore, the exam conflict becomes irrelevant for such concurrent courses.

G. *Schedule Changes*

After the schedule for both fall and spring semesters has been published and distributed to students, subsequent changes must be specifically identified and posted to preclude reliance on the original schedule. These amendments must be carefully coordinated since one minor change can have a ripple effect in course, exam, and classroom conflicts. Although the spring semester schedule is posted at the same time as the fall schedule, it is identified as a tentative schedule to preclude unnecessary reliance until a finalized schedule is posted just prior to the spring registration period.

H. *A Different Approach*

Administrators new to the scheduling process will likely experience a significant learning curve when developing their first course schedule. Associate Deans throughout the nation have struggled with attempts to automate and computerize the scheduling task. Although some have used Microsoft® Excel (Excel) to organize the schedule, Excel does not provide

the extensive individualized parameters necessary to automate the decision-making portion of the process. Discussions on the Associate Dean listserv have confirmed that many law schools have handled scheduling by using a manual process such as a magnetic calendar.

After several false starts, the first author of this Article, as a newly appointed Associate Dean, finally settled on using multi-colored Post-it® Notes on a large paper calendar. This approach worked well for purposes of visualizing conflicts, but was clumsy and potentially disastrous when transporting the schedule between home and work. Once the first author became more experienced with scheduling, she began working with a computer staff member to examine the feasibility of designing a program to handle the process. The staff member discovered the software we evaluated⁴ and after an initial review of the system's capabilities through an online product introduction, the first author decided to use a preview copy of the software and run a Fall 2001 schedule to determine how closely it paralleled the schedule created using the manual scheduling process. The following discussion incorporates the first author's experiences with this parallel run into a descriptive explanation of computerized scheduling. We first review the tools for and literature on course scheduling.

III. REVIEW OF COURSE SCHEDULING LITERATURE & TOOLS

A. Academic Literature

The majority of work on course scheduling that has appeared in academic journals has focused on the methodologies employed to obtain the schedules. The published works are oriented towards business or engineering schools, probably because that is where people with the requisite skill set to develop course scheduling tools reside in an academic environment. We are not aware of any articles that address course scheduling in law schools.

Authors have reported using techniques based on mathematical programming,⁵ heuristics,⁶ and a decision support system (DSS) that serves to

4. ScheduleExpert, Inc., *SchedulExpert Post Secondary* <http://www.schedulexpert.com/index_postsecondary.html> (accessed June 23, 2003).

5. M. A. Badri, *A Two-Stage Multiobjective Scheduling Model for [Faculty-Course-Time] Assignments*, 94 *European J. of Operational Research* 16 (1996); M. A. Badri et al., *A Multiobjective Course Scheduling Model: Combining Faculty Preferences for Courses and Times*, 25 *Computers and Operations Research* 303 (1998).

6. Jaques A. Ferland & Charles Fleurent, *SAPHIR: A Decision Support System for Course Scheduling*, 24 *Interfaces* 105 (1994); Timothy R. Hinkin & Gary M. Thompson, *SchedulExpert: Scheduling*

aid experienced users.⁷ Mathematical programming tends to have limited applicability with the complex set of constraints and preference information required in the law school environment. Likewise, a DSS that simply aided the manual development of a schedule is impractical given the number of courses, rooms and faculty that must be considered in a mid-size law school. Thus, heuristic methods—methods that attempt to find quick and good solutions to complex problems—would seem to have the most relevance in the law school environment.

B. Software Vendors

A search on the internet allows one to find a number of vendors offering commercial course scheduling systems. Table 1 lists the course scheduling packages and company information for selected system vendors. As noted earlier, anecdotal evidence from a listserv for law school associate deans suggests that few law schools have used computerized tools. The reason for this would seem to be that most systems do not have the full feature set required by law schools.

Table 1
Software Packages for Course Scheduling Offered by and Contact Information for Selected Vendors.

Software Package	Company	URL
ASTRA Schedule Gold	Ad Astra Information Systems	http://www.aais.com
CELCAT Timetabling	CELCAT	http://www.celcat.com
gp-Untis	Gruber & Petters Software	http://www.grupet.at
gti-3	Planning Software Ltd.	http://www.plansoft.co.uk
Kat Timetabler	SciSoft	http://www.scisoft-kat.com
ScheduleExpert Post Secondary	ScheduleExpert, Inc.	http://www.scheduleexpert.com
Syllabus Plus	Scientia, Ltd.	http://www.scientia.com

Courses in the Cornell University School of Hotel Administration, 32 *Interfaces* 45 (2002); Scott E. Sampson et al., *Class Scheduling to Maximize Participant Satisfaction*, 25 *Interfaces* 30 (1995); Jan Stallaert, *Automated Timetabling Improves Course Scheduling at UCLA*, 27 *Interfaces* 67 (1997).

