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SPAEve Version 2: An Improved Course and Classroom Scheduling Adapted for Evening Classes

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ABSTRACT

An Excel template SPAEve is further enhanced to assist course timetabling in CTU campuses. SPAEve version 1 was tested by schedule programmers of CTU yet there were issues like failure of the system to run on some computers and more needed capabilities should be added into the system. Some CTU campuses were successful in using SPAEve version 1 in scheduling their evening classes. SPAEve version 2 addresses these issues aiming for a successful usage of the software. This enhanced version now runs with Windows operating system, at least with 2 GB memory in Microsoft Excel 2007. The following features are added in this version: (a) external-reference of schedule, faculty profile, prospectus, advisory, and designation databases to reduce memory requirement and speed-up calculation; (b) detection of data that will cause run-time error; (c) userforms for ease-of-use; (d) detection of conflicts of room utilization; (d) detection of over-loaded or under-loaded faculty; (f) improved pictographic plotting of program by teacher, program by section, and room utilization; (g) determination of subjects not found on prospectus database; and (h) summary of schedules. SPAEve version 2 further demonstrates its considerable importance to achieve a better productivity in course timetabling for evening classes in CTU campuses.

Keywords - Information Technology, VBA programming, Class-faculty or course scheduling, Microsoft Excel, Cebu City, Philippines

INTRODUCTION

SPAEve (Schedule Programming Assistant for Evening Classes) is a class-faculty scheduling assistant that has macros of visual basic for applications (VBA) in Microsoft Excel to automate the generation of program by teacher, program by section, room utilization, and subject schedules for evening classes. It can determine conflicts in schedules both faculty loads and room utilization 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 this application. SPAEve also looks into other workload of 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.

Cebu Technological University (CTU) caters evening classes to accommodate more students where schedules are by block sections according to degree-year-section prepared by the different Department Chairs. The main task of Department Chair is to plot class schedules of all degree offerings in the department according to year and sections, when there are more than one section. Recently, class scheduling problems in CTU are concerned with an increase in enrollment while having a limited full-time organic faculty. During enrollment period, the Department Chair monitors the progress of enrollment for every degree offering in the department particularly freshmen so that an appropriate number of sections for a degree are considered. Thus, to further speed up course scheduling for evening classes, SPAEve has to be enhanced.

Academic faculty-class scheduling is complicated and time consuming challenging problem encountered by academic institutions (Valdes, Crespo, & Tamarit, 2002; Miranda, Rey, & Robles, 2012; Boland, Hughes, Merlot, & Stuckey, 2008). Problems with class programming is not new and it has been studied extensively and been addressed by different approaches (Schaerf, 1999; Lewis, 2008). However, in practice, "only a small number of these studies have been implemented as decision support system (DSS)" (Miranda, Rey, & Robles, 2012). In the case of CTU, not all class programmers (faculty and staff involve in class scheduling) have successfully adapted to SPAEve version 1 due to some issues like a failure of the system to run on some computers, users need more training on the use of the technology and more needed capabilities should be added into the system. There are underlying factors as to this scenario where some are negative perception about the application, resistance

to change particularly in adaption of new technology (Cooper & Zmud, 1990), and organization's lack of commitment (Ginzberg, 1981).

OBJECTIVE OF THE STUDY

The objective of this study was to enhance the first version of SPAEve to:

- Make SPAEve run smoothly in personal computers with Windows operating system with at least 2 GB random access memory in Microsoft Excel 2007 by
    a. creating external references of schedule database, faculty profile, prospectus and other needed data
    b. speed up macro processing time by modifying VBA codes and procedures and turning off screen update
- Add userforms for ease of use
- Determine data that will cause run-time error
- Detect conflicts in room utilizations viewed together with conflicts in faculty schedules
- Detect overloaded and under-loaded faculty
- Improve pictographic plotting of program by teacher, program by section, and room utilization
- Determine subject codes not found in prospectus
- Summarize schedules by block section

MATERIALS AND METHODS

A personal computer (PC), Microsoft Excel software, and class-faculty schedules were mainly the needed materials in developing SPAEve. Faculty profile (undergraduate to graduate programs taken, administrative designation, and other recent activities in research, extension, and production), prospectus of all degree offerings, and section advisories were the needed data to be incorporated in the program by the teacher and section accordingly.

