Scheduling Staff and Space: A Matter of Course

Kristley So sat at her desk with pieces of paper fanned out in a semi-circle all around her. In her role as University Registrar, she had to come up with the proper scheduling of teachers, rooms, other facilities and curriculum. It all had to line up, but there were instances when there was no available faculty member at a given time, or no available room, or two courses vital for graduation might have to be scheduled in the same timeslot due to faculty issues. There were so many factors that Mrs. So had to consider simultaneously, including the objectives of the University to offer as many courses as possible so that students will be able to graduate the soonest. Up to now, she'd been doing this by paper and plenum sessions, but she wondered: could there be a better way? Could an Integer Linear Programming model be used to solve the problem?

Mrs. So asked the help of the Vice President for Academic Affairs to create a committee for enrollment. The VPAA agreed and formed the Enrollment Committee composed of Engr. Seb Montano, Institutional Planning & Policy Development Director; Mrs. Noime Tan, Information Technology Director; Mrs. Kristley So, University Registrar; Engr. Xhelia Ilano, Industrial Engineering Chairperson; Mr. Deejay Ronquillo, Controller and Engr. Seth De Silva, Scheduling Officer.

It was Tuesday morning and the weekly meeting of the Enrollment Committee was in full swing. Mrs. So called a meeting and the meeting went as follows:

Mrs. So: Every enrollment period is indeed a challenging time for most of the offices in the University.

Mrs. Tan: What do you mean?

Engr. De Silva: Well, in the past semesters, we are not able to maximize the course offering due to several reasons:
1) Parallel sections being offered
2) Non-availability of classrooms
3) Schedule does not fit students' or faculty needs.

Mr. Ronquillo: If we are unable to optimize our course offerings, we will lose much of our income. We are not optimizing the usage of classrooms, and we think we need to hire more faculty to accommodate the courses offered but in fact the current faculty pool were not fully loaded yet.

Engr. Ilano: What can I do about the situation? Other Engineering Departments did not coordinate their offerings with our service courses, which results in parallel sections – two courses being offered in the same timeslot. It becomes harder for me to supply faculty.

Mrs. So: Mrs. Tan, would it be possible to extract the data from our system? Maybe we can ask Engr. Ilano's help if we can try it in the College of Engineering as sample data.

Engr. Ilano: Sure! We could check if it is possible to use integer linear programming. I will send a letter to our Information Technology Center (ITC) on what data we need.

Engr. Montano: How long it will take to formulate this? Can we implement/test it next semester?

Mr. Ronquillo: I'm really excited about the results. We can do some Cost-Benefit Analysis on this.

Mrs. So: Let's meet in one week's time to discuss the progress.

The following day, Engr. Ilano wrote a letter to the ITC Director with the list of data needed of the Enrollment Committee.

To: Mrs. Noime Tan
            ITC Director

From: Engr. Xhelia Ilano
            IE Chairperson

Subject: Scheduling of IE Courses

Please generate data from the Industrial Engineering Department to be used for a study to optimize our scheduling. Data we would specifically like to know include:

1. Number of Available Classrooms for Engineering Classes.
2. Number of Available Academic Personnel in the College of Engineering.
3. Projected Demand for next semester for the College of Engineering based on 3-year historical data.
4. Number of Enrollees in the College of Engineering this Current Semester.

Please add any other information you find to be relevant. Thank you.

At the end of the week, ITC Director submitted the following data to the Enrollment Committee:

Table 1
Number of Available Classrooms For The College Of Engineering

Building	Floor	LECTURE	LABORATORY	TOTAL
CS	2nd	20		**20**
	3rd	4		**4**
ST	1st	3		**3**
	2nd	5		**5**
	3rd	5		**5**
OZ	1st	6	9	**15**
	2nd	5	7	**12**
	3rd	2	7	**9**
CL			3	**3**

TOTAL Number of Hours per week Classroom Availability (Lecture)= 50 classrooms/day x 14 hours/day x 5 days/week = 3,500

TOTAL Number of Hours per week Classroom Availability (Laboratory)= 26laboratories/day x 10 hours/day x 5 days/week = 1,300

Table 2
Number of Available Academic Personnel In The College Of Engineering

Department	Full Time Faculty	Full Time Admin	Part Time Faculty	Part Time Admin	Teaching Hours/week min	Teaching Hours/week max
Chemical Engineering	4		3	1	99	180
Civil Engineering	9	1	2		180	315
Computer Engineering	7	1	3	1	153	285
Electronics Engineering	8	1			144	255
Electrical Engineering	4	2	2		90	180
Industrial Engineering	4	2	2		90	180
Mechanical Engineering	5	2	3	1	117	240
GRAND TOTAL	**41**	**9**	**15**	**3**	**873**	**1635**
Total Teaching hours per week						
Minimum hours per week	738	0	135	0		
Maximum hours per week	1230	135	225	45		

NOTE: **Full time Faculty can work 18-30 hours per work.**
Part time Faculty can work 9-15 hours per week.
Administrator can work 0-15 hours per week

The number of loads for the full-time faculty per week is 18 – 30 hours but for part-time permanent faculty is 9 – 15 hours per week. Administrator positions can work 0 – 15 hours per week. The coverage hours are MWF for full-time faculty from 7am – 9pm and for TTh 7:30am – 9:30pm for 1 - 4 units lecture and laboratory 1- 2 units courses offered by the department.

Table 3
Projected Demand for This Semester For The College Of Engineering Based On 3 Years Of Historical Data.