7. L. R. Foulds & D. G. Johnson, *SlotManager: A Microcomputer-Based Decision Support System for University Timetabling*, 27 *Decision Support Systems*, 367 (2000).

Table 1 (Cont'd.)

Software Package	Company	URL
TPHi Timetabler	Infosilem, Inc.	http://www.infosilem.com
TTMaker	Root Software Pty Ltd.	http://www.rootsoftware.com
Turbo Timetabler 4.0	www.timetabler.com	http://www.timetabler.com

Our aim in this article is not to provide a comprehensive review of the systems offered by vendors, but rather describe how one school has been able to apply the software of one of the vendors. As such, we provide Table 1 simply to indicate that there is a choice for those schools that are in the market for such systems. By listing the companies in Table 1, we do not mean to suggest that these are the best systems. Which system is best would depend on a school's budget and how well the capabilities of the systems meet the school's needs. In the next section we discuss the capabilities we see as important for course scheduling in law schools.

IV. APPLYING TECHNOLOGY TO COURSE SCHEDULING

To be effective, a technology-based solution to course scheduling in law schools requires a number of key characteristics: a good graphical user interface, a good fit between the requirements of the environment (i.e., constraints and objectives) and the capabilities of the software, a variety of data entry methods, an effective algorithm, strong reporting capabilities and easy integration with other technology systems. We'll discuss each of these in turn.

A. *Good Graphical User Interface (GUI)*

An easy to use interface is a definite requirement for an effective tool. The GUI is the aspect of the tool that occupies the majority of users' time. Good GUIs are intuitive, have context sensitive help and tool-tips (the pop-ups that appear when you pause your mouse over an item)—in other words, the features that one has come to expect with high quality Windows®-based software.

B. *Good Fit between Environment and Capabilities*

The fit between the environment and the capabilities of the tool is important, since if the fit is good, one is not forced into the situation of trying

to adapt one's environment to fit the tool. The environmental characteristics can be categorized as constraints and objectives.

Constraints can be categorized as hard (the things that must be satisfied) or soft (those things that should be accommodated). Examples of hard constraints might be never double-booking a faculty member or never scheduling a faculty member in his/her unavailable time. Examples of soft constraints might be meeting faculty members' room preferences and scheduling faculty members in their preferred teaching times.

Ideally, the hard and soft constraints used in a technology tool would match those that exist in one's environment. If a tool allows one to specify more constraints than actually exist in one's environment, then the constraints can be turned off, or made irrelevant, simply by specifying values for the constraint limits that would not actually affect the results.⁸

The ability to turn off constraints if they are irrelevant is preferable to a tool's inability to represent a relevant constraint.⁹ If a tool does not represent a particular constraint, then one is faced with two undesirable choices: try to adapt one's environment to fit the tool, or try to develop some kind of work-around in the tool itself.

Objectives are the criteria one uses to evaluate the quality of a course schedule. Examples of criteria might be the extent to which faculty are scheduled during their preferred teaching times, the extent of conflict between courses that should have no or minimal conflict, and the utilization of the more desirable rooms in one's facility. Even though two institutions may share the same criteria, it is unlikely that they will agree on the relative importance of the criteria. Thus, another desirable feature would be the ability to identify the priorities on the criteria.

8. For example, *SchedulExpert* can be used to pick the instructors who will teach each course (which is a less common situation than *Pepperdine's*, where a user pre-specifies the faculty teaching each course). In this case, the software considers the maximum number of course preparations for each faculty member. If one's environment does not consider course preps as a relevant factor in the course scheduling process, then the constraint can be made irrelevant by specifying a limit on the number of course preps that equals or exceeds the number of courses a person will teach.

9. During her testing of the *SchedulExpert* software, the first author found just such a problem. At that time, the software would allow one to define the valid meeting-day patterns for courses, but all the courses that could meet for a specified number of days per week would be able to use any of the defined patterns having that number of meeting days. In *Pepperdine's* environment, however, there were more allowable meeting-day patterns for first-year classes, which could meet on consecutive days, than there were for upper-division classes, which generally needed at least one off-day between meetings. With the feature set that existed at that time, *Pepperdine* would have to force the software into imposing the appropriate meeting patterns by restricting each upper-division course from meeting on certain days. By doing so, however, they would have been reducing the overall flexibility available to the scheduler. Rather than force *Pepperdine* to pursue this undesirable action, the second author modified the software so that one could, on a course-by-course basis, define specific meeting-day patterns, or select to use the standard patterns.

