MULTI-DISCIPLINARY PROBLEM-BASED INDUSTRIAL ENGINEERING PROJECT

Assistant Prof. Dr. Natha Kuptasthien
Department of Industrial Engineering
Faculty of Engineering
Rajamangala University of Technology Thunyaburi, Thailand
E-mail: natha.k@en.rmutt.ac.th

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Abstract

The new paradigm for engineering education nowadays expects new engineering graduates from universities to have more qualifications in both technical and enterprising skills. This paper objective is to discuss a success story of setting multi-disciplinary project groups to solve problems occurred in a case study of an industrial company. The final year of an industrial engineering undergraduate program at Rajamangala University of Technology Thunyaburi requires a 3-credit in Industrial Engineering Project. A student team has a year to search for topic, conduct the study and make final conclusion. The cooperative partner is a well-known Thai herbal company. The project methodology included a visit to the company and discussion with the executives, defining problems and study scopes using various techniques, setting up a project team, gathering data, analyzing data, suggesting action plans to solve problems, implementing the proposed plan, evaluating results and making a final conclusion. The project team integrated multidisciplinary areas of marketing, financing and industrial engineering. The results showed magnificent outcomes in marketing, financing and production. Marketing department had a successful re-branding launch. The shareholders agreed to invest more money to strengthen the financial status. Moreover, there were some productivity improvements from production department.

Introduction

The role of engineering schools worldwide is to provide a foundation of the basic scientific theories and technical knowledge, as well as develops proficiency in communication skills, teamwork, political science, economics, psychology, cultural differences and international relations (Lee et al. 1995, Miller and Olds 1991). Main customers of these engineering schools are industrial companies that hire new engineering graduates to work in a real-life environment. Customer requirements on new graduatesô qualification are higher every year due to rapid changing in global economy as well as manufacturing technologies. The new paradigm of engineering education shows more expectations. The engineering graduates should have

- Ability to apply knowledge of *math, sciences, and engineering*
- Ability to *design and conduct experiments*, analyze and interpret data
- Ability to *design a system component*
- Ability to function on *multi-disciplinary* teams
- Ability to identify, formulate, and *solve engineering problems*
- Understanding of professional and *ethical responsibility*
- Ability to *communicate* effectively
- Ability to engage in *life-long learning*
- Ability to *use techniques, skills, and tools.*

Thailand is country on the Indochinese Peninsula, located in Southeast Asia. Thai educational structure consists of a six-year primary level, a three-year lower secondary level, another three-year upper secondary level. At upper secondary level, two options are available for students, either normal high school or vocational education. The higher education in colleges and universities length of study is approximately four years, except five-year architectural and six-year medical programs. Figure 1 summarizes the current educational system in Thailand.

