

Development of Schedule Programming Assistant for Day Classes (SPADay) Version 1.0: Course Timetabling in Excel

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ABSTRACT

Timetabling of class-faculty schedules is complex and lengthy wherein universities assign significant workforce and material resources each semester. Manual scheduling produces conflict schedules of class-faculty and room utilizations that in many instances are determined only when classes have already started. Timetabling problems in CTU are concerned with many students but limited organic faculty members. The objectives of this study were to automate: 1) consolidation of the tabulated schedules from the different departments and colleges; 2) detection of conflict faculty schedules; and 3) pictographic plotting of class-faculty schedules and room utilizations according to the formats adopted by the university with calculated number of contact hours and preparations. The method adapts Visual Basic for Applications programming in Microsoft Excel. From the data of block schedules provided by different departments or colleges, conflict schedules are detected and modified by users. Once harmonized, plotting pictographically class-faculty schedules into program by teacher, program by section, and room utilization are automated. SPADay leads to immediate detection of conflict schedules of faculty members, checking of inconsistent information were implemented, speedy printing of outputs into different

formats, and generation of class-faculty schedules database that can be adopted with minor revisions and fine-tuning of such schedules for proceeding semesters.

Keywords – Information technology, Excel-VBA computer programming, class-faculty or course timetabling, Microsoft Excel, applied research, Cebu City, Philippines

INTRODUCTION

It is common and a fact that building or programming class schedules is complicated and time consuming in which universities allocate a number of staff, faculty and material resources every semester (Valdes, Crespo, & Tamarit, 2002; Miranda, Rey, & Robles, 2012; Kronos Inc., 2003). Scheduling problems in Cebu Technological University (CTU) are concerned with a lot of students with a limited organic faculty. In consequence, students who can only afford to study in a state university like CTU are offered with evening programs just to accommodate them. Likewise, the school has to hire a lot of part-time faculty members to teach day and evening programs. To speed up scheduling of classes and assigning faculty members to classes, the school needs a computer aided class-faculty assignment application software.

Majority of scheduling problems are classified as “combinatorial problems”, such as communications, industrial control, operational research and production planning (Shiau, 2011). Several methods have been applied to course scheduling problems, like heuristic algorithm (Shiau, 2011; Valdes et al., 2002; Pongcharoen, Promtet, Yenradee & Hicks, 2008), integer programming (Kristiansen, Sørensen, Stidsen, 2015; Birbas, Daskalaki, Housos, 2009); and simulated annealing (Avella, D’Auria, Salerno, Vasil’Ev, 2007). Shiau (2011) and Pongcharoen, et al. (2008) proposed for meta-heuristic algorithms having a capability of allowing instructors or lecturers to do lecture based on preferences. Likewise, Lewis (2006) recommends the consideration of “many different sorts of constraints, problem instances, user-requirements and political factors”.

Schedule Programming Assistant has both day and evening versions since CTU caters both day and evening classes. The author presents here the SPADay version 1.0. The importance of this computer-aided class-faculty or course scheduling process are mainly on speeding up or establish on-time preparation of course schedules for every semester, immediate detection of conflicts by creating database of class-faculty schedules, and implementing automated pictographic plotting of schedules by teacher, by section, and by room utilization.

OBJECTIVE OF THE STUDY

The study was focused on automating, without any constraints being considered, the manual process of the adopted university timetabling to improve productivity. Its objectives were to automate: 1) consolidation of the tabulated schedules from the different departments and colleges; 2) detection of conflict faculty schedules; and 3) pictographic plotting of class-faculty schedules and room utilizations according to the formats adopted by the university with calculated number of contact hours and preparations.

MATERIALS AND METHODS

A personal computer (PC), Microsoft Excel software, and class-faculty schedules were mainly the needed materials. Faculty profile such as undergraduate to graduate programs taken, administrative designation, and other recent activities; research, extension, and production were incorporated in the program by teacher (Figure 1a) other than his or her class schedules. The course timetabling proposed in the study is focused on automating the manual process by developing VBA codes in Microsoft Excel that automate detection of conflict schedules, calculation of number of contact hours and preparations, consolidation of the tabulated schedules from the different departments or colleges, pictographic plotting of schedules by teacher, by section and by room utilization according to the formats adopted by the university.

Course Scheduling Process

The primary step applied in SPADay consists of a series of pictographic plotting of block schedules by course-major, year, and section from all academic departments. The first stage focuses on gathering all the information needed in creating class-faculty schedule database. Such database also contains information of courses or subjects, classrooms, number of students, and contact time. Once all of this information is collected and consolidated in one file, then, comes the second stage.