C. *A Variety of Data Entry Methods*

To yield good schedules, a scheduling tool requires an extensive set of data on courses, faculty, facilities and students. Ideally an Associate Dean would not be restricted only to entering this data manually. Other means of getting data into a tool could be importing it from text files, databases, or other software packages. Another valuable data collection channel is offered by the internet. A scheduling tool that supports faculty specifying their teaching preferences via the internet can both increase the accuracy of the information¹⁰ and substantially reduce the effort required to enter data. Ideally, course preferences would also be collected on-line from students and this information could then help drive the scheduling process.

D. *Effective Optimization Algorithm*

At its heart, a good tool will have a robust, effective optimization algorithm. The tool should be capable of developing the schedule with little intervention required on the part of the user. It should also be capable of dealing with the full extent of the hard and soft constraints that exist in the law school environment. By harnessing the power of a computer to generate schedules, an effective optimization algorithm will elevate a tool above a manual approach in terms of schedule quality. In our experience, the ability of a scheduling tool to quickly generate a schedule is much less important than having the scheduling tool generate a good schedule. Indeed, when scheduling is done only one or two times per year, even letting a tool run overnight is not particularly burdensome, if the schedule it yields meets the needs of the various constituents.

E. *Strong Reporting Capabilities*

A good scheduling tool should have excellent reporting capabilities. One should be able to view the schedule from student, faculty and facility perspectives. One should be able to print, save, and export reports. Finally, one should be able to see a schedule in a format with which one is familiar. Even if the schedule is excellent, if one has difficulty extracting it from a tool, then the tool's utility suffers.

10. Because errors can be made when translating a paper form into a software package.

F. *Easy Integration with Other Systems*

Computer systems do not exist in a void. Schools may have web-based enrollment tools or room-management tools and there are often university-wide systems with which a course scheduling tool must interact. One does not wish to increase the number of separate data entries that must be made in the different systems; rather the disparate systems should share data and link seamlessly to each other.

V. OUTCOMES

To test the software we evaluated (the software), we compared it against the existing manual course scheduling process. The outcomes of particular interest are the quality of the schedule the software developed, the time commitment required to use the software, and the ability of each faculty member to more closely control the scheduling outcome. We address each of these in turn.

A. *Schedule Quality*

To evaluate the effectiveness of the software, we ran the auto-scheduler for sixty minutes on a Pentium III®-500 based personal computer. During the sixty minutes, the auto-scheduler developed and evaluated 142,900 schedules. We report the results for the best of those schedules, which the auto-scheduler saves. Where possible, we also report how the software's schedule compares to Pepperdine's actual schedule. This comparison can only be done in a general sense, since a number of the courses in the law school's actual schedule did not match the information provided to the software.

B. *Faculty Satisfaction*

Of the fifty-five faculty members teaching in the current term, forty-six were scheduled for their ideal number of teaching days. The other nine faculty were all scheduled for one day fewer than their ideal number of teaching days. For eight of those nine faculty, the requirements on the courses they were teaching prohibited the auto-scheduler from matching their ideal number of days. This result compares well with the law school's actual schedule.

The software does not schedule faculty at times they are designated as unavailable. It attempts to schedule faculty only during their preferred teaching times, but will, if necessary, schedule faculty in their "available

but not preferred” times. Of the fifty-five faculty, fifty-one were scheduled only in their ideal times. The remaining four faculty were scheduled a total of 590 minutes in their available, but not preferred times. However, the timing restrictions imposed on the courses taught by these faculty accounted for 470 of the minutes. Thus, across all fifty-five faculty, the schedule had a total of only 120 minutes of controllable activities scheduled in the available, but not preferred teaching times. In contrast, the law school’s actual schedule would have required scheduling several faculty for times that were identified as unavailable to the software. Also, the law school’s manual schedule had a total of at least 1060 minutes of courses scheduled in faculty’s available, but not preferred teaching times. This is 470 minutes more than in the software’s schedule.

With respect to limiting the total free time between courses within a day, ten of the fifteen faculty teaching more than one course in a day fell within their specified limit on free time. Five faculty exceeded the specified limits, by a total of 230 minutes. Finally, all faculty received their desired minimum time between courses taught on the same day. These results are similar to those in the law school’s manual schedule.

