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Indian Economy in Combination with Engineering

Kanhaiya Lal Meena

Associate Professor, Dept. of Economics, SPNKS Govt. PG College, Dausa, Rajasthan, India

ABSTRACT: India's engineering sector has experienced tremendous growth over the past few years as a result of increased investments in industrial production and infrastructure. It is a significant component of the manufacturing PMI Index and has shown revival in the post-pandemic period.The PMI Index has been comfortably over 50 since the start of 2020, indicating an economic resurgence. However, the industry has faced significant challenges as a result of the Russia-Ukraine conflict, which has increased inflation globally, driven up oil prices to over USD 100 per barrel, fluctuated commodity prices, disrupted supply chains, and Covid-induced lockdowns in China's manufacturing and trade hubs.Nevertheless, the Indian economy as a whole and the engineering sector, in particular, had handled these challenges well. Engineering makes up a sizable portion of Indian industries, and the Index of Industrial Productivity (IIP) for latest came in at 7.1% (before was 2.2%), demonstrating an improvement across industrial sectors.

KEYWORDS: India, economy, engineering, pandemic, globally, productivity, capacity, recovery, sector

I.INTRODUCTION

Engineering economics, previously known as engineering economy, is a subset of economics concerned with the use and "...application of economic principles"[1] in the analysis of engineering decisions.[2] As a discipline, it is focused on the branch of economics known as microeconomics in that it studies the behavior of individuals and firms in making decisions regarding the allocation of limited resources. Thus, it focuses on the decision making process, its context and environment.[1] It is pragmatic by nature, integrating economic theory with engineering practice.[1] But, it is also a simplified application of microeconomic theory in that it assumes elements such as price determination, competition and demand/supply to be fixed inputs from other sources.[1] As a discipline though, it is closely related to others such as statistics, mathematics and cost accounting.[1] It draws upon the logical framework of economics but adds to that the analytical power of mathematics and statistics.[1]

Engineers seek solutions to problems, and along with the technical aspects, the economic viability of each potential solution is normally considered from a specific viewpoint that reflects its economic utility to a constituency. Fundamentally, engineering economics involves formulating, estimating, and evaluating the economic outcomes when alternatives to accomplish a defined purpose are available.[3]

In some U.S. undergraduate civil engineering curricula, engineering economics is a required course.[4] It is a topic on the Fundamentals of Engineering examination, and questions might also be asked on the Principles and Practice of Engineering examination; both are part of the Professional Engineering registration process.[1]

Considering the time value of money is central to most engineering economic analyses. Cash flows are discounted using an interest rate, except in the most basic economic studies.

For each problem, there are usually many possible alternatives. One option that must be considered in each analysis, and is often the choice, is the do nothing alternative. The opportunity cost of making one choice over another must also be considered. There are also non-economic factors to be considered, like color, style, public image, etc.; such factors are termed attributes.[5]

Costs as well as revenues are considered, for each alternative, for an analysis period that is either a fixed number of years or the estimated life of the project. The salvage value is often forgotten, but is important, and is either the net cost or revenue for decommissioning the project.

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Some other topics that may be addressed in engineering economics are inflation, uncertainty, replacements, depreciation, resource depletion, taxes, tax credits, accounting, cost estimations, or capital financing. All these topics are primary skills and knowledge areas in the field of cost engineering.[2]

Since engineering is an important part of the manufacturing sector of the economy, engineering industrial economics is an important part of industrial or business economics. Major topics in engineering industrial economics are:

- The economics of the management, operation, and growth and profitability of engineering firms;
- Macro-level engineering economic trends and issues;
- Engineering product markets and demand influences; and
- The development, marketing, and financing of new engineering technologies and products.[6]
- Benefit–cost ratio