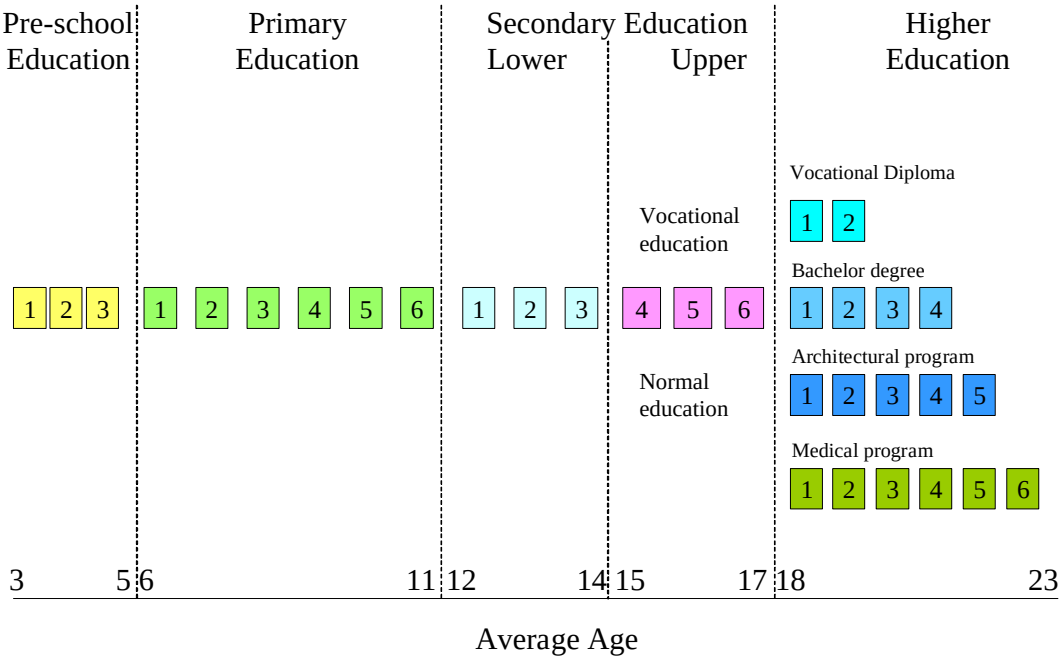

Figure 1 Thai Educational Structure

Industrial Project Course at RMUTT

Rajamangala University of Technology Thanyaburi (RMUTT) has long been developed and gained high recognition for its educational quality for over 30 years under the name of Rajamangala Institute of Technology (RIT). RIT with its nation wide campuses became 9 Rajamangala Universities of Technology in 18 January 2005. Its original main campus of over 750-rai is called Rajamangala University of Technology Thanyaburi (RMUTT). Rajamangala University of Technology Thanyaburi (RMUTT) still maintains its original focus on quality teaching and learning of science and technology and aims for high recognition from industries and organizations for its qualified graduates who are well-equipped with professional knowledge and practical skills with far-sighted vision.

The Faculty of Engineering puts its focus on the development of engineers well-equipped with professional knowledge, skills, and the ability to apply the knowledge and skills in the working situations. The programs offered are as follows:

- Four-year bachelorôs degree program in Engineering for graduates with a vocational education or grade 12 certificate (Science and Math). Both full time and part time programs include the following disciplines: Civil Engineering, Electrical Engineering, Mechanical Engineering, Industrial Engineering, Electronic &

Telecommunication Engineering, Textile Engineering, Computer Engineering, Chemical Engineering, and Material & Metallurgical Engineering.

- A credit-transferred three-year bachelorôs degree program in Engineering for graduates with a diploma in vocational education.
- A master degree program in Engineering for bachelor degree graduates of any field. The program includes the following disciplines: Civil Engineering, Mechanical Engineering, Electrical Engineering, Industrial Engineering and Textiles Engineering.

The curriculum structure is shown in Table 1. There are 143 credits for four-year program and 111 credits for three-year program. The curriculum contains 1 semester (about 4 months) of co-op training, 1 course of pre-project which assures that every student have project group with suitable project title, as well as 1 course of Industrial Engineering project to finish the program. These training and courses intend to prepare students enter real workplaces after graduation. Moreover, they help setting up collaboration between industrial companies and a university.

Table 1 Industrial Engineering Curriculum Structure

Topic	Four-year Program	Three-year Program
1. General Education	**37**	**27**
1.1 Social Science	3	0
1.2 Humanities	3	0
1.3 Languages	6	3
1.4 Sciences & Mathematics	24	24
1.5 Physical Education	1	0
2. Specific Requirements	**100**	**81**
2.1 Engineering Core Courses	21	18
2.2 Industrial Engineering Major Courses	54	48
2.3 Industrial Engineering Electives	25	15
3. Free Electives	**6**	**3**
Total	**143**	**111**

What is Multi-disciplinary?

Ability of function with multi-disciplinary teams is one of the new paradigms in engineering education. It means an engineer should be able to work with team members who are from several departments with different backgrounds in order to solve occurred problems. Normally, engineering students rarely take courses with students from other departments. Therefore, they have not been prepared much in this multi-disciplinary area. This research shows an example of using multi-disciplinary teams to solve industrial-based problems.

Industrial Project Methodology

Figure 2 shows an example of how the project group solves the industrial problem. The industrial-based project methodology starts at the ñPre-projectò course when the group searches for a project title with a cooperative industry. Pre-project form must be filled including a problem statement, project objectives, studying criteria, project plan and expected

benefits. The group must present a project idea to the committee with an oral examination for project approval. The student enrolls ñIE Projectò the following semester. The project group gathers necessary information, analyzes data, proposes a problem solution, implements to the real situation and measures the outcome before making a final conclusion. The outcome usually shows a comparison between before and after.