There are primarily two (2) kinds of SPAEve workbooks the SPAEve Department and SPAEve Consolidated that process respectively the schedules at the department level and the consolidated or all schedules of the campus. From version 1, the database of schedules and other needed data are in the same workbook (Figure 1). The approach in resolving the central problem that SPAEve version 1 fails to run on personal computers with low specification or that primarily has low random ac-

cess memory (RAM) and the processor is to restructure SPAEve aiming at reducing memory requirement. Since SPAEve is a workbook in Excel, reducing the size of the workbook and applying external reference for database of consolidated schedules and needed data was the key to reduce memory requirement (Figure 1) as the memory requirement is directly proportional to size of workbook (Add-ins.com LLC, 2013).

In SPAEve version 2, macro codes and procedures were modified, selecting sheet objects were avoided, conditional formats and formulas in worksheets were minimized, and screen updating is off until the code has finished executing to improve its performance (Balson, 1998).

RESULTS AND DISCUSSION

Reducing the number of block section schedules from 24 to 12 (**Error! Reference source not found.**) and creating separate workbook for Needed Data (faculty profile, prospectus, designation and advisory), the size of SPAEve Department reduces by about 75%. Likewise, creating separate workbooks for Consolidated Schedules Database and for Need Data as shown in **Error! Reference source not found.** reduces the workbook size of SPAEve Consolidated by about 80%. As VBA codes and procedures were also modified and screen update is turned off consequently improved macro processing time roughly by 5, 3, and 3 times faster than version 1 in processing schedule by teacher, section, and room utilization, respectively, both for SPAEve Department and SPAEve Consolidated.

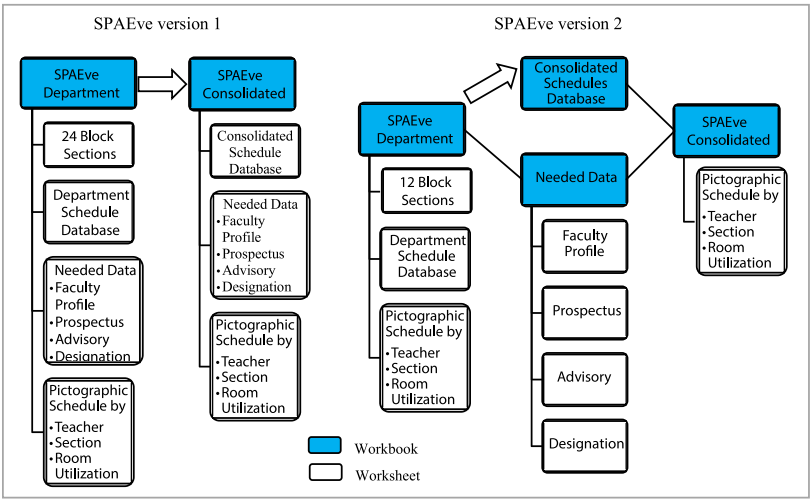


Figure 1. Restructuring SPAEve

User forms in SPAEve are designed to serve as window or dialog box. A main userform guides schedule programmers of the routinely procedures in processing the database of schedules. Schedules are stored in a ***DATABASE*** sheet where macro buttons in processing the database are grouped into three (3) with a corresponding userform (**Error! Reference source not found.**). Steps are easy to follow as the three group of userforms are indicated with 1st, 2nd, and 3rd order.

Adding capabilities in SPAEve version 2 makes it more user friendly. First, there can be data that will cause run-time error and stop the calculation process undesirably of which the desired outcome of that particular macro will not be achieved. To avoid this scenario, where users got stack and do not know what to do, a macro is added to determine data entries that may cause run-time error. A cell that is found to have error is highlighted for ease of correction.

Secondly, resolving conflicts in course schedules are the most challenging task on the part of schedule programmers. Conflicts are not only on faculty loads, as some faculty are given load from several departments, but conflicts on the use of rooms are also encountered in CTU. Thus, the newer version of SPAEve can determine conflicts both faculty loads and room utilization.

Thirdly, due to the limited number of faculty, faculty can be loaded from several departments without a prior knowledge on the status one's faculty load. Hence, a macro that determines overloaded or under-loaded faculty is added to aid in practicing fair and balance faculty loading.