The sector has been de-licensed and enjoys 100% FDI. The engineering sector is anticipated to benefit from the increased budgetary allocation for infrastructure and PLI launched in the textile and auto industries.The recent collapse in commodity prices would also provide some respite to the business. Engineering companies focused on ethanol (Praj Industries) and homegrown defence equipment (BEL) will garner the benefits that will flow from the governmental push to these industries.With the drive for growth in the budget and PLI as well as increased capital expenditures in steel, chemicals, pharma, components, cement, and auto that may signal the beginning of a multi-year capex cycle, the sector outlook appears positive. From our universe of 32 companies in the engineering sector, On account of improved capacity utilisation, cost optimization, gaining market share (backward and forward integrations), and better customer negotiating, larger enterprises were able to demonstrate a decent to high growth in their operating profits. Like most other sectors, the engineering industry faced Supply chain constraints, delays in dispatches and inflationary run-up in commodity prices, which impacted the growth of their topline, BEL[3], a Navratna Defense PSU, reported a solid performance against the backdrop of growing attention to defence equipment. The company received orders worth Rs 19,200 crore in FY21, and, it had a backlog of orders totalling Rs 57,570 crore. With Rs 15,084 crore in net revenue for FY21, the order backlog is 3.8 times the realised revenue. Thermax experienced strong top-line growth, but was challenged by rising freight and commodity costs. Thermax also has a strong 20% order pipeline increase that is due to both volume and price growth. The top provider of corrosion-resistant glass-lined equipment, GMM Pfaudler, continued to exhibit exponential development in its topline, increasing by 154%.The Praj Industries reported an increase in net sales of 78%.[4] The rise in operating profit showed a trend that was relatively similar to the rise in net sales. The operational profit increased by 79% for GMM Pfaudler and 67% for Praj Industries, respectively. The greatest increase in net profit was 85% at Praj Industries. Despite a 21% increase in the top line, Triveni Engineering's bottom line had exponential growth of 182%. In FY21, the company had a growth of 57% in domestic enquiry generation and a growth of 25% in overseas enquiry generation.AIA Engineering Ltd is the second largest hi-chrome producer in the world. Net realisations per tonne increased 38% to Rs 147.9 per kg YoY, owing to product mix and price increases using pass through of the increase in ferro chrome prices on to the customers. Net revenue driven by higher realisations and volume growth was up by 22%. [5]The operating profit and net profit however grew by 9.5% and 5.5% respectively. With the order book standing at Rs 502 crore and brownfield expansion plans of Rs 200 crore, the company is focused on accelerated growth.Overall, our coverage universe of the Engineering sector has reported reasonable FY21 performance on the back of economic revival garnering a strong order pipeline, margins were largely supported by pass-through of raw material cost to customers, and capacity expansions will lead to growth in the near to midterm.[6]

II.DISCUSSION

Some examples of engineering economic problems range from value analysis to economic studies. Each of these is relevant in different situations, and most often used by engineers or project managers. For example, engineering economic analysis helps a company not only determine the difference between fixed and incremental costs of certain operations, but also calculates that cost, depending upon a number of variables. Further uses of engineering economics include:

- Value analysis
- Linear programming
- Critical path economy

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- Interest and money - time relationships
- Depreciation and valuation
- Capital budgeting
- Risk, uncertainty, and sensitivity analysis
- Fixed, incremental, and sunk costs
- Replacement studies
- Minimum cost formulas
- Various economic studies in relation to both public and private ventures[7]

Each of the previous components of engineering economics is critical at certain junctures, depending on the situation, scale, and objective of the project at hand. Critical path economy, as an example, is necessary in most situations as it is the coordination and planning of material, labor, and capital movements in a specific project. The most critical of these "paths" are determined to be those that have an effect upon the outcome both in time and cost. Therefore, the critical paths must be determined and closely monitored by engineers and managers alike. Engineering economics helps provide the Gantt charts and activity-event networks to ascertain the correct use of time and resources.[7]

Proper value analysis finds its roots in the need for industrial engineers and managers to not only simplify and improve processes and systems, but also the logical simplification of the designs of those products and systems. Though not directly related to engineering economy, value analysis is nonetheless important, and allows engineers to properly manage new and existing systems/processes to make them more simple and save money and time. Further, value analysis helps combat common "roadblock excuses" that may trip up managers or engineers. Sayings such as "The customer wants it this way" are retorted by questions such as; has the customer been told of cheaper alternatives or methods? "If the product is changed, machines will be idle for lack of work" can be combated by; can management not find new and profitable uses for these machines? Questions like these are part of engineering economy, as they preface any real studies or analyses.[8]