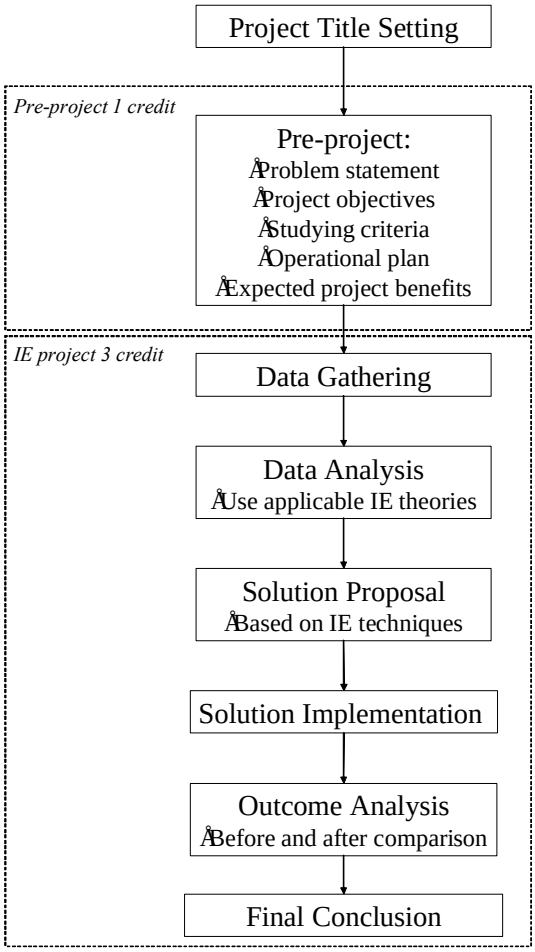

Figure 2 Real-life Industrial Engineering Project Solving Methodology

Project Partner: Prachandra Osoth Dispensary Co., Ltd.

Prachandra Osoth Dispensary Co., Ltd. is a well-know Thai herbal medicine company who has been in the business for more than 80 years. Company executives are the third generation of this family-own business. The company went through several changes in herbal medicine consumption behaviors. Nowadays, with new trends of alternative medicines, Thai herbal medicine becomes more popular with higher competitiveness. The company has been encountered with various problems which can be divided into 3 areas of marketing, financial and industrial. After a visit to the company and a discussion with the executives, the project was set. For effectiveness, the multi-disciplinary team consisted of three sub-teams, marketing, financial and production. Each sub-team has its own working scope including gathering data, analyzing data, suggesting action plans to solve problems, implementing the proposed plan, evaluating results and making a final conclusion. The team

met once a month for progress update and discussion. Figure 3 shows functions overlap among three primary business functions. As shown in the figure, all team members learnt to work multi-disciplinarily. Figure 4 shows project organization chart including sub-team members and representatives from the partner company.