The second stage processes further the database. This stage determines conflict schedules (Figure 1b) given to faculty; accounts the total number of block sections, courses, faculty, and rooms prepared and assigned by schedule planners from all academic departments; and plots pictographically the tabulated schedules into

program by teacher, program by section (Figure 3), and room utilization (Figure 4). At this point, the details of conflict schedules are identified. The planners (Department Heads) from each department and the coordinators (College Directors) meet more frequently to harmonize all schedules by eliminating conflict bookings or timetable conflicts particularly in assigning faculty loads and usage of rooms, and getting rid of overloading faculty assignments in terms of the number of preparations and contact hours per week both in lecture and in laboratory.

As soon as harmonization of all schedules is done, the objective of the third stage is to save outputs of program by teacher, program by section, and room utilization in PDF format before printing all outputs.

RESULTS AND DISCUSSION

Consolidation of Class-Faculty Schedules

Course timetabling or scheduling in CTU is done by department and colleges where consolidation of schedules can be automated in SPA produced in tabular form. For ease of evaluation, consolidated database are having the fields of course-year-section, number of students, subject code, faculty, room, time and day (Figure 1b).

Detection of Conflict Faculty Schedules

As SPADay version 1.0 automates consolidation of all schedules, it can then evaluate the database in terms of conflict schedules given to any faculty member. It can detect either completely or partly overlapping (conflict) schedules. As the code is implemented, the user is notified with the key words “OK” (conflict-free) or “CONFLICT”. Detected conflict schedules are conditionally highlighted with pink color for ease of recognition (Figure 1b & Figure 2).

Pictographic Plotting of Class/Faculty/Room Schedules

Achieving a pictorial representation or pictograph layout aids class schedulers in having a clear picture of the subjects, the day-time when they will be done, the teacher who will perform the task, and the location where to conduct the instruction. As the schedule is pictographically plotted, the number of contact hours and preparations are also calculated (Figure 2 to Figure 5).

Description of SPADay

Hence, the development of SPADay is focused on automating the manual process adopted by the university. Unlike SchedulExpert (Hinkin & Thompson, 2002), udpSkeduler (Miranda, Rey, & Robles, 2012); and those developed by Avella, D'Auria, Salerno, & Vasil'Ev (2007), Birbas, Daskalaki, & Housos (2009), Pongcharoen, P., Promtet, W., Yenradee, P., & Hicks, C. (2008), and Shiau (2011) all of which incorporated constraints or faculty preferences in their algorithm. SPADay does not employ optimization process for constraints or faculty preferences. It has similarity to SlotManager (Foulds & Johnson, 2000) where the computer codes (macros) are written in Microsoft Windows environment. However, like SchedulExpert and udpSkeduler, SPADay make use of an intuitive graphical interface. Very much similar to SPAEve version 2 (Mondejar, 2013), SPADay adopts a practical pictographic heuristic interface of plotting schedules by section. From the pictograph by section, pictograph schedules by teacher, room utilization and subject can be generated. SPADay is a spreadsheet-based decision support system (Power & Sharda, 2007) developed in Microsoft Excel.

SPADay is a class-faculty scheduling assistant that has VBA codes and procedures using macros in Microsoft Excel to automate the generation of program by teacher, program by section, room utilization, and subject. It can determine conflict schedules where such schedules can be modified easily. Fused schedules are also detected and plotted in schedule forms. Instructional forms of programs by faculty, section, and room utilization can be readily printed as outputs of the application. SPADay also looks into another workload of a faculty other than instruction like research, extension, and production activities. Faculty profile such as undergraduate to graduate programs (Bachelor to Doctoral degrees), and special skills or trainings taken is likewise considered. Tabular schedules by section can also be generated.

TIME	Mondajar, J							status
	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	
6:00-7:00								OK
7:00-8:00								CONFLICT
8:00-9:00								OK
9:00-10:00								CONFLICT
10:00-11:00								OK
11:00-12:00								CONFLICT
12:00-1:00								OK
13:00-14:00								CONFLICT
14:00-15:00								CONFLICT
15:00-16:00								CONFLICT
16:00-17:00								CONFLICT

TIME	BSIT I - B							status
	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	
6:00-7:00								OK
7:00-8:00								OK
8:00-9:00								OK
9:00-10:00								OK
10:00-11:00								OK
11:00-12:00								OK
12:00-1:00								OK
13:00-14:00								OK
14:00-15:00								OK
15:00-16:00								OK
16:00-17:00								OK