Civil Engineering is a well-known branch of engineering which majorly deal with the professional application of designing, constructing infrastructure, and the maintenance of physically and naturally built infrastructures.It is one of the oldest and most broad fields of engineering, and it covers a wide variety of subdisciplines, including environmental engineering, geotechnical engineering, and structural engineering.Planning, Designing, Construction, and operating of any infrastructure projects such as bridges, dams airports are taken care of by civil engineers. In order to become a civil engineer, one must complete a four-year Civil Engineering specialization from an accredited engineering program. Demands the number of civil engineers is increasing in India due to its large population. India has the second highest population in the world, and with that comes a large number of infrastructure projects. These projects require the expertise of civil engineers to get them off the ground.Additionally, the Indian economy is growing rapidly. This has led to an increase in construction activity, which has in turn led to a higher demand for civil engineers.[9] The country is also investing heavily in its infrastructure, which is creating even more opportunities for civil engineers. This industry has the potential to provide employment to millions of people. Indian construction in India is the second largest industry as it employs more than 35 million people and contributes to about 10% of the country's GDP. The sector has seen strong growth in recent years, with the government's push for infrastructure development and housing.The Indian construction industry is expected to grow even further in the coming years. This growth is driven by the government's continued focus on infrastructure development, as well as the growing demand for housing. With the right policies in place, the construction industry in India has the potential to become one of the world's leading industries. The construction industry in India has the potential to provide employment to millions of people. With the country's population expected to grow to 1.5 billion by 2030, the demand for housing, office space, and infrastructure will continue to grow. This presents a unique opportunity for the construction industry to create millions of jobs and help boost the economy.The construction industry is already one of the largest employers in India, with over 40 million people employed in the sector. With the right policies in place, the industry has the potential to create even more jobs and provide a much-needed boost to the economy.India is experiencing rapid economic growth, and as the economy shifts from manufacturing to services, there is a growing need for civil engineers to design and manage the construction of infrastructure projects[10] (such as airports, highways, bridges, and water treatment plants). However, there are not enough qualified professionals to meet the demand for infrastructure development in India.As a result, many large international firms have opened offices in India to develop their own talent pool by training local engineers. This could be an opportunity for students who are interested in pursuing a career as a civil engineer! As one of the most populous countries in the world, India has a large and growing

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economy that creates a demand for qualified civil engineers. Some of the top Indian companies that hire civil engineers include the following companies:Tata Group,Reliance Industries,L&T,Hindustan Construction Company,IVRCL,Larsen & Turbo Ltd,ABB Ltd,Ambuja Cement Ltd and many more.These companies are all leaders in the Indian economy, and they offer a variety of positions for civil engineers of all experience levels. If you're looking for an exciting and challenging career in civil engineering, these are some of the top companies you should consider.[11]

The civil engineering field is expected to grow by 25% every year. This is due to the increasing demand for infrastructure and the need for qualified professionals to design and build these projects. With the ever-growing population, there is a constant need for new housing, roads, and other structures, which creates a lot of opportunities for civil engineers. Civil engineers work in a variety of industries, from natural resources to transportation, and have skills that are in demand across the country and around the world.In recent years, the Indian government has begun building new highways, water pipelines, and power plants to help fuel economic growth and provide improved living conditions for its citizens.[12]

III.RESULTS

Linear programming is the use of mathematical methods to find optimized solutions, whether they be minimized or maximized in nature. This method uses a series of lines to create a polygon then to determine the largest, or smallest, point on that shape. Manufacturing operations often use linear programming to help mitigate costs and maximize profits or production.[7] Considering the prevalence of capital to be lent for a certain period of time, with the understanding that it will be returned to the investor, money-time relationships analyze the costs associated with these types of actions. Capital itself must be divided into two different categories, equity capital and debt capital. Equity capital is money already at the disposal of the business, and mainly derived from profit, and therefore is not of much concern, as it has no owners that demand its return with interest. Debt capital does indeed have owners, and they require that its usage be returned with "profit", otherwise known as interest. The interest to be paid by the business is going to be an expense, while the capital lenders will take interest as a profit, which may confuse the situation. To add to this, each will change the income tax position of the participants.[13]