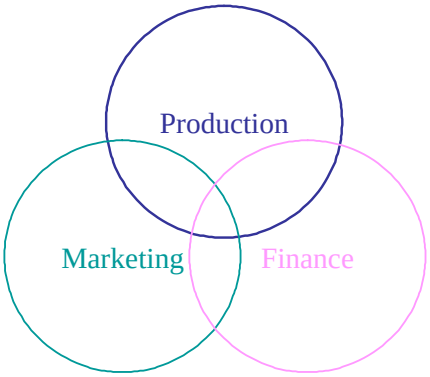

Figure 3 Overlaps Among Three Primary Business Functions

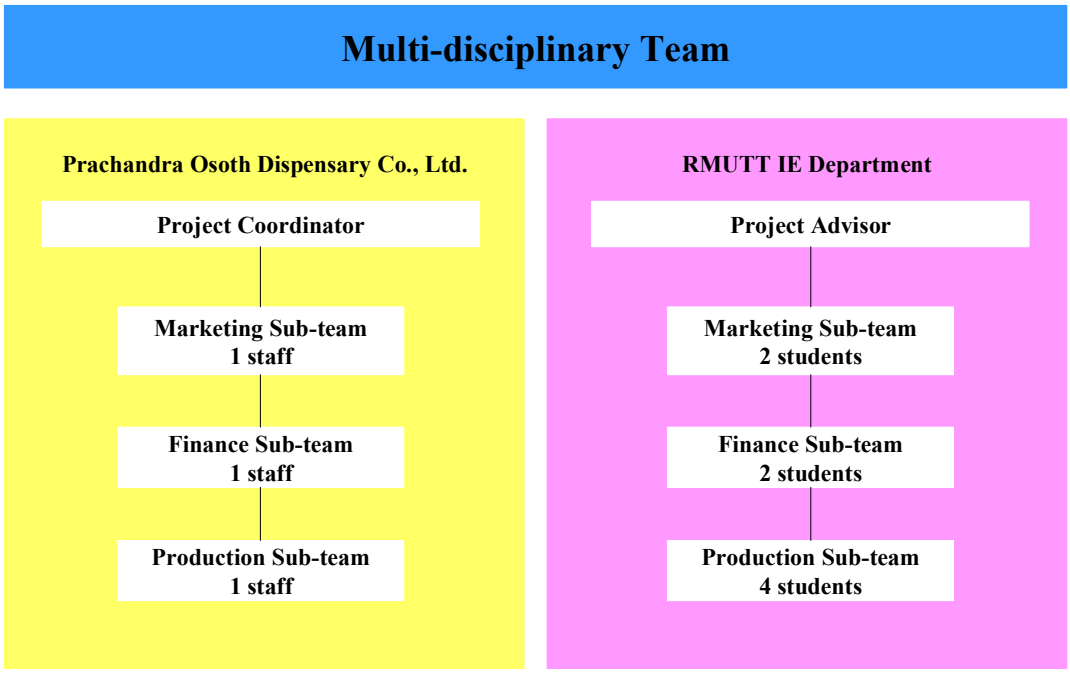

Figure 4 Project Organization Chart

Marketing: Re-branding Prachandra Osoth

Marketing sub-team focused on re-launching Prachandra Osoth brand under the positioning that is most appealing, unique and relevant to target group. The re-branding process is shown in Figure 5.

1) Situation review covered five areas: brand, current products, packaging, sales/distribution channels and competitors. Prachandra Osoth brand still has good heritage

among trade and older Thai population. However, it had no role in the market place. The inconsistency supply of some medicines made the consumer switched to use competitorsô brands instead. The product awareness was low. There were only 2 popular products. The new 15 products had not been introduced to the mass market. Packaging review showed that more communication should be put on medicinesô labels to clarify its ingredients and efficacy. Sales and distribution channels had difficulties on product supply and non-attractive trade margin compared to competitors. On competitors review, Thai herbal market is separated into 2 channels: massive sales and direct sales. Massive sales market is large and stable with low growth. On average, the trade margin is about 30%. Direct sales market is up and coming with high price. It is mixed between local and imported herbs focusing on friend-get-friend strategy with high margin up to 50%.

2) SWOT Analysis was done next. There were strength, weakness, opportunity and threat analysis. Figure 6 shows Prachandra Osoth SWOT analysis.

Strength	**Weakness**
Å Outstanding formulations Å Long brand heritage: 80years+ Å Segmented product Å Open-minded management Å Short decision lead time Å Ambitious and motivated working team	Å Low brand awareness Å Long time out of market Å Product fluctuation Å Non-reliable sales/distribution Å Limited label information
Opportunity	**Threat**
Å Thai herbal trend coming Å Thai traditional medicine has been appreciated Å Government support	ÅThai FDA restriction ÅLong FDA approval lead time ÅPrice war in market place ÅHigh demanding trade on margin

Figure 6 Prachandra Osoth SWOT analysis

3) Market Research for Concept Test had objectives to understand consumer usage behavior and attitude towards Thai herbal medicines, to identify consumers trigger and barrier in selecting herbal medicine, to understand the shift of usage pattern, to identify market trend, ideal products and market opportunities and to evaluate product concept, to choose one concept that was most appealing to target customers and to gauge consumer acceptance toward pricing structure of each product concept. A qualitative research methodology was used. The results were used to layout brand positioning, marketing strategy and budgeting.

4) Brand positioning is shown in figure 7, including topics in consumer needs, target group, competitive environment, reasons to believe, benefits, brand essence, discriminator and values.