Department	Units	Lec.	Lab.	Total No. of Sections	Total Hours / Week	Total Hours / Week/ Dept.
Chemical Engineering	1	2	8	43	26	119
	2	6			12	
	3	27			81	
Civil Engineering	1	2	18	73	56	199
	2	18			36	
	3	33			99	
	4	2			8	
Computer Engineering	1		28	77	84	221
	2	19	3		56	
	3	27			81	
Electronics Engineering	1		27	86	81	246
	2	12			24	
	3	47			141	
Electrical Engineering	1		20	54	60	159
	2	3			6	
	3	31			93	
Industrial Engineering	1		5	48	15	142
	2	5	1		16	
	3	37			111	
Mechanical Engineering	1		12	52	36	171
	2	10	7		62	
	3	19			57	
	4	4			16	

Table 4
Numberof Enrollees in The College Of Engineering This Current Semester

Department	1st Yr.	2nd Yr.	3rd Yr.	4th Yr.	5th Yr.	Total
Chemical Engineering	115	61	87	70	80	**413**
Civil Engineering	179	137	96	101	95	**608**
Computer Engineering	345	225	177	157	189	**1093**
Electronics Engineering	467	271	233	192	193	**1356**
Electrical Engineering	101	65	62	72	57	**357**
Industrial Engineering	92	71	78	81	64	**386**
Mechanical Engineering	187	140	96	77	86	**586**

For the total population of 100%, 70% are allotted for the on-semester courses. These on-semester courses are the courses offered based on the curriculum of each program. The remaining 30% are allotted for the off-semester courses, including the petition courses, and the courses offered due to the following reasons: failing students, probationary status, working students, economic problem and leave of absence. Petition courses are usually offered 7 – 9 pm MWF or TTh 6:30 – 8:30 pm. Sometimes, a Saturday morning session for 3 hours is offered.

During enrollment, the Enrollment Committee gathered in the Registrar's Conference Room to discuss things that came up.

Mrs. So: The Human Resource Management and Development Office (HRM&DO) Director called my attention to the bombardment of requests from different departments in the College of Engineering for additional faculty members to handle the courses offered.

Mr. Ronquillo: That's good news! It means we have an increase in enrollees.

Engr. De Silva: Oh my, that is not the case! The statistics show that many sections had fewer than 20 enrollees because of so many parallel sections being offered.

<p align="center">**Table 5**
Actual Number of Sections Offered For The College Of Engineering This Semester</p>

Department	Units	Lec.	Lab.	Total No. of Sections	Total Hours / Week	Total Hours / Week/ Dept.
Chemical Engineering	1	2	9	52	29	146
	2	6			12	
	3	35			105	
Civil Engineering	1	3	28	109	87	297
	2	26			52	
	3	50			150	
	4	2			8	
Computer Engineering	1		35	103	105	300
	2	24	5		78	
	3	39			117	
Electronics Engineering	1		40	110	120	318
	2	12			24	
	3	58			174	
Electrical Engineering	1		30	70	90	207
	2	3			6	
	3	37			111	
Industrial Engineering	1		7	59	21	174
	2	9	2		30	
	3	41			123	
Mechanical Engineering	1		17	71	51	233
	2	13	9		80	
	3	26			78	
	4	6			24	

Mrs. So: As a result, the following are the additional faculty members requested by each department:

<p align="center">**Table 6**
Additional Faculty Members Requested for The College Of Engineering This Semester</p>

Department	Full Time	Part Time
Chemical Engineering	1	1
Civil Engineering	2	
Computer Engineering	1	1
Electronics Engineering	3	
Electrical Engineering	1	1

Mr. Ronquillo: Did I interpret it right? If we have less than 30 enrollees in a section, it means that the University is subsidizing the operational cost. In addition, hiring more faculty will also increase our operational cost.

Engr. Ilano: That is correct, Sir Ronquillo. Each faculty member will be paid $30 per unit (equivalent paying hours).Fulltime faculty can teach up to 30 paying hours while a part-time faculty can teach up to 15 paying hours.

Engr. Montano: Each section with less than 30 enrollees will cost the University a loss of $ 32.50 per unit per student for lecture classes and $45.00 per unit per student for laboratory classes.

Mr. Ronquillo: How many sections have fewer than 30 enrollees?

Mrs. So: Here's the data extracted by the ITC.

Table 7
Number of Sections with Below 30 Enrollees This Semester In The College Of Engineering

Department	Units	Lec.	Average Number of Enrollees	Lab.	Average Number Of Enrollees
Chemical Engineering	1			1	15
	3	8	15		
Civil Engineering	1	1	13	10	21
	2	8	24		
	3	17	18		
Computer Engineering	1			7	23
	2	5	20	2	25
	3	12	8		
Electronics Engineering	1			13	16
	3	11	19		
Electrical Engineering	1			10	12
	3	6	15		
Industrial Engineering	1			2	26
	2	4	26	1	24
	3	4	29		
Mechanical Engineering	1			5	22
	2	3	12	2	27
	3	7	5		
	4	2	8		

Engr. Montano: These are very alarming. The data shows that most of these sections are similar courses and not all are in full capacity in terms of enrollees.

With this information on hand, Engr. Ilano as part of the Enrollment Committee had to answer Mrs. So's and Mr. Ronquillo's questions:

1. What are the constraints/challenges that need to be considered?

2. How many sections should be offered to optimize the utilizations?

3. How many full-time and part-time faculty should the University schedule in a semester if the sections offering was optimized based on projected demand?

4. How can the results of ILP will help the University in terms of cost savings?