CTU adapts pictographic presentation of class schedules by teacher, section, and room utilization. The pictographic presentation of class schedules is further enhanced in SPAEve version 2. CTU offers a number of degree programs with several major particularly in industrial technology. Consequently, subject codes of each degree program should be entered at prospectus database. SPAEve version 2 has a macro to check whether a particular subject code(s) assigned to class schedules are found in prospectus database or not. Finally, the database of consolidated schedules can be summarized in tabulated format by block section where days with same schedules are fused.

User's Manual for SPAEve version 2

The SPAEve template was created using Microsoft Excel 2007 and the macro were coded with Microsoft Visual Basic for Applications. The template for SPAEve Department consists of 20 worksheets: Sched1 to Sched3, Database, Faculty1 to Faculty4, INSFAC, Section1 to Section4, INSEC, Room1 to Room3, INSROOM, Subject, and day-time code. While the template for SPAEve Consolidated consists of 17 worksheets: Faculty1 to Faculty4, INSFAC, Section1 to Section4, INSEC,

Room1 to Room3, INSROOM, Subject, and day-time code, and SecSubFacRoom. The data of class-faculty section block schedules are entered into Sched1 to Sched3 worksheets of which every SPAEve Department can handle 12 block schedules. The different macros can be activated by using the buttons and userforms. The general procedure in using SPAEve Department are as follows:

Step 1. Naming list of degree offerings, faculty, and rooms
Step 2. Pictographic plotting of degree-year-section-major block schedules
    2.1. Tabulate or Re-Tabulate schedules
    2.2. Send tabulated schedules to the DATABASE worksheet
Step 3. Processing Schedules at DATABASE sheet.

The ***SPAEve Department*** and ***SPAEve Consolidated*** can be named or renamed to the desire of the schedule programmers from the different departments applying names that can be easily recognized. However, the ***Consolidated Schedules Database*** and ***Needed Data*** workbooks filenames should be retained to avoid failure in submitting schedules to consolidated database and getting information from these workbooks.

Naming list of degree offerings, faculty, and rooms

To be consistent with all entries, the naming of degree offerings, faculty, and rooms should be agreed upon by all departments' schedule programmers so that every entry related to a particular name will be accounted. These information should be entered first and only in Sched1 worksheet (**Error! Reference source not found.**) before plotting the block schedules. The lists provided will become items to be selected in the drop-down list.

Pictographic plotting of degree-year-section-major block schedules

All input data for block schedules are entered in Sched1, Sched2, and Sched3. As shown in **Error! Reference source not found.**, information about the degree, year, section, major, and number of students are entered at the top portion of a block schedule. Ensuring valid data entry particularly on the subject code, faculty, room, and time is an important task; thus, to prevent invalid data entry in a worksheet, a drop-down list for these items are provided making the data entry go smoothly. In other words, only those lists provided as agreed upon by the schedule programmers (e.g. **Error! Reference source not found.**) are the valid choices. If a particular subject code, faculty, room or time is not among the list, such data can be added in the list applying the agreed way of naming. For every subject timetabling, four items should

be completely entered such as subject code, faculty, room, and time entered at a corresponding day-column and time-row. In selecting which time-row, just take note of start-time. For example, if it starts at 8:00 or 8:30 AM, subject timetabling should be entered at 8:00-9:00 time-row (**Error! Reference source not found.**).