Interest and money time relationships come into play when the capital required to complete a project must be either borrowed or derived from reserves. To borrow brings about the question of interest and value created by the completion of the project. While taking capital from reserves also denies its usage on other projects that may yield more results. Interest in the simplest terms is defined by the multiplication of the principle, the units of time, and the interest rate. The complexity of interest calculations, however, becomes much higher as factors such as compounding interest or annuities come into play.

Engineers often utilize compound interest tables to determine the future or present value of capital. These tables can also be used to determine the effect annuities have on loans, operations, or other situations. All one needs to utilize a compound interest table is three things; the time period of the analysis, the minimum attractive rate of return (MARR), and the capital value itself. The table will yield a multiplication factor to be used with the capital value, this will then give the user the proper future or present value.[14]

In a recent interview to Huffington Post, the India chief of IMF Ranil Salgado admitted that the institution has been wrong in its assessment. He also accepted that the slowdown wasn't cyclical but structural. Although he seemed impressed by certain government measures to revive the economy he said it couldn't happen without significant investments in education and health. In case people have forgotten let me remind them that the government recently decided to clip Rs 3,000 crore from the education budget. Although improved financial transmission and a possible quick resolution of global trade tensions maybe some possible upsides to growth projections but a delay in the revival of domestic demand, a further slowdown in global economic activity and geo-political tensions can also prove downside risks.The GST Council has decided not to tamper with the tax rates. While there is an advantage of this move, there are also negatives to it. The government has been falling short of its targeted collections and a hike in the rates would have helped in this regard but, on the other hand, animosity between the Centre and some states has been intensifying due to delay in payouts to the states. Tax cuts usually put the saved money directly into the hands of consumers, which they can spend on other goods and services. From a macroeconomic point of view, this is a time to cut both personal income taxes and indirect taxes. That would be the quickest way to push demand and correct the cyclical downturn in demand. This what the experts say but this downturn isn't cyclical, it is a structural anomaly.[15]

