CRITICAL CONNECTIONS IN ENGINEERING MANAGEMENT: THE ROLE OF INFORMATION AND DECISION MAKING IN MANAGEMENT

# Introduction

As our ability to observe the intricate components of systems that drive our world advances, the need to capture and use this data in a meaningful way becomes an ever-growing concern. Nowhere is this more apparent than in the industries that form the building blocks of the modern economy. With the rise of globalism and integration of technology into every facet of business operation, competitive advantages are exacerbated across world markets. Those who can’t adapt and use historical performance as an indicator of needed future changes end up failing to maintain their existence amid the sea of disruption. To add to this hostile environment, the companies that can find their way through these pressures end up in a vicious cycle of demanding higher quality results in shorter time frames with less resources. While this environment has led to many of the greatest developments in our era, the need to maintain these levels of continuous improvement has created extremely difficult situations requiring unique analysis techniques and intuitive approaches to discern and properly navigate them.

Managers charged with the responsibility of deciding the direction of action through these situations must display strong competencies and creative thought processes to be successful. Having the ability to take advantage of new technologies and understand their application; locate, obtain, and organize information from data; and evaluate and analyze collected information to make decisions and solve problems are all key factors necessary for proper management. This requires most managers to be fully engaged and have advance analytical skills from fields such as engineering. To complement this broad range of skills, the knowledge of systems and processes to extract and visualize data can be critical to gaining an edge in understand the nature of events surrounding situations which can further improve their decision-making process.

Information and decision making become the focal point for most of these requirements and can be the leading pieces of a successful venture or the omitted points of a complete failure depending on how they are approached and handled. Informed decision making takes advantage of the combination of these processes, utilizing skills from each to fully describe the current situation being examined and then justify the movement in a course away from it. Making up the components of this phase in the management process are various tools, methods, and systems that each have many branching elements needing special training and skill to master. Experience in areas such as big data, data analysis, business intelligence, problem solving, and crisis management along with the knowledge of instruments such as management information systems (MIS), executive dashboards, and decision models are vital to accomplishing informed decision making and can aid in clarifying uncertain environments. The use of data to make decisions without a clear understanding of these concepts can lead to misunderstanding system trends, poorly developed target metrics, and the failure to select the optimal choice for given conditions. Adding to this necessity, many data streams not carefully analyzed and cleaned to yield useful information can contain inconsistent readings, skewed results, and the impact of external factors not relevant to substance of the decision to be made. Only through the application of proper techniques can data be verified as information and then applied to make the best decisions.

# Literature Review

Information and decision making are two fields which each represent the aggregated application of procedures and techniques used by managers to complete the process of controlling and planning in systems they are responsible for. These elements that make up the two broader fields help managers define their environment, set a clear progression on how they approach issues, and mitigate the shear complexity of some situations. Being the bulk of what managers do, having a clear understanding of these topics is essential to be an effective manager. The main topics to understanding information in the role of engineering management include the concept of data, analytics, and management systems. For decision making in engineering management a conceptual understanding of the process, environment, and goal must be understood.

## Information

The theory of information is based on the ideas of information extraction, processing, and application, but where does this information come from? Information and Data are two commonly interchangeable terms, even being represented as synonyms of one another in Microsoft Word. However, the two terms take on a completely different meaning in the context of engineering management and information theory. Data represents unaltered numerical values, facts, and statistics collected from a reference. This raw data still contains any elements of external noise introduced during collection and typically have an incoherent and unstructured form. Basing decisions on data can present many challenges from the effect of outliers, false readings, and gaps. Sources of data can lead to huge, difficult to interpret data collections known as big data which contain massive amounts data that cannot be evaluated using simple techniques. To access and evaluate these large data collections, methods and tools have been developed. These tools and methods make up a field specifically devoted to transforming all types of data into useful information referred to as data analytics. This field can be subdivided into several key areas that make up a procedure to evaluate data. Components of this include data extraction, data aggregation, data cleaning, data mining, exploratory data analysis, and data transformation. Through these steps data is pulled from its source into a dataset, stripped of all nonessential or bad elements, organized in an interpretable manner, searched through for relevant information, and converted into useful information. The end result is information that easily understood, relevant to the current source, represents good quality and realistic metrics, completely describes the system of interest, and is appropriate for the give conditions. This information in then usually stored in an area where it accessible for decision makers when needed. These pools of useful information are kept in information systems which streamline the process of pulling the correct pieces of information at the right time. These information systems come in many different forms depending on the time orientation, internal or external nature, and structure of the information they store. Types of information systems include management information systems (MIS), decision support systems (DSS), and knowledge work systems (KWS).