TIME	M 201							status
	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	
6:00-7:00								OK
7:00-8:00								CONFLICT
8:00-9:00								OK
9:00-10:00								CONFLICT
10:00-11:00								CONFLICT
11:00-12:00								CONFLICT
12:00-1:00								OK
13:00-14:00								CONFLICT
14:00-15:00								CONFLICT
15:00-16:00								CONFLICT
16:00-17:00								CONFLICT

Figure 2. Pictographic output of Program by Teacher (left), Program by Section (middle), and Room Utilization (right) where actual class-faculty contact time (yellow) and conflicts (pink) are highlighted automatically with the number of preparations and the total hours per week.



Republic of the Philippines
CEBU TECHNOLOGICAL UNIVERSITY
 BARILI CAMPUS
 Barili, Cebu



PROGRAM BY TEACHER
DAY PROGRAM
 2nd Semester, AY 2012-2013

INS Form 5A
 October 2012
 Revision: 1

NAME: **Engr. Jeremy P. Mondejar**

Bachelor Degree: Agricultural Engineering Status: Organic
 Master Degree: Water Resources Engineering Major: Water
 Doctoral Degree: Minor: Agricultural

Special Training: SWAT, VBA, WETSPRO, GIS, Remote Sensing, Hydrological Extremes Analysis

TIME	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
7:00-8:00							
8:00-9:00							
9:00-10:00	Math 6 BSAE 2 M204 9:00- 11:00	Eng'g 1 BSAE 2 M204 9:00- 12:00	Math 6 BSAE 2 M204 9:00- 12:00	Eng'g 1 BSAE 2 M204 9:00- 12:00			
10:00-11:00							
11:00-12:00							
12:00-1:00							
1:00-2:00		Math 3a CAS II-B To 104 13:00- 14:00	Eng'g 1 BSAE 2 M204 13:00- 14:00	Math 3a CAS II-B To 104 13:00- 14:00			
2:00-3:00	Math 3a CAS II-B To 104 14:00- 17:00						
3:00-4:00							
4:00-5:00							
5:00-6:00							
6:00-7:00							

Recommending Approval: **VICTOR D. VILLAGANAS, LL.B., Ed.D.**
 University Vice-President for Academic Affairs
 Approved: **BONIFACIO S. VILLANUEVA, Ed.D.**
 University President
 Reviewed & Certified True & Correct: **ALFREDO C. NEBLI, ME4**
 Director - CATM
 Certified Proper & in Order: **CATALINO S. HIGIDA, PhD-TM**
 Campus Director
 Prepared by: **JEREMY P. MONDEJAR, Edcor., MSc**
 Chair - DAET

No. of Student	Subject code	Descriptive Title	Course/Yr/Sec
11	Eng'g 1	Surveying	BSAE 2
7	Math 2	Plane Trigonometry	BSAE 1
30	Math 3a	Basic Statistics	CAS II-B
11	Math 6	Analytic Geometry and Calculus II	BSAE 2

No. of Preparations: 4 Administrative Designation: Chairman - Dept. of Agr'l Eng'g & Technology
 No. of Hours/Week: 17 Production: SPA PRODN
 Extension: SPA EX
 Research: SPA

Figure 3. Pictographic output of Program by Teacher where actual class-faculty contact time outlined and all the necessary details of courses/subjects assigned including profile of the teacher are generated automatically



Republic of the Philippines
CEBU TECHNOLOGICAL UNIVERSITY
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 Barili, Cebu