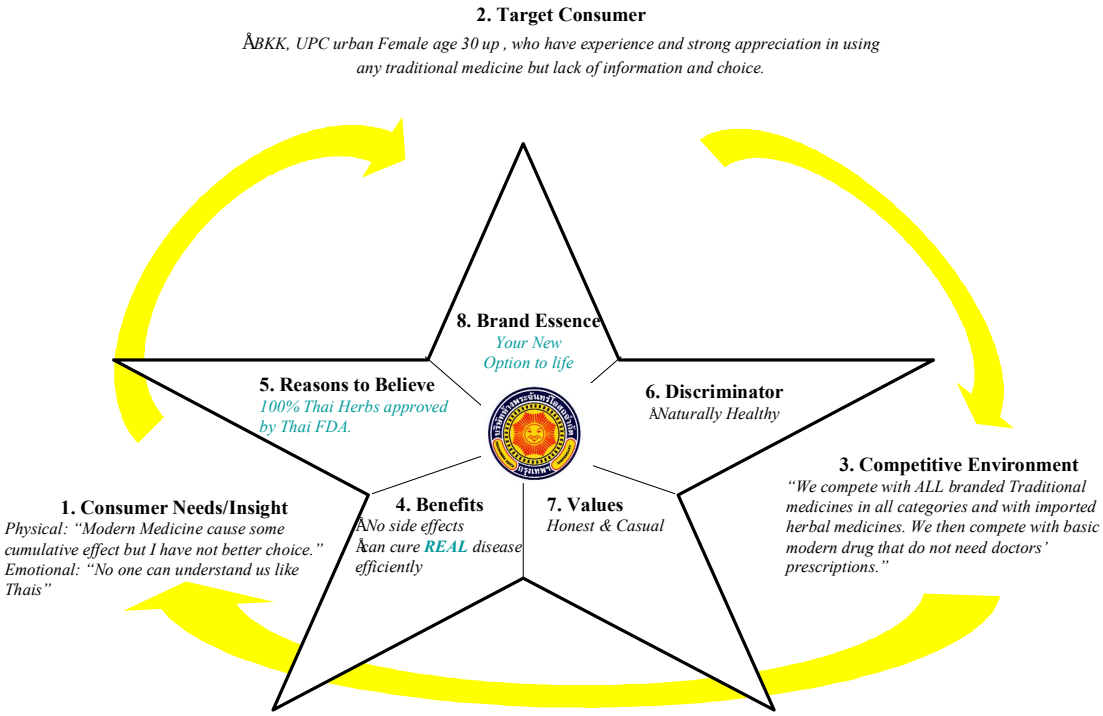

Figure 7 Final Brand Positioning

5) Marketing Strategy & Budgeting were set to rebuild brand awareness among trades and consumers. The target group was finalized with final marketing theme of ñ100% Natural Alternative Medicineò. The implementation annual plan was concluded into four categories of product, place, price and promotion. The advertising and promotion activities were schedule including an re-brand launch event, printed advertising, radio advertising, public relation, columns on magazine and consumer promotion.

Finance: Additional Investment

Financial sub-team focused on investigating Prachandra Osoth financial status. The company executives wished to invest in a few new machines. With a project feasibility study, the Internal Rate of Return (IRR), payback period and Net Present Value (NPV) were analyzed. Table 1 shows the financial calculation for additional investment project.

Table 1 Cash flow Calculation

Description	Year									
	1	2	3	4	5	6	7	8	9	10
1. Cashflow - in	8,932,527	2,400,000	2,880,000	3,456,000	4,147,200	4,976,640	5,971,968	7,166,362	8,599,634	13,521,981
2. Cashflow - out										
2.1 Asset	6,932,527	0	0	0	0	0	0	0	0	0
2.2 Operating Expenses	2,926,592	2,994,729	2,968,685	2,943,214	2,918,344	2,894,106	2,870,531	2,847,652	2,825,505	2,804,124
Net Cashflow (Baht)	-926,592	-594,729	-88,685	512,786	1,228,856	2,082,534	3,101,437	4,318,710	5,774,129	10,717,857

The calculations results were IRR = 54.58%, payback period = 5 years, NPV= 8,441,335 Baht and break even point of 2,259,421 Baht of sales. These numbers helped the company executives to negotiate with a bank loan and attracted shareholders to invest more

money to the company. The additional investment resulted in buying a new blister packing machine, working area improvement regarding Good Manufacturing Practice (GMP) standard, new product research and development fund and recruiting new qualified workforce.

Production: Productivity Improvement

As all the students were in Industrial Engineering filed, the production area was intensely focused on problem solving. From data gathering, problems were defined are separated into 4 categories:

1) Method study and productivity improvement. It focused on improving production process, shortening working distance and reducing cycle time. The result showed 20% of productivity improvement.

2) Preventive maintenance system. Before the study, there was no maintenance system which caused a high rate of machines breakdown. After implementing the preventive maintenance system, the machine breakdown rate was reduced which resulted in higher output.

3) GMP document preparation. The company has a plan to implement Good Manufacturing Practice (GMP) standard to improve its production system. After studying all GMP standard requirements and gathering relevant data. The standard operation procedure (SOP) documents were prepared. And if the company can further implement this document system successfully, it can be granted a GMP standard in the near future.

4) Plant design for GMP standard. The plant layout and production related tools were observed by using check sheets. There were some issues needed to be improved. Therefore, the team designed a new layout that conformed to GMP standard.

Summary and Conclusion

Real-life industrial engineering projects at the senior level shows satisfied outcomes. It is an appropriate way to prepare engineering student to the real working world. The paper includes Thai educational background, Industrial Engineering curriculum at RMUTT, Industrial Engineering project methodology, multi-disciplinary team working at a partner company. There were tremendous improvements in all three major areas in the business organization. Marketing sub-team achieved in re-launch brand with a solid marketing strategy. Financial sub-team analyzed satisfying indexes, so the company was confident to invest more capital fund. Production sub-team proposed several improvement methods to strengthen its manufacturing system. On the other hand, the students gained real-life working experience. They learnt how to work in multi-disciplinary group. It impacted on more confident after they graduated.

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