Research and exploration for operational research education in industry and engineering subject

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Abstract: On the basic of exploring the relationship of industry engineering and operational research technique, the thesis analyzes the location and utility of the operational research education in the whole industry engineering subject education. It brings forward the system design about operational research and relative class among industry engineering subject and the imagine of concrete class design for industry engineering operational research class, it puts forwards the view of optimizing operational research teaching, and it also makes some exploration and research on operational research education of industry engineering subject.

Key words: industry engineering; operational research; education

1. Operational research and industry engineering

Modern industry engineering is one of the important science technologies on the time of economic takeoff and development. Because there are some consistencies on the ingenerate characteristic and developing progress between industry engineering and operational research, in the early time, the industry engineering and operational research are developed almost synchronously. By looking back industry engineering developing history, it is easy to see that industry engineering uses lots of operational research method and technology, as a synthetical application subject, it acquires famous effect in practice. The table 1 is all the probably and potential useful situations that the OR (Operational Research) methods are used on the different segments of industry engineering.

However, the manufacturing process is more and more complication and diversification with the technique development, which can't solve the practical problems effectively only depending on some early OR branch theory, because most of the methods face the identical thing or different logic structure problems of different things, the management problems in industry engineering always are anfractuous and synthetical problems. Therefore, it asks a higher requirement for all kinds of methods of OR combination application.

Moreover, the traditional methodology of OR faces the existed system, but most of systems that the IE need to analyze and solve are the new systems that need to be built. On this aspect, it starve for the OR technique can provide the invention and design concept models.

Otherwise, OR methods make the optimization as the core concept, but the dependence of optimization is that the structure of problems are very clear and the time are relatively steady. On the IE research field, the environment of most problems are fluctuant or else invariable, so how to improve the fit capability of optimization

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idea of OR methods in the practice utilization, enlarge the utilization scope is a problem need to be solved.

Table 1 IE problems and OR methods

Module name	Function	Problem example	Representative OR module and method
Demand management	Forecast sale order administration	Forecast independent demand; Make delay delivery time	Forecast module: time series; Regression analysis: linear regression forecasting/multi regression; Statistic: forecasting error
Inventory plan	Aggregate inventory plan; Discrete inventory plan	Make inventory policy, confirm stock capability, deduce storage; Make sure safety stock, forecast inventory cost	Inventory control system; Regression level measurement
Production plan	Production plan; Resource plan	Balance productivity; Adjust produce capability	Mathematics programming, dynamic programming, linear programming; Simulation: bottle-neck simulation; Heuristic arithmetic &VIM: game theory/equilibrium theory/mixed strategy
Master production schedule	Master production schedule; Rough-cut capacity planning	Confirm produce cost and produce time, distinguish bottle-neck working procedure, make up what production with what order	Heuristic arithmetic: bathe control
Requirement planning	Material requirement planning; Capacity requirements planning	Confirm demand unit (dependent/independent demand); Distinguish bottle-neck procedure	Mathematics programming: bathe optimizing; Statistic and probability theory: safety stock; Inventory control: dependent and independent demand inventory module
Production activity control	Charge scheduling; Send order; Process layout; Production report	Analysis bottle-neck, balance production capability; Transmit order on time; Abide by delivery time, deal with the problem of production scarcity; Rapidly, correctly supply data	Mathematic programming: optimal process arrangement; Simulation: bottle-neck simulation; Queue theory & random process: ahead of schedule, capacity, value; Heuristic arithmetic: Johnson's rule; VIM: charge, process arrange, sequencing, bathe control; AI&ES: process arrange, sequencing
Purchase	Send order; Check and accept goods; Stock goods;	Ensure provide the material continuously; Zero defects; Stocks, order quantity point	Mathematic programming, price-break order quantity, statistic, sampling, control picture, inventory control, control system
Performance evaluation	Order situation; Resource situation; Material situation;	Multi-delivery times; Raise produce capability utilize rate; Deduce bottle-neck loop; Modify safety stock; WIP, raise stock velocity	Net-work technology; Inventory control, making safety stock

According to the description of the main content of IE and the research object of OR, it is easy to see that IE, as a man-machine synthetic system, need the OR technique more and more, especially with the development of IT, the trend must be deepened. As a result, in cultivating the students of IE subject, how to make OR education had become the problems that must be explored and researched.