## Decision Making

Once access has been made to information, careful analysis can be done based on defined objectives to conclude on and justify a decision. This is comprised of multiple parts that must considered various factors and makes up a manager’s decision-making process. These parts, considered under normative decision theory, form a multistep process that begins with the identification of a problem. Problems represent the basis for any decision and are the launch point from which consequences of a decision propagate. Problems can be performance threats that impede the output of a system or performance opportunities which offer the ability to improve a system’s current capabilities. As managers approach these problems and the decision-making process as a whole their methods and actions are heavily influenced by the way handle and interpret the information they are given. This unique way of consuming information is known as their cognitive style and can take on different forms. Depending on a manager’s style they could tend to rely more on feelings than thoughts or intuition than sensing. From this trait a manager may be more inclined to make a decision based on the structure of the problem and weight the facts available with different importance. Applying the balanced use of systematic and intuitive thinking when initially starting this process can aid in keeping their minds open to unforeseen possibilities while maintaining their focus on the time management throughout their effort. The environment of a problem then comes into the spotlight as different amounts of information on a particular issue can lead to different outcomes from the decision-making process. Uncertain environments require uniquely structured decisions, tailored to provide the best opportunity for success, while risky environments can yield several alternatives to choose from which each have different chances that they will result in the desired outcome. Certain environments are typically the easiest to work in and can usually be planned for with decisions preprogrammed for a proven outcome. These environments are typically not seen as they assume complete information, which is hardly the case in any process. After these considerations the next step in this process can be commenced and decisions can be crafted for the situation. This involves minor test of alternatives to ensure their feasibility before progressing to the next step to choose a preferred course of action. In this step managers typically end up falling into one of two categories. These can be defined by the classical model and behavioral model. Those managers who show actions leaning towards a classical model act rationally and assume that the situation shows all the characteristics of complete information. Managers who’s actions are similar to the behavioral model act under bounded rationality with limited knowledge and only assume results are as certain as they pertain to the immediate system. Once a decision is made the following step is to implement it before finally evaluating results. This process relies heavily on information gathered from the issue at hand and can easily be derailed if improper data is collected. The result of properly applying these steps with all considerations accounted for is the optimal decision under current system conditions. Despite this, the managers using this model of implementation can still fall victim to many traps due to limited representation from information obtain from the system, biased in the final decision from personal preferences, ease of implementation from satisficing decisions, and reluctance to shift to far from current trends to complacency.

# Information and Decision Making in Engineering Management

## Relationship to Engineering Management Principles

Information and decision making are two components that form the basic resolution steps for any problem and thus is clearly tied to the process of actively managing a system. The procedural format used to properly apply these fields in management lends itself to the structured form of engineering and together they help to form a reliable and proven set of techniques to make appropriate changes for an improved system. Further drawing similarity between principles in engineering management, the application of these concepts usually seeks to find the most ethical outcome that benefits everyone. Non-optimal decisions that yield little benefit are typically tossed aside and not considered in the final decision selection. The process attempts to mitigate bias from the user and leads them down a path that should result in the implementation of an independent and information driven decision. When managers perform the tasks of planning projects and controlling processes, information is key to monitoring how their plans are carried out and how processes perform. This can help to identify areas where changes will need to be implemented to mitigate gaps in coverage, take advantage of potential opportunities, and realign project objectives.

## Importance in Engineering Management

Engineering management is a broad field that covers the general actions related to leading efforts in technical areas. One of the key factors to being a successful manager in this field is the ability to understand the nature and components of the system being managed and act on that understanding to drive positive changes for better outcomes. A more complete understanding of the system can only be obtained through comprehensive knowledge of information regarding system dynamics and characteristics. This means that having the ability to discern information from data, perform data analytics when information is not available, and access the tools and methods to complete these tasks is essential to system understanding and a key factor to engineering management. Once the system is understood these characteristics are then used to find areas of improvement or possible deficiencies that might occur. After identifying these problems knowledge of decision-making processes and personal traits that might influence them is crucial to ensure that the best outcome is chosen and implemented. The failure to do this can lead to system failures and missed opportunities.

## Challenges to Integration by Engineering Managers

In the current working environment, many challenges face the proper use of information and decision-making skills. These include data reliability, poorly defined goals, and the improper application of results. Mostly relating to how information is used by decision makers, these issues can present the opportunity for serious complications in system function if they can persist and infiltrate the work of knowledge workers. Data reliability is an issue that can arise without operator error and is generally the result of noise capture in devices used to measure a process or system. This can lead to missing elements and outliers in datasets which results in situations where decision makers must act on incomplete information. Without complete knowledge of system information there is always the risk that expected outcomes will not be realized and fail to meet the outlined objectives. Poorly defined goals can stem from several sources including incomplete information, the poor use of judgement by decision makers, and miscommunicated objectives. Though this issue typically leads to the selection of a less than optimal decision, the worst by product that results is the lack of trust with respect to the information being used and the personal performing analysis with it. The improper application of results can lead to multiple problems and can be traced to misunderstanding the information, inadequately define performance metrics, and pressure on decision makers. This can lead to decisions based on self-interest, that can make the decision maker look appealing in the moment, but usually lead to systemic issues in the process they are applied too.

## The Future of Engineering Management

Despite these possible short comings, the future role of information and decision making in engineering management has limitless potential. Being so closely tied to the function of management, these two fields have experienced an explosion of available technologies and tools that can be applied improve their results. Advances in modeling techniques, machine learning, data collection, and computing power have given decision makers the opportunity to interpret and analyze vast amounts information in a time efficient manner. With the rapid rate of technological advances seen over the past few years this is only expected to accelerate.

## Preparation for The Future

Those individuals preparing themselves for a future in engineering management can develop a comprehensive skillset in these areas long before they actual begin their career. By taking advantage of opensource technologies and the online access to vast amounts of research available on these subjects, they can be better equipped to deal with the challenges facing these fields and be able to benefit from their proper application. Exploring beyond the classroom setting, students can learn programming languages, database interfaces, decision support tools, and management techniques through free sources that will enable them to jump into an industry and excel. Having this lead on their peers could have a large impact on their future employment and the progression path they follow as the shortened learning curve would help them make a quicker impact with their work.

# Conclusion

With the increased use of data analytics and integration of technology into the decision-making process the need for technically savvy managers will only continue to grow. Understanding concepts and ideas relating to information and decision making are central components to this technical competency and the success of future mangers will most likely rely on possessing these skills. The challenges facing information collection and proper analysis of this information are issues that are constantly being reduced and will facilitate the wider and more acceptable use of these processes for critical decisions. This will mean that those who enter the field must have a commitment to lifelong learning as new technologies are introduced and sources of decisions rely even more on information gained from data and the interpretation of results.

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