PROGRAM BY SECTION
 DAY PROGRAM
 2nd Semester, AY 2012-2013

INS Form 5B
 October 2012
 Revision: 1

Curriculum and Year: **BSIT 1B**

Major: **Computer Technology**

Advisee: **Engr. Jerome Aguilar**

Assignment: **Ground and Classroom Cleaning**

TIME	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
7:00-8:00							
8:00-9:00	Math 2 Pohino, S To 201 8:00-9:30	Tech 122 Amejo, W M203 8:00-11:00	Math 2 Pohino, S To 201 8:00-9:30	Tech 122 Amejo, W M203 8:00-11:00		NSTP 2 Albarracin, G Covered Court 8:00-11:00	
9:00-10:00	Tech 122 Amejo, W M203 9:30-11:00		Tech 122 Amejo, W M203 9:30-12:00		Comp 1 Calvo, C M201 9:00-12:00		
10:00-11:00							
11:00-12:00	Hum 1 Basallo, J L 202 11:00-12:00	Soc Sci 2 Escabal, L M 103 11:00-12:00		Soc Sci 2 Escabal, L M 103 11:00-12:00			
12:00-1:00							
1:00-2:00	Tech 122 Amejo, W M203 13:00-16:00	Hum 1 Basallo, J L 202 13:00-14:00	Tech 122 Amejo, W M203 13:00-15:00	Hum 1 Basallo, J L 202 13:00-14:00	Soc Sci 2 Escabal, L M 103 13:00-14:00		
2:00-3:00	Engl 2 Flores, J L 204 14:00-15:30	Engl 2 Flores, J L 204 14:00-15:30	PE 2 Chu, M L 102 15:00-17:00	Engl 2 Flores, J L 204 14:00-15:30	Draw 122 Pohino, S M202 14:00-17:00		
3:00-4:00	Fil 2 Gonzales, B L 201 15:30-17:00	Fil 2 Gonzales, B L 201 15:30-17:00		Fil 2 Gonzales, B L 201 15:30-17:00			
4:00-5:00							
5:00-6:00							
6:00-7:00							

Prepared by: **JEREMY P. MONDEJAR, Engr., MSc**
 Chair-DAET

Certified Proper & in Order:
CATALINO S. LIGIDA, PhD-EdM
 Campus Director

Reviewed & Certified True & Correct:
ALFREDO C. NERILME
 Director-CATM

Approved:
BONIFACIO S. VILLANUEVA, EdD
 University President

Recommending Approval:
VICTOR D. VILLAGANAS, LL.B., EdD
 University Vice-President for Academic Affairs

No. of Student	Subject code	Descriptive Title
41	Comp 1	Basic Computer Operation
	Draw 122	Technical Sketching, Instrument Drawing and Blueprinting w/ CAD
	Engl 2	Writing in the Disciplines
	Fil 2	Pagbasa at Pagsulat Tungo sa Pananaliksik
	Hum 1	Art Appreciation
	Math 2	Plane Trigonometry
	NSTP 2	CWTS/ ROTC/ LTS 2
	PE 2	Advanced Swimming
	Soc Sci 2	Basic Economics (w/ Taxation & Land Reform)
	Tech 122	AC/DC Circuit and Electrical Instrument

Figure 4. Pictographic output of Program by Section where actual class-faculty contact time outlined and all the necessary details of courses/subjects assigned including profile of the teacher are generated automatically



Republic of the Philippines
CEBU TECHNOLOGICAL UNIVERSITY
 BARILICAMPUS
 Barili, Cebu
ROOM UTILIZATION
DAY PROGRAM
 2nd Semester, AY 2012-2013



INS Form 5C
 October 2012
 Revision: 1

Room Assignment: **M 201**

TIME	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
7:00-8:00							
8:00-9:00	Comp 1 BSIT I- A Calvo, C 8:00-11:00	Tech 326 BSIT I Aguilar, J 8:00-12:00		Tech 326 BSIT I Aguilar, J 8:00-12:00	IndlMgt 326 BSIT I Calvo, C 8:00-9:00		
9:00-10:00		Comp 1 BSHML A Calvo, C 9:30-10:30	IndlMgt 326 BSIT I Calvo, C 9:30-11:30	Comp 1 BSHML A Calvo, C 9:30-10:30	ES 111a Pohino, S 9:00-12:00		
10:00-11:00		Comp 1 BSHML A Calvo, C 10:30-12:00		Comp 1 BSHML A Calvo, C 10:30-12:00			
11:00-12:00							
12:00-1:00							
1:00-2:00	OJT 2 BSIT IV Calvo, C 13:00-17:00	Comp 1 BSHML B Calvo, C 13:00-14:00	Tech 326 BSIT I Aguilar, J 13:00-17:00	ES 111a BSAE 2 Pohino, S 13:00-16:00	Tech 326 BSIT I Aguilar, J 13:00-16:00		
2:00-3:00		Comp 1 BSHML B Calvo, C 14:00-15:30	Comp 1 DVM2 Calvo, C 14:00-17:00	Comp 1 BSHML B Calvo, C 14:00-15:30	Comp 1 BEED I Calvo, C 14:00-17:00		
3:00-4:00							
4:00-5:00	ES 111a BSAE 2 Pohino, S 16:00-17:00	Comp 1 BEED II Calvo, C 16:00-17:00		Comp 1 BEED I Calvo, C 16:00-17:00			
5:00-6:00							
6:00-7:00							
Prepared by: <u>JEREMY P. MONDEJAR, Engr., MSc</u> Chair-DAET							
Reviewed & Certified True & Correct: <u>ALFREDO C. NERI, MEd</u> Director- CATM				Certified Proper & in Order: <u>CATALINO S. HIGIDA, PhD-TM</u> Campus Director			
Recommending Approval: <u>VICTOR D. VILLAGANAS, L.L.B., Ed.D</u> University Vice-President for Academic Affairs				Approved: <u>BONIFACIO S. VILLANUEVA, Ed.D</u> University President			