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NITI Aayog Vice-President Rajiv Kumar seems optimistic about the state of the economy. He feels despite all odds the economy will grow by six per cent or maybe more. But how, he doesn't know.Despite general expectations, the RBI kept key policy rates unchanged keeping in view the rising inflationary trends. Disappointingly, real GDP growth for FY20 is revised downwards from 6.1 per cent in the October policy to five per cent for FY20.According to a PTI report, the previous low was recorded at 4.3 per cent in the January-March period of 2012-13. The GDP growth was at seven per cent in the corresponding quarter of 2018-19.The gross value added (GVA), a measure of the value of goods and services produced in an area, industry or sector of an economy plunged to a near ten-year low. A lot of so-called experts have been citing the rising stock exchange indices as a sign of a healthy economy. But that is a very poor way of looking at the economy. Stock exchanges do nothing for the health of an economy. The slowdown is visible across other sectors as well. Construction sector GVA grew 3.3 per cent in July-September 2019 compared to 5.7 per cent in the previous quarter and 6.8 per cent in the second quarter of the previous fiscal year. The GDP growth in 1H-FY20 has averaged at 4.75 per cent.Right from the days of demonetisation Indian real estate has been devoid of any appreciable forward momentum and it has continued in the same vein 2019. Dwindling consumption, lacklustre investment and the global slowdown overshadowed all possibilities for growth.The real estate sector's performance – a reliable barometer of India's overall economic health – painfully reflected the macro-economic state of affairs. The liquidity crisis did not relent and dented any 'real' growth during the year.As Johnny-come-lately, the apex bank in its fifth bi-monthly policy review sharply lowered GDP growth projection for the entire fiscal to five per cent from 6.1 per cent. RBI also revised its headline retail inflation projection upwards to 5.1-4.7 per cent for the second half of 2019-20. Putting pressure on household expenses, retail inflation is likely to remain "very high" in the upcoming three-four months before a possible dip in the first half of 2020-21.However, there are chances that it may take longer as inflation is influenced by a number of factors. While RBI could ask banks for faster transmission of lending rates, it needs to team up with the government and cater to the needs of stressed sectors like banking, manufacturing, construction, automobile and real estate. Banks have only transmitted 0.6 per cent of 2.25 per cent repo cut by RBI, choking up the economy.There's really nothing to cheer for RBI repo rate cut though it means everything and yet results in nothing. Because the economy is choked up as India's public and private sector commercial banks have collectively choked up the domestic economy by refusing to pass on the repo rate cuts to the consumers and the industry for the past five years. Consistently high interest rates have dissuaded the industry from borrowing to invest in greenfield projects and plant expansions. India's private investment is at a 14 year low, according to CMIE.The National Statistical Office (NSO) released the GDP estimates for the Q2 of FY20 showing a sixth straight fall in the quarterly GDP growth – from 8.1 per cent in Q4 of FY18 to 4.5 per cent for Q2 FY20. Manufacturing, which contributes 77.6 per cent to the IIP, was growing at a much higher rate earlier – at a simple annual average of 10 per cent between FY05 and FY11 (base 2004-05) – but had fallen to just four per cent of simple annual average growth rate between FY12 and FY19 (base 2011-12). Simple data can confuse and confound. For example, the latest monthly data of the CMIE shows an unemployment rate of 7.48 per cent in November – down from 8.45 per cent in October 2019. But the labour force participation rate (LFPR) – which reflects how many of the labour force (those either working or looking for work) are employed – fell to a new low of just 42.37 per cent.There is broad unanimity among the various experts about uplift in 2020. Private sector consensus prediction is that GDP will grow above six per cent in 2020-21, the next financial year. The RBI expects an early comeback — an average 6.1 per cent in April-September 2020. And the International Monetary Fund's October World Economic Outlook forecast India's GDP growth accelerating to seven per cent in 2020, up from 6.1 per cent in 2019. Incidentally, these are the two institutions, the RBI and IMF, which were the last to revise their earlier projections. This optimism is presumed upon an uptick in spending and production from monetary and fiscal policy support, namely, enhanced pass-through of cumulative monetary easing in 2019, lower business taxes, partially eased labour regulations, further counter-cyclical stimulus expected in the forthcoming budget, and other sector-specific relief measures. An improved rabi crop outlook owing to robust monsoons adds to this optimism. Progressive improvement in liquidity and financing conditions of the stressed non-bank sector is also anticipated.However, most segments are fundamentally weak or strained. A quick health check shows businesses and consumers are less than fit. Many large firms are still to deleverage, regain balance sheet strength to contemplate investing afresh.The protracted slowdown has slowed this process. It has also tipped newer firms into this pool, adding fresh bad loans to the existing stockpile of non-performing assets and aggravating overall stress. Consumers or households, also increased their liabilities in the last two years in which income growth slowed, not an ideal situation for borrowing or spending more. The weakened capacities could therefore mute the magnitude of aggregate demand response, or private investment and consumption.[16]

The public or government sector is increasingly strained. This is a large segment with significant economic influence through taxation and expenditure policies. To elaborate, higher government spending alone contributed 1.9 percentage

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points to last quarter's GDP growth of 4.5 per cent. But now, the government is cash-strapped. On the revenue side, it is affected by declining economic activities that reduce tax collections as well as recent tax cuts; committed expenses strain the expenditure side. The resource constraint is posing a difficult choice, whether to axe spending or raise taxes. Either will result in further demand compression. It is to be hoped such a vicious spiral does not set in.

Implications

Using the compound interest tables mentioned above, an engineer or manager can quickly determine the value of capital over a certain time period. For example, a company wishes to borrow $5,000.00 to finance a new machine, and will need to repay that loan in 5 years at 7%. Using the table, 5 years and 7% gives the factor of 1.403, which will be multiplied by $5,000.00. This will result in $7,015.00. This is of course under the assumption that the company will make a lump payment at the conclusion of the five years, not making any payments prior.