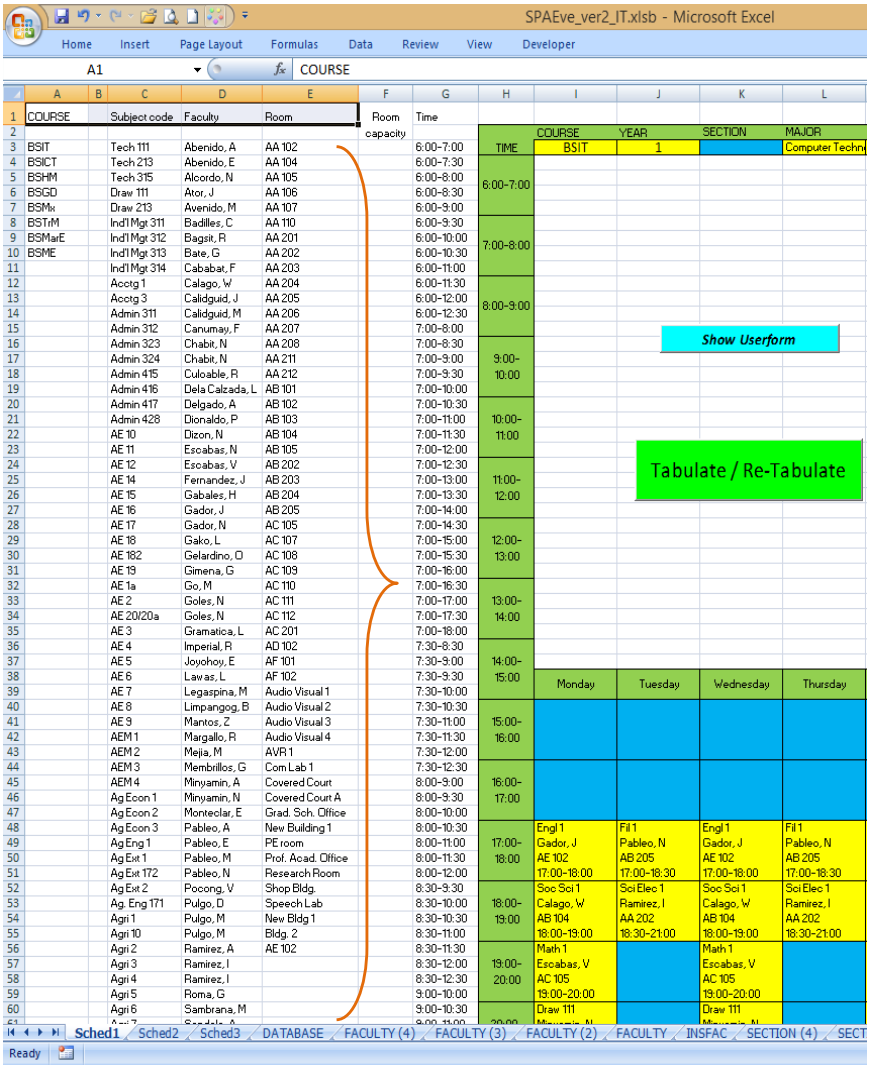
After pictographic plotting of degree-year-section-major block schedules, schedules has to tabulated or re-tabulated by clicking on the ***Tabulate/Re-Tabulate*** button making them ready to be sent to DATABASE worksheet. Click on ***Show Userform*** to view the main userform (**Error! Reference source not found.**). Click on ***To Internal DB*** to submit tabulated schedules of Sched1 to Sched3 sheets to DATABASE sheet.

Processing Schedules at DATABASE sheet

Showing the main userform guides the user on the steps to follow in processing schedules at DATABASE sheet (**Error! Reference source not found.**). The macros are grouped as 1st, 2nd, and 3rd as the repetitive steps to follow accordingly. It is repetitive since the user can add schedules at schedule worksheets (Sched1, Sched2, Sched3) anytime and repeat the procedure from step 2 or step 1 if necessary. At this stage, the different degree-year-section-major block schedules at DATABASE sheet can now be examined in terms of errors in data entries; list of faculty, sections, rooms, and subject codes with schedules; conflicts in faculty load and room utilization; subject codes not found in prospectus; details of faculty load in terms of class hours per week, number of preparations and units, and over-loaded or under-loaded status.

- SPAEve version 2 is provided with a macro that checks data entries that may cause run-time error. Run ***Correct first: Data Entries that may cause run-time error*** to avoid stopping the calculation process undesirably of which the desired outcome of that particular macro will not be achieved.
- There is no strict sequence to follow in running the different macro buttons at the different group of macros (1st, 2nd, and 3rd). However, the most important macro to be performed before proceeding to the 2nd and 3rd groups is to click on

Prior to running Program by Faculty, Program by Section, Room Utilization, and Subject. This creates the list of faculty, sections, rooms, and subjects with schedules. Thus, this macro should be run again whenever schedules are added or changed to make sure that all schedules accounted accordingly.



