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Graduate Engineering Economics for Engineering Managers

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The purpose of this paper is to propose a new agenda for developing skills in engineering economics for engineering managers. One finding is that no current textbook covers the right range of topics. The proposed range of topics suggested in this paper is based upon the following premise: Engineering managers must have expertise in topics directly related to the management and direction of the enterprise. Beyond the correct assessment of tradeoffs, they must be able to communicate with many operations and other non-technical managers in the common language in the business. These requirements include:

Financial Accounting concepts and measures used by stakeholders and top management as part of a balanced scorecard.

Cost Accounting purposes, principles and common conventions employed in development of enterprise information systems

Capital Management including sources, uses and cost of funds available for projects

Most of the present graduate engineering economics texts focus attention on the third item, capital management. For a manager, this is not sufficiently broad. This paper examines each of the three areas and proposes topical coverage required in each based largely on intuitive arguments. An obvious refinement is to survey well qualified practicing engineering managers to elicit their perception of the issues.

Financial accounting needs

Every manager must have an understanding of the basics of accrual accounting since it is the basic language of the business. This extends well beyond the mechanics of bookkeeping and transaction processing and must necessarily focus on understanding the concepts and how they affect business decisions inside the firm. Managers must understand typical financial statements which include: the income statement, the balance sheet and the cash flow statements. While they need not be able to construct such documents, they must be able to understand the impact of the documents and their contents on the operation of the business.

For example, managers must understand that a write down of the inventory on the balance sheet results in a reduction of profit in the profit and loss statement for that period. They must understand the behavioral implications of such an action and management's occasional reluctance to accept the writedown. They must also understand financial indicators and ratios so they can understand the implications of low liquidity, high debt ratios and slow asset turnover to name a few. They must understand the implications of the accounting equation and the difference between concepts such as cash and equity. Moreover, they must understand the concept of shareholder value and equity growth . Once this is understood it will be natural for managers to understand why measures such as return on equity, return on assets and return on invested capital give different numbers, why those numbers are different than what they mean to the operation of the firm. Even those graduate students who have taken an undergraduate engineering economics course seldom demonstrate the requisite mastery of these concepts.

Cost accounting needs

One of the first tasks a new operating manager must learn is how the cost accounting system of his company operates. That would include: where costs are collected, how they are measured and how they are allocated to various products or services. Often compromises are made in the design of such cost accounting systems in order to accomplish specific purposes. Therefore managers need to understand the three underlying purposes of cost accounting systems and the difficulties involved in obtaining successful results in all three areas from a single system. In particular managers need to understand how to isolate relevant costs to use in decision situations and, in particular, need to understand uses and misuses of cost information. These are largely based on cost accounting methods for allocating overhead to private costs. Therefore, the manager must have a good level of understanding of the various overhead bases, multi-base systems and activity based costing as a way to overcome some of difficulties inherent in the construction of the system. Finally managers must understand how flexible budgeting processes and cost accounting systems are connected.

Capital management needs

First any manager must understand the basics of discounted cash flow and project appraisal techniques, how to value cash flows and how to deal with issues such as establishing a time horizon, selecting an interest rate and including depreciation and taxes. These are fundamental topics in capital budgeting. Beyond these fundamentals, however, there are other very important topics which managers must understand. For example, changes in working capital required by the project. They also need to understand the sources of capital available to the company, the costs of those sources and

the computation of a weighted average cost of capital as one threshold. It is also important that managers recognize the link between acceptable capital projects and the creation of economic value. Without an understanding of the sources and cost of capital, it is difficult for managers to make this linkage . Managers must also understand differences in risk: for example, financial versus operational, diversifiable versus non-diversifiable, and proper inclusion of risk assessments into the capital budgeting appraisal process. Most importantly managers must understand the linkage between project approval and the strategy of the organization. They must understand that no matter how attractive a proposal is financially, if it does not fit within the strategy of the organization, it will not be approved by top management. This seems commonsensical; however, it's quite common for managers and engineers to be disappointed by negative results in the capital budgeting process based on what they perceive as whims of management. Understanding of advanced capital budgeting topics such as the treatment of capital projects as options can shed light on some of these decisions. Other important advanced topics include: the adjusted present value concept which separates project cash flows from their financial effects, multi attribute approaches, particularly with regard to their limitations as well as their appropriate successes.

Making room for these new topics

It should be obvious that this specification contains much more than can be merely added to an existing graduate engineering economics course. Given the time which can be devoted to this entire area, coverage of some traditional topics must be mitigated in order to provide capacity for coverage of the new topics proposed. Following are suggestions

for determining those topics which should be reduced or eliminated in order to make room for the new design.

Focus accounting coverage on concepts needed by consumers of accounting information

Engineering managers will by definition be consumers, not providers, of accounting information. Therefore, it makes sense to eliminate coverage of details really required only by prospective providers of accounting information. This means that bookkeeping transactions beyond illustrative examples , extensive practice in testing with debits and credits, a complex flexible budgeting and variance analyses should be avoided.

Eliminate traditional topics aimed solely at computational convenience

Much of the engineering economics literature has evolved from a traditional approach where algebraic simplification was required to reduce the computational burden on students. In this age of spreadsheets and electronic preprogramed calculators these topics need not be covered. Examples of topics which could be eliminated are manipulation of factor tables, gradients, pretax analysis. Another topic easily dropped is the coverage of obsolete depreciation methods.

Limit Coverage of esoteric models in project appraisal

Often advanced engineering economics courses rely on coverage of sophisticated models as a way to justify their advanced billing. In reviewing these models it is important to maintain the perspective of a manager as contrasted with the perspective of an analyst. Under this deadline consideration should be given to sparse coverage

of models with extraordinary data requirements not usually identifiable in practice. For example, the determination of the optimal economic life of an asset rests on assumptions about declining salvage value over time. In a practicing world, real data for this analysis rarely exists. As another example capital budgeting optimization at a single point in time has gained little acceptance in a practicing world as the information in the estimates does not have the precision required to make the output of such models useful. That is not to say that there is no value in teaching these ideas but rather if the objective is to educate managers there inclusion can be justified only if it does not infringe on coverage of topics outlined in the previous section. These remain very useful topics for learners who are focused upon building the capital budgeting tools of the future. Those students might be well-served by a second course.

Integrating the topics

Real world problems do not arise in closed system textbook contexts. Rather they are always immersed in a larger scenario where conflict in objectives, personal agendas and managerial edicts must be overcome. Communicating these intricacies to engineering managers requires a more robust approach than traditional textbook problems. A better solution can be found in the use of sophisticated business cases. Classroom attention can then be focused on the interpretation of analyses made using financial calculators or spreadsheets. This shifts the focus in learning from getting the right answers to asking the right questions. Allowing students to focus on computational details and formulation of decision rules does not measure the kind of learning that is important to prospective managers. A review of popular texts [1],[2] reveals that less than 15% of the content is

focused on the financial accounting and managerial accounting topics identified, only [1] discusses the capital budgeting and project review processes. Strategic fit, adjusted present value, and options considerations are not covered. In other words, these texts emphasize the analyst's viewpoint rather than the manager's as identified here.

The author has identified a series of cases and notes that can be structured to provide an "open system" learning experience that accomplishes the broader management purposes of engineering mangers and develops a capacity for independent thought that managers need. These will be shared with session attendees.

REFERENCES

[1] Canada Sullivan and White, Capital Investment Analysis for Engineering and Management, Second Edition, Prentice-Hall, 1996

[2] Park and Sharp-Bette, Advanced Engineering Economics, John Wiley and Sons, 1990