A much more applicable example is one with a certain piece of equipment that will yield benefit for a manufacturing operation over a certain period of time. For instance, the machine benefits the company $2,500.00 every year, and has a useful life of 8 years. The MARR is determined to be roughly 5%. The compound interest tables yield a different factor for different types of analysis in this scenario. If the company wishes to know the Net Present Benefit (NPB) of these benefits; then the factor is the P/A of 8 yrs at 5%. This is 6.463. If the company wishes to know the future worth of these benefits; then the factors is the F/A of 8 yrs at 5%; which is 9.549. The former gives a NPB of $16,157.50, while the latter gives a future value of $23,872.50.

These scenarios are extremely simple in nature, and do not reflect the reality of most industrial situations. Thus, an engineer must begin to factor in costs and benefits, then find the worth of the proposed machine, expansion, or facility.[17]

The fact that assets and material in the real world eventually wear down, and thence break, is a situation that must be accounted for. Depreciation itself is defined by the decreasing of value of any given asset, though some exceptions do exist. Valuation can be considered the basis for depreciation in a basic sense, as any decrease in value would be based on an original value. The idea and existence of depreciation becomes especially relevant to engineering and project management is the fact that capital equipment and assets used in operations will slowly decrease in worth, which will also coincide with an increase in the likelihood of machine failure. Hence the recording and calculation of depreciation is important for two major reasons.

1. To give an estimate of "recovery capital" that has been put back into the property.
2. To enable depreciation to be charged against profits that, like other costs, can be used for income taxation purposes.

Both of these reasons, however, cannot make up for the "fleeting" nature of depreciation, which make direct analysis somewhat difficult. To further add to the issues associated with depreciation, it must be broken down into three separate types, each having intricate calculations and implications.

- Normal depreciation, due to physical or functional losses.
- Price depreciation, due to changes in market value.
- Depletion, due to the use of all available resources.[18]

Calculation of depreciation also comes in a number of forms; straight line, declining balance, sum-of-the-year's, and service output. The first method being perhaps the easiest to calculate, while the remaining have varying levels of difficulty and utility. Most situations faced by managers in regards to depreciation can be solved using any of these formulas, however, company policy or preference of individual may affect the choice of model.[7]

The main form of depreciation used inside the U.S. is the Modified Accelerated Capital Recovery System (MACRS), and it is based on a number of tables that give the class of asset, and its life. Certain classes are given certain lifespans, and these affect the value of an asset that can be depreciated each year. This does not necessarily mean that an asset must be discarded after its MACRS life is fulfilled, just that it can no longer be used for tax deductions.

Capital budgeting, in relation to engineering economics, is the proper usage and utilization of capital to achieve project objectives. It can be fully defined by the statement; "... as the series of decisions by individuals and firms concerning how much and where resources will be obtained and expended to meet future objectives."[7] This definition almost perfectly

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explains capital and its general relation to engineering, though some special cases may not lend themselves to such a concise explanation. The actual acquisition of that capital has many different routes, from equity to bonds to retained profits, each having unique strengths and weakness, especially when in relation to income taxation. Factors such as risk of capital loss, along with possible or expected returns must also be considered when capital budgeting is underway. For example, if a company has $20,000 to invest in a number of high, moderate, and low risk projects, the decision would depend upon how much risk the company is willing to take on, and if the returns offered by each category offset this perceived risk. Continuing with this example, if the high risk offered only 20% return, while the moderate offered 19% return, engineers and managers would most likely choose the moderate risk project, as its return is far more favorable for its category. The high risk project failed to offer proper returns to warrant its risk status. A more difficult decision may be between a moderate risk offering 15% while a low risk offering 11% return. The decision here would be much more subject to factors such as company policy, extra available capital, and possible investors.[19]