COURSE	Subject code	Faculty	Room	Room capacity	Time
BSIT	Tech 111	Abenido, A	AA 102		6:00-7:00
BSICT	Tech 213	Abenido, E	AA 104		6:00-7:30
BSHM	Tech 315	Alcordo, N	AA 105		6:00-8:00
BSGD	Draw 111	Ator, J	AA 106		6:00-8:30
BSMx	Draw 213	Avenido, M	AA 107		6:00-9:00
BSTrM	Ind'l Mgt 311	Badilles, C	AA 110		6:00-9:30
BSMarE	Ind'l Mgt 312	Bagsit, R	AA 201		6:00-10:00
BSME	Ind'l Mgt 313	Bate, G	AA 202		6:00-10:30
	Ind'l Mgt 314	Cababat, F	AA 203		6:00-11:00
	Acctg 1	Calago, W	AA 204		6:00-11:30
	Acctg 3	Calidguid, J	AA 205		6:00-12:00
	Admin 311	Calidguid, M	AA 206		6:00-12:30
	Admin 312	Canumay, F	AA 207		7:00-8:00
	Admin 323	Chabit, N	AA 208		7:00-8:30
	Admin 324	Chabit, N	AA 211		7:00-9:00
	Admin 415	Culoable, R	AA 212		7:00-9:30
	Admin 416	Dela Calzada, L	AB 101		7:00-10:00
	Admin 417	Delgado, A	AB 102		7:00-10:30
	Admin 428	Dionaldo, P	AB 103		7:00-11:00
	AE 10	Dizon, N	AB 104		7:00-11:30
	AE 11	Escabas, N	AB 105		7:00-12:00
	AE 12	Escabas, V	AB 202		7:00-12:30
	AE 14	Fernandez, J	AB 203		7:00-13:00
	AE 15	Gabales, H	AB 204		7:00-13:30
	AE 16	Gador, J	AB 205		7:00-14:00
	AE 17	Gador, N	AC 105		7:00-14:30
	AE 18	Gako, L	AC 107		7:00-15:00
	AE 182	Gelardino, O	AC 108		7:00-15:30
	AE 19	Gimena, G	AC 109		7:00-16:00
	AE 1a	Go, M	AC 110		7:00-16:30
	AE 2	Goles, N	AC 111		7:00-17:00
	AE 20/20a	Goles, N	AC 112		7:00-17:30
	AE 3	Gramatica, L	AC 201		7:00-18:00
	AE 4	Imperial, R	AD 102		7:30-8:30
	AE 5	Joyohoy, E	AF 101		7:30-9:00
	AE 6	Lawas, L	AF 102		7:30-9:30
	AE 7	Legaspina, M	Audio Visual 1		7:30-10:00
	AE 8	Limpangog, B	Audio Visual 2		7:30-10:30
	AE 9	Mantos, Z	Audio Visual 3		7:30-11:00
	AEM 1	Margallo, R	Audio Visual 4		7:30-11:30
	AEM 2	Mejia, M	AVR 1		7:30-12:00
	AEM 3	Membrillos, G	Com Lab 1		7:30-12:30
	AEM 4	Minyamin, A	Covered Court		8:00-9:00
	Ag Econ 1	Minyamin, N	Covered Court A		8:00-9:30
	Ag Econ 2	Monteclar, E	Grad. Sch. Office		8:00-10:00
	Ag Econ 3	Pableo, A	New Building 1		8:00-10:30
	Ag Eng 1	Pableo, E	PE room		8:00-11:00
	Ag Ext 1	Pableo, M	Prof. Acad. Office		8:00-11:30
	Ag Ext 172	Pableo, N	Research Room		8:00-12:00
	Ag Ext 2	Pocong, V	Shop Bldg.		8:30-9:30
	Ag. Eng 171	Pulgo, D	Speech Lab		8:30-10:00
	Agri 1	Pulgo, M	New Bldg 1		8:30-10:30
	Agri 10	Pulgo, M	Bldg. 2		8:30-11:00
	Agri 2	Ramirez, A	AE 102		8:30-11:30
	Agri 3	Ramirez, I			8:30-12:00
	Agri 4	Ramirez, I			8:30-12:30
	Agri 5	Roma, G			9:00-10:00
	Agri 6	Sambrana, M			9:00-10:30