OR education occupies important location in the IE education all the time. On the one hand, IE subject is always an important subject in the management; on the other hands, OR class is always the required course of every management subjects of postgraduate students (including MBA). The main utilization of the OR education

in the whole IE education embodies: (1) supply a necessary basic to study other economic and management courses; (2) supply the science quantity tools for management decision; (3) cultivate the student through mode and learn capability of whole optimization; (4) supply important basic to make higher management science research.

2. Exploration for design of OR teaching in IE

2.1 Courses body design relatively with OR in IE

The main courses relative with OR are mathematic basic and economic quantity analysis courses, usually, we call them “management mathematic courses”, and regard them as a system to design optimizing wholly. The basic thought is “training aim, knowledge structure required, courses required”, the thought scope begin from undergraduate stage, at the same time we think about the level of the courses in the science technique system. The design thought shows in details as Table 2 and Table 3:

Table 2 Design thought of management mathematics courses system

Training aim →	Capability required →	Knowledge required →	Courses required
Mathematic knowledge and ability required as an eligible IE talent	·abstract thought ·practice application ·learn other	·mathematic basic theory ·quantity analysis method	·basic: undergraduate stage courses, graduate stage courses ·major basic: undergraduate stage courses, graduate stage course

Table 3 Level of management mathematic courses in the science technique system

Level of science technique system →	Philosophy →	Basic science →	Technique science
Management mathematic courses and their level		Basic courses: Undergraduate ·Advanced mathematic ·linear algebra ·probability theory … Graduate ·management mathematic basic …	Major basic courses: Undergraduate ·OR ·application statistic … Graduate ·advanced OR ·advanced application statistic ·System analysis …

The strongpoint of the whole thought is very clear: (1) It is easy to see what knowledge level had been improved from undergraduate stage to graduate stage, the degree of improve weather or not up to the requirement. (2) It is easy to see if the course of undergraduate and graduate repeat, if they repeat, then we can check the detail content, if the courses make students study repeatedly. (3) It is easy to check the advanced and reasonable and condense of whole courses system content. (4)It is easy for macro-scope to control and improve.

2.2 The OR courses design in IE subject

For most years of teaching practice up to now, we brought forward an OR courses system with all kinds of different content and period and multi-series for undergraduate, graduate and doctor students of IE subject in Table 4.

These courses are different not only on periods and names, but also on content, and have strong pertinence. According to the IE subject students’ character that they are strong on mathematic basic, but weak on economic management knowledge, so in the teaching, firstly we make it clear that OR, as the main methods of management sciences, is how to solve practice problems of management. Then according to the engineering students who have strong understanding ability and their subject background, we quicken the teaching schedule properly, on the

content, we try to embody OR's management practice application in the IE subject.

Table 4 Design of the main OR course in IE subject

Level	Course name	Course object	Course character	Period	Main content
Postgraduate	OR I	Undergraduate student of IE	Required course	64	Determinate part in OR
	OR II	Undergraduate student of IE	Required course	32	Random part in OR
	OR	Double degree student of IE	Required course	48	Determinate and random conspectus in OR
Graduate	OR A	Graduate student of IE and other part administrations	Degree course	40	Determinate part in OR
	OR B	Graduate student of other part administrations	Degree course	40	Higher determinate part in OR
	Random OR	IE graduate student	Elective course	30	Random part in OR
	Multi-object decision and synthetic evaluation	IE graduate student	Elective course	40	Multi-objects decision and evaluation in OR
Doctor	Quantity method of management	IE doctor student	Required course	30	Partly quality method in OR
	Game theory and information economics	IE doctor student	Elective course	30	Game theory in OR

2.3 The whole optimization of graduate degree course and graduate teaching in OR

As a degree course of IE subject, OR had been taught for many years. With the teaching scope of graduate education enlarges recent years, a problem stands out day by day, is that the student graduating from management subject had studied the course, but OR is a required course for them on graduate stage, so most of content is studied repeatedly.