"In general, the firm should estimate the project opportunities, including investment requirements and prospective rates of return for each, expected to be available for the coming period. Then the available capital should be tentatively allocated to the most favorable projects. The lowest prospective rate of return within the capital available then becomes the minimum acceptable rate of return for analyses of any projects during that period."[8]
Decisions are made routinely to choose one alternative over another by individuals in everyday life; by engineers on the job; by managers who supervise the activities of others; by corporate presidents who operate a business; and by government officials who work for the public good. Most decisions involve money, called capital or capital funds , which is usually limited in amount. The decision of where and how to invest this limited capital is motivated by a primary goal of adding value as future, anticipated results of the selected alternative are realized. Engineers play a vital role in capital investment decisions based upon their ability and experience to design, analyze, and synthesize. The factors upon which a decision is based are commonly a combination of economic and noneconomic elements. Engineering economy deals with the economic factors. Before an economic analysis technique is applied to the cash fl ows, some decisions about what to include in the analysis must be made. Two important possibilities are taxes and inflation. Federal, state or provincial, county, and city taxes will impact the costs of every alternative. An after-tax analysis includes some additional estimates and methods compared to a before-tax analysis. If taxes and inflation are expected to impact all alternatives equally, they may be disregarded in the analysis. However, if the size of these projected costs is important, taxes and inflation should be considered. Also, if the impact of inflation over time is important to the decision, an additional set of computations must be added to the analysis. Many of the fundamentals of engineering ethics are intertwined with the roles of money and economics-based decisions in the making of professionally ethical judgments. Some of these integral connections are discussed here, plus sections in later chapters discuss additional aspects of ethics and economics. The terms morals and ethics are commonly used interchangeably, yet they have slightly different interpretations. Morals usually relate to the underlying tenets that form the character and conduct of a person in judging right and wrong. Ethical practices can be evaluated by using a code of morals or code of ethics that forms the standards to guide decisions and actions of individuals and organizations in a profession, for example, electrical, chemical, mechanical, industrial, or civil engineering. There are several different levels and types of morals and ethics. An engineering project or alternative is formulated to make or purchase a product, to develop a process, or to provide a service with specified results. An engineering economic analysis evaluates cash flow estimates for parameters such as initial cost, annual costs and revenues, nonrecurring costs, and possible salvage value over an estimated useful life of the product; process, or service. Many public sector projects such as bridges, dams, highways and toll roads, railroads, and hydroelectric and other power generation facilities have very long expected useful lives. A perpetual or infinite life is the effective planning horizon. Permanent endowments for charitable organizations and universities also have perpetual lives. The economic worth of these types of projects or endowments is evaluated using the present worth of the cash flows.[20]

IV.CONCLUSIONS

The most commonly quoted measure of economic worth for a project or alternative is its rate of return (ROR). Whether it is an engineering project with cash flow estimates or an investment in a stock or bond, the rate of return is a well accepted way of determining if the project or investment is economically acceptable. Compared to the PW or AW value, the ROR is a generically different type of measure of worth, as is discussed in this chapter. Correct procedures to calculate a rate of return using a PW or AW relation are explained here, as are some cautions necessary when the ROR technique is applied to a single project's cash flows. The ROR is known by other names such as the internal rate of return

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(IROR), which is the technically correct term, and return on investment (ROI). From the perspective of someone who has borrowed money, the interest rate is applied to the unpaid balance so that the total loan amount and interest are paid in full exactly with the last loan payment. From the perspective of a lender of money, there is an unrecovered balance at each time period. The interest rate is the return on this unrecovered balance so that the total amount lent and the interest are recovered exactly with the last receipt. Rate of return describes both of these perspectives. Rate of return (ROR) is the rate paid on the unpaid balance of borrowed money, or the rate earned on the unrecovered balance of an investment, so that the final payment or receipt brings the balance to exactly zero with interest considered. Installment financing can be discovered in many forms in everyday fi nances. One popular example is a "no-interest program" offered by retail stores on the sale of major appliances, audio and video equipment, furniture, and other consumer items. Many variations are possible, but in most cases, if the purchase is not paid for in full by the time the promotion is over, usually 6 months to 1 year later, finance charges are assessed from the original date of purchase. Further, the program's fine print may stipulate that the purchaser use a credit card issued by the retail company, which often has a higher interest rate than that of a regular credit card, for example, 24% per year compared to 15% per year. In all these types of programs, the one common theme is more interest paid over time by the consumer.[20]