TIME	COURSE	YEAR	SECTION	MAJOR
	BSIT	1		Computer Technr

TIME	Monday	Tuesday	Wednesday	Thursday
6:00-7:00				
7:00-8:00				
8:00-9:00				
9:00-10:00				
10:00-11:00				
11:00-12:00				
12:00-13:00				
13:00-14:00				
14:00-15:00				
15:00-16:00				
16:00-17:00				
17:00-18:00	Engl 1 Gador, J AE 102 17:00-18:00	Fil 1 Pableo, N AB 205 17:00-18:30	Engl 1 Gador, J AE 102 17:00-18:00	Fil 1 Pableo, N AB 205 17:00-18:30
18:00-19:00	Soc Sci 1 Calago, W AB 104 18:00-19:00	Sci Elec 1 Ramirez, I AA 202 18:30-21:00	Soc Sci 1 Calago, W AB 104 18:00-19:00	Sci Elec 1 Ramirez, I AA 202 18:30-21:00
19:00-20:00	Math 1 Escabas, V AC 105 19:00-20:00		Math 1 Escabas, V AC 105 19:00-20:00	
20:00			Draw 111	

Figure 2. The naming of degree offerings, faculty, and rooms should be agreed upon by all departments' schedule programmers

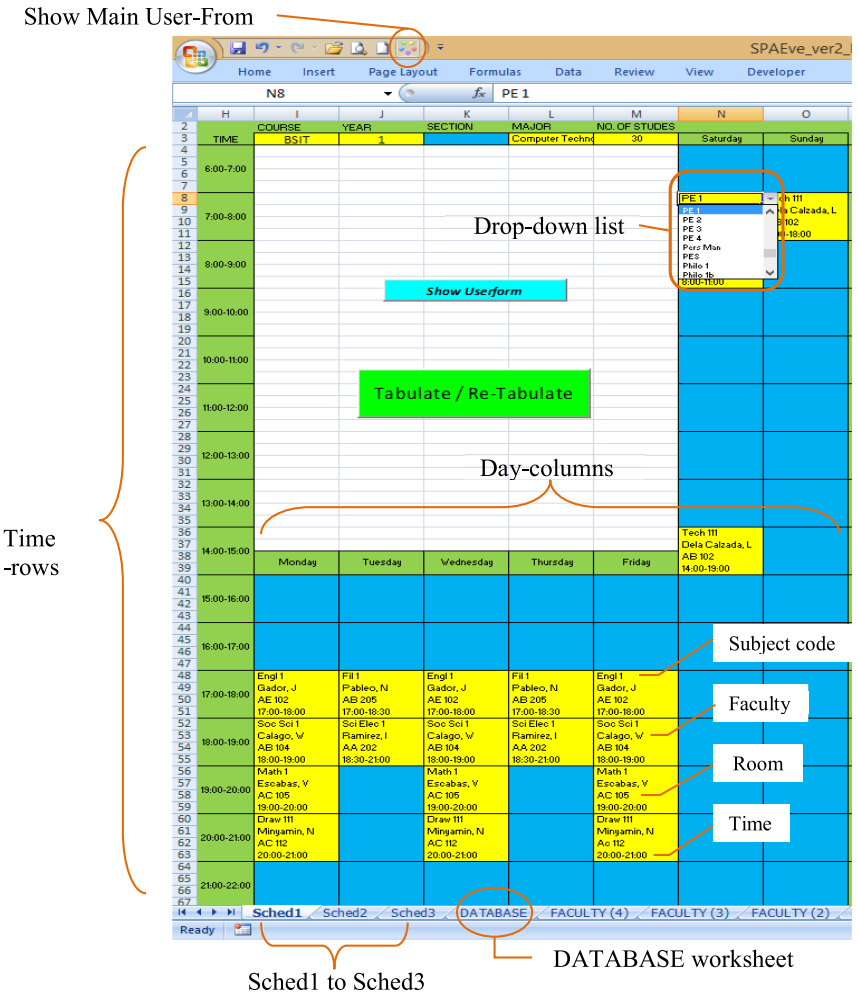


Figure 3. SPAEve template at Schedule (Sched 1, Sched 2, Sched 3) worksheets

Figure 4. SPAEve version 2 Userforms

Once data entries are corrected and list of faculty, sections, rooms, and subjects with schedules are generated; the schedules by teacher, by section, and room utilization can be plotted pictographically by choosing an item on the list and running the 2nd group of macros (**Error! Reference source not found.**). Consequently, the final output of SPAEve, as a standard instructional form adapted by the CTU (INSFAC, INSSEC, and INSROOM) can be obtained by running the 3rd group of macros. Whichever is processed at FACULTY, SECTION, and ROOM worksheets will be the item to be processed at INSFAC, INSSEC, and INSROOM, respectively. The user has the option to use the 2nd and 3rd group of userforms or directly use the combo list and macro buttons on FACULTY, SECTION, ROOM, INSFAC, INSSEC, and INSROOM worksheets. For INSFAC, INSSEC, and INSROOM just click on ***Update Load and Faculty Details, Update Section Load,*** and ***Update Room Utilization***, respectively.

The Needed Data Workbook