Figure 5. Pictographic output of Room Utilization where actual class-faculty contact time outlined and all the necessary details of courses/subjects assigned including profile of the teacher are generated automatically

Pictographic scheduling

SPADay consists of several worksheets with three (3) main groups. The first group is the main data group of block schedules, where 24 block schedules (4 blocks per worksheet) can be plotted and the database. This group stores the schedule related information that is necessary in generating the three (3) main outputs such as program by teacher, program by section, and room utilization. The pictographically plotted block schedules (Figure 1) comprises mainly of time and 7-day columns for the corresponding days of the week. The pictograph has several four (4)-row enclosed cells for the four (4) necessary details of subject code, teacher, room and contact time as the needed information for every course to be taken by a particular program for a corresponding semester. This pictographic approach facilitate the planner in having visual picture of the block schedule, where same approach is applied in the output of program by teacher, program by section, and room utilization. The pictographic data of the block schedules sheets serve as source of data for which are tabulated and sent to the “Database” sheet (Figure 1). In the “Database” sheet, conflicts and inconsistent data can be determined.

The second group is the pictographic outputs of program by teacher, program by section, and room utilization (Figure 2). This group process the database where schedules for a particular faculty, section, and room usage are plotted pictographically. Here, conflict schedules for a particular faculty, section, and room are seen and identified. This is where schedule planners (Department Heads) and the coordinators (College Directors) decide on harmonizing schedules by eliminating conflicts particularly in assigning faculty loads and usage of rooms. Getting rid of overloading faculty assignments in terms of the number of preparations and class-faculty contact hours per week are also seen.

The third group is the final outputs, which are intended for the production of hard copies of the final and executable class-faculty schedules and room utilization (Figure 3 to Figure 5). This group automates the generations of program by teacher, program by section, and room utilization for distribution to faculty and posting of class schedules during enrolment period. This process saves a lot of time in the generation of outputs due to successful automation.

Based on the initial tests of SPADay version 1.0, some other aspects have to be included in the system for better capabilities and results. Among them are to determine immediately in one worksheet in terms or overloaded and underloaded faculty, number of preparations and student contact hours per week, and conflicts not only on faculty loads but also usage of rooms. The author intends to simplify

the standard forms of the program by teacher, program by section, and room utilization; improve pictographic plotting such that the pass 30 minutes of the hour should be plotted exactly and modify codes and procedures to speed-up processing time.

CONCLUSIONS

The study in developing a VBA codes and procedures in Microsoft Excel has generated satisfactory pictographic plotted class-faculty schedules and classroom utilizations. Class-faculty schedules were done without considering constraints like time availability of instructors. However, such consideration can be applied only by the schedule planner, but not as an input constraint in SPADay. Nevertheless, the results show significant improvement compared to the manual approach.

Using SPADay in course scheduling has led to better productivity. First, the working time required in plotting separately and manually three needed outputs of program by teacher, program by section, and room utilization has significantly reduced to a single plotting of program by section and the rest were successfully automated. Second, early and immediate detection of conflict schedules and inconsistent information were implemented. Third, the time required for the harmonization of class-faculty schedules and room utilization had also reduced. Fourth, printing of outputs for the distribution of hard copies for program by teacher, program by section, and room utilization using the corresponding required formats has been automated and accelerated. Finally, the database that is generated in SPADay can be adopted with minor revision and fine-tuning of schedules for proceeding same semesters. Hence, SPADay has bridge and reduced the gap between manual and automated class-faculty scheduling.

TRANSLATIONAL RESEARCH

The results of the study have been translated as a tool to speed up course timetabling in Cebu Technological University. The intent of this application software has translated assistance to class-faculty planners in creating class-faculty schedules with no or minimal conflicts in a significantly reduced time compared to the pure manual process. This initial research, likewise, translates awareness that course timetabling application software can be developed in spreadsheets (particularly in Microsoft Excel). Such discovery of the versatility of Microsoft

Excel provides an idea that spreadsheets are an effective medium as a decision support system for university course timetabling.

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