C. Student Satisfaction

Student satisfaction with a schedule is determined based on the conflict between courses the students must take and those they wish to take. The software allows one to define Dispersion Groups—sets of courses within which there should be no (or minimal) conflict. In the law school’s case, there were twelve such groups. Table 2 provides information on these groups and summarizes the schedule conflicts within the groups.

Table 2
Course Conflict Information

Course Group	Type of Group	Courses in Group	Total Contact Hours	Number Days	Number Conflicts
1	Concentration	11	31	5	0
2	Concentration	8	21	5	2
3	Concentration	14	28.5	2	12
4	Concentration	2	5	5	0
5	Required	6	16	5	0
6	Required	6	16	5	0
7	Required	6	16	5	0
8	Concentration	9	20.5	5	1 ^a
9	Concentration	7	16	5	0
10	Concentration	5	12	3	0
11	Concentration	9	26.5	5	3

Table 2 (Cont'd.)

Course Group	Type of Group	Courses in Group	Total Contact Hours	Number Days	Number Conflicts
12	Required	9	26	5	0

^aTwo courses were required to be scheduled at the same time.

First, we note from Table 2 that no required course group, for which conflict must be avoided to have a valid schedule, actually has conflict. In fact, the conflict within any course group is minimal, except for group 3, in which there are twelve conflicts (a conflict being defined as a course pair overlapping in their scheduled times). The reason for the high conflict in this particular group is that 28.5 contact hours must be scheduled during only two days of the week. Given that the courses in this group are restricted to being offered between 1:30 P.M. and 8:30 P.M., there are only fourteen possible contact hours over the two-day period and so some conflict must occur between the courses in this group. In fact, the courses are scheduled so that there are never more than three, or fewer than two, offered at anytime, which is the best possible arrangement in this particular case. The conflicts are comparable to those in the law school's manual schedule.

D. Facility Utilization

The software allows one to rate the desirability of rooms and then schedules to maximize the seat utilization of the desirable rooms. The law school grouped its rooms into two desirability categories: normal (eleven rooms) and high (two rooms). In the software's schedule, the highly desirable rooms had a seat utilization that was 32% higher than that for the rooms of normal desirability. In comparison, in the law school's actual schedule, seat utilization of the more desirable rooms was 10% higher than that of the less desirable rooms.

E. Effort Required

Using a tool like the one we examined clearly requires a substantial amount of data. The software allows one to import or manually enter data. Importing data can reduce the amount of time required, but obviously will only be possible in situations where the necessary data exists in electronic form. In our school, we spent approximately fifteen days entering/importing the data into the software. With any tool, there is a learning curve. The law school's staff validated the software using an iterative process of developing a schedule, examining it, and changing parameters

or having the program modified. We repeated these steps about three times, stopping when we judged the schedule to be acceptable.

The net effect of the time expenditure is that the law school spent about the same time using the software as it would have had the schedule been developed manually. However, we expect significant time savings to be experienced as we use the software for future scheduling needs. The reason for this is that we expect the effort required to maintain the data to be much lower compared to the initial data entry effort. Moreover, since we have moved down the learning curve with the software, we expect a lower number of iterations before an acceptable schedule is found.

F. *Greater Faculty Control over Scheduling*

Finally, one of the most psychologically significant outcomes of using a computerized scheduler is the ability to give faculty more direct input into the scheduling process. The software provides forms, which can be distributed to faculty members to collect faculty scheduling desires. The software also enables an administrator to collect faculty preferences via the internet. By completing an individual profile, the faculty has control over the parameters used for course scheduling. Although compromises will likely be necessary at some point in the process, there is less "bargaining" needed between the Assistant or Associate Dean and the professor because the professor is able to communicate his or her needs directly into the computerized scheduler.

VI. CONCLUSION

Scheduling is a puzzle requiring preparation, patience, and perseverance. Student needs should drive the process, but care must be taken to match these needs with faculty needs. Satisfying academic requirements within the parameters of faculty resources, classroom availability, and student constraints is most properly handled by computer processing. Magnetic calendars, spreadsheets, or table-sized paper charts with multicolored Post-It® Notes, are helpful, but time-consuming and clumsy. After using a preview version of the software to run a sample schedule parallel to a current schedule originally prepared using a manual scheduling process, the first author used the software to prepare the law school's course schedule. The results of the parallel run were amazingly similar to the schedule manually developed using a large paper calendar and moveable Post-It® Notes. We expect that the software will be of great use to new Associate Deans, who have not moved down the learning curve for manual course scheduling.