To solve the problem, we advise to adjust the OR teaching content of graduate and undergraduate, changing the graduate degree course OR to OR A and OR B, the period of A is the same as the primary OR. OR A will be taught to the students who didn't study OR. OR B will be taught to the students who had studied OR, it will teach the advanced content of OR. The content of A and B is different, and students can choose one of the courses according to their own situation, some students with more ability can elect one course and audit the other course.

The content of two courses will be considered fully about the join and improve of "OR" teaching of undergraduate stage. It not only avoids the repeated study, but also provides more study chance for students.

The key of course reform is the choice and teaching of "OR B" course's content. Because "OR A" is just like the original "OR", which has successful teaching experience for many years, but "OR B" is a new course, the teaching objects are the students who had learned "OR" in the undergraduate stage. For example, the undergraduate students of management school in Tianjin University had studied OR for 96 periods in two semesters, they had fully understood basic content of "OR". Moreover, most of graduate students are excellent students in undergraduate stage, many of them joined OR test in the graduate entrance test, they had deeply understanding about OR, so what matter to teach them and how to teach, will attract them and make them feel having gain is a big problem.

We think that the rules should be hold on choosing teaching content about: (1) the content is that they didn't learned on undergraduate stage; (2) the content belongs to the important branch of OR main content; (3) the content is the active branch recently in OR field; (4) the content is the branch that has important practice application background in economic management field.

For these students have better basic, the rules we should hold on teaching methods are: (1) the explain of basic content should have theory depth; (2) not only introduce the classical part of basic content, but also introduce the new research dynamic; (3) introduce some new computer software; (4) lead students to a deep understanding about the course's character, content and how to apply it in practice.

3. The teaching of OR should combine with the scientific research of IE

3.1 Tracing closely science develop of OR and strengthening basic theory research

All the tutors should trace closely the scientific, developing and dynamic of OR, IE and the relative subjects. The teaching content should be complemented constantly new content currently of some IE research and application hotspot, such as adding evaluation technique, logistic technique, supply chain theory, game theory technique, risk analysis and conflict analysis, etc. The school should open some elective course for IE graduate students, for example, multi-objects decision and synthetically evaluation technique, game theory and its application, financial risk analysis, and so on, exploiting continuously graduate students view, enhancing their science research ability.

On the other hand, the teaching should pay more attention to basic theory research of IE, and the same time, combining the tutor's research work and the directing for the graduate student paper, inducting graduate students to give their attention to IE subject foreland, cultivating their innovation sprite and independent research ability.

3.2 Combining the reality requirement of IE and deepening practice application research

The school must pay more attention to IE basic theory research and application research. It also should pay more attention to the application research of OR's theory and method in IE, cultivating the graduate students' ability to solve IE practice problem by using theory methods. Tutors should direct graduate students to study the relative OR methods based on tutor's practice application project. The management school should advocate graduate paper to be written by the real project, encourage student to publish paper on higher class journal, exciting and enhancing IE subject students' practice work ability in practice research work.

4. End

Faced 21 century, time of knowledge economic and high science technique had deadly demanded for management talent with more strong rational thought and study ability, which make OR education lie more important location in IE education, which put forwards more charge for OR education.

Prospecting OR education work in 21 century, on the teaching, we should carry out multimedia teaching and more case teaching, make the combination of OR course system and IE content to optimization wholly; on directing graduate students' paper, whether the theory research or the application research, it should deeply use modern OR technique and raise quantity analysis level to acquire more excellent fruits.

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