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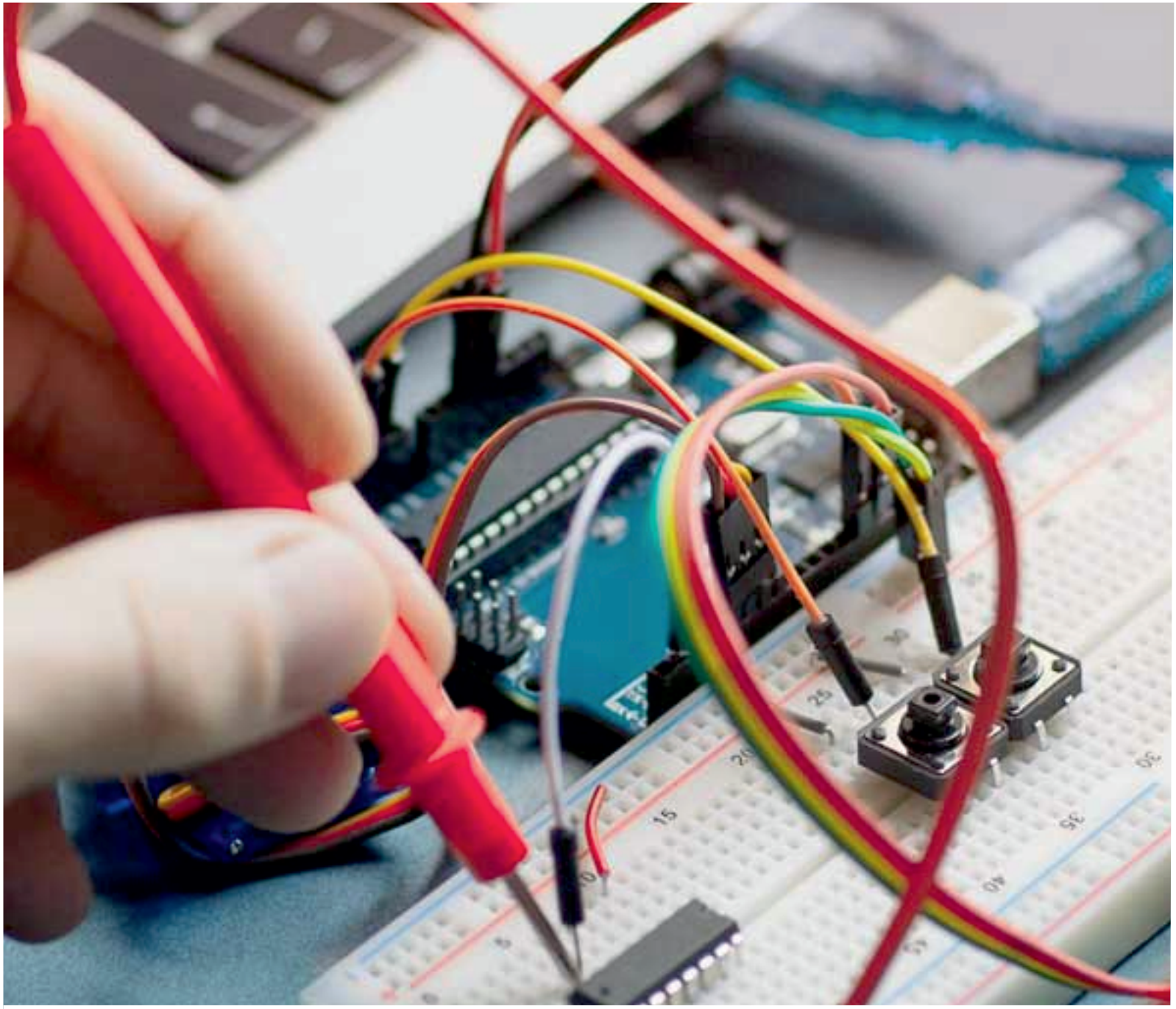

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