The ***Needed Data*** workbook contains the faculty profile (undergraduate to graduate programs taken, administrative designation, and other recent activities in research, extension, and production), prospectus of all degree offerings, and section advisories.

The Consolidate Schedules Database workbook

The Consolidate Schedules Database workbook contains all the block schedules of all degree programs offered by the campus. The procedure of using this macro enabled workbook is exactly the same as processing schedules at DATABASE sheet of ***SPAEve Department*** as explained above.

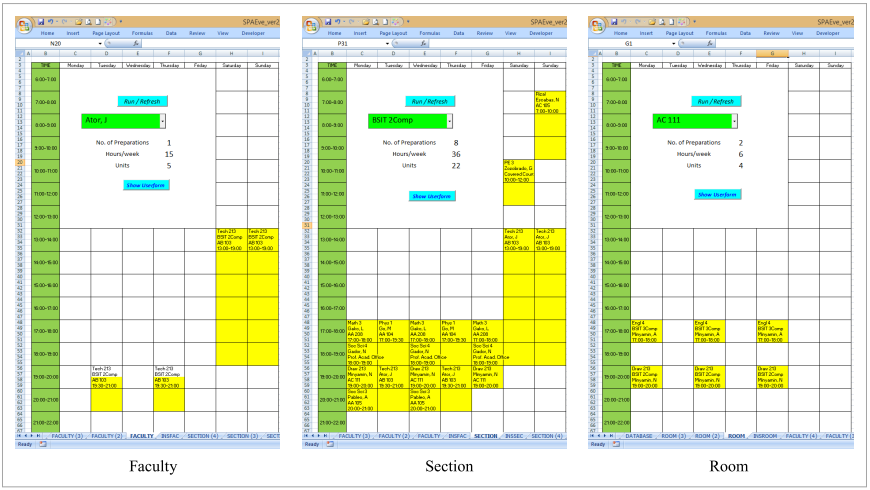


Figure 5. Pictographic plotting of schedules by faculty, section, and room utilization

Using SPAEve Consolidated

There is only a little difference in using ***SPAEve Consolidated*** compared to ***SPAEve Department***. ***SPAEve Consolidated*** processes the data of ***Consolidate Schedules Database*** workbook. The most important macro to be performed before proceeding to the 2nd and 3rd groups is to click on ***1st: Update list of Sections, Subject, Faculty, Rooms*** (**Error! Reference source not found.**B) button and the rest is the same as ***SPAEve Department***.

CONCLUSIONS

This study has significantly improved the VBA codes and procedures, and the structure of SPAEve making it able to run in computers with Windows operating system, at least with 2 GB memory having Microsoft Excel 2007, consequently, increasing its efficiency and performance. In conclusion, when the workbook size is becoming large, the data to be processed should be in a separate workbook. Moreover, with the advent of high-end personal computers nowadays, SPAEve could run without difficulties.

SPAEve has been a very important application software in CTU campuses in speeding up the generation of class-faculty schedules every semester since 2012. This enhanced version will further facilitate class-faculty schedule programmers and boost their interest on using this application software. SPAEve has offered to make a stop on purely manual class-faculty scheduling or course timetabling in all CTU campuses.

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