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The State of Project Control in the 21st Century

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Project Control on major projects has changed over time and its meaning has also significantly altered. There are several software packages available for project planning, scheduling, cost, estimating, and budgeting. It is up to the Client to authorize the use of a particular software, available reporting format, price, and ease of operation. Present day Project Management is conducted over the phone. Changes that are approved over the phone mean that record keeping is highly essential. Data is stored in remote Cloud Computers, Supply Chain Management for Procurement and Construction Management with cell phones and bar codes. The Project Control methodology has gone through major improvements with a variety of computer software; that continues to undergo change, which will be highlighted in this paper. Distance and location of the project is of no concern anymore.

Introduction: a historical perspective

The Client's criterion is that the planned projects are executed according to drawings and specifications, completed within the budget, and mutually agreed and approved schedule. Visibility of the status of the project should be available at all times and is critical; deviations and changes to any of the planned effort should be brought to the attention of the Client for a timely resolution. In the past most of the schedules were drawn by hand similar to Gantt chart with no logical ties to activities on the project. In 1958, the U.S. Navy on the Polaris mobile submarine-launched ballistic missile project, the Program Evaluation and Review Technique (PERT) was developed to monitor and control the cost of the project.

In the early nineties many of the project schedules were developed in the main frame computers. The author had the opportunity to work with the following IBM main frame software: McDonald-Douglas Schedule and Cost System (MSCS) main frame IBM 320 scheduling software, Planning-Scheduling 2 (PS2) developed by Stone & Webster Engineering Corporation, Boston, MA for use on IBM 320, Artemis developed by Metier Management Systems, London, UK for main frame IBM computers.

It was time consuming and the scheduler had to be familiar with the operation of the main frame. With advent of desk top computers several software were developed, such as: Primavera Systems (P3), Valley Forge, PA, Open Plan, Houston, TX, PROLOG Construction Management Software from Meridian Systems, Folsom, CA, Microsoft Project, from Microsoft, Redmond, WA and Artemis for microcomputers and Apollo for desk top computers and others to plan, schedule, monitor and periodic schedule updates. Later it became convenient to add

resources, cost, ability to develop S curve, and graphics were added to visually show the status of the project in progress once the computing system took a major advancement. (1)

For any planned project, the following are essential: Scope, Plan, Budget, Resources, Location, access to proposed project site, and any restrictions from the town or municipality.

Once project commences, the Project Manager (PM) in conjunction with the Project Control Manager (PCM) diligently manage the project, keeping the project team up to date with all relevant information as stated above. Communication between the project team and the client's team is very essential at all times.

PCM should prepare the Organization Chart and the Work Breakdown Structure (WBS)^(2,3) to manage the project with ease. PCM should also create the Cost Account plan for each work package under the WBS. Software available in the industry with WBS templates, the PCM had to fill up the blanks thoroughly and get the WBS working. Create the Work Packages (WP), Cost Account Packages (CAP), coding structure for the schedule, and cost.

Human Resource Planning (HRP) is an essential organization process that will help in choosing the right amount of workforce well qualified with the required skill levels to perform the engineering design, develop the drawings, and specify the equipment. Similar resource planning is recommended for the Construction work force to carefully study the market for the availability of labor and the need for specialized skill personnel to build the project in the field as planned, designed, and with the equipment purchased. This will reduce the shortage of personnel in the midst of design or during construction. The PCM and CM should have a well laid out procedure for resource management

and a resource allocation plan in the engineering office as well as at the Construction site.

During the Alignment Meeting to be held at the beginning of the project, the PCM together with the PM, Engineering Manager (EM), and Construction Manager (CM), should stress the importance of transparency, visibility, quick action on changes to scope, schedule, cost, substitutions, changes to procurement, anticipated risk, and other activities that may impact the cost and schedule of the project. Rapid change in the demographics of skilled personnel around the world has necessitated that the PM and PCM make everyone comfortable in the working environment and adopt any suggestions to improve the method of working; however small it may be, should be implemented without offending the person or persons. Language barriers should not come in the way while evaluating a person's performance on the project. More weight and credit should be given to the person's contribution to the success of the team and overall project.

These days everyone is using different types of gadgets from cell phones, to tablets and laptops, and even desk top computers. People are constantly on the phone, they keep it next to them while dining, sleeping, or driving. Large numbers of devices are available in the market that complements the users of these phones. Many of these phones come equipped with high resolution cameras that can take vivid color pictures and excellent videos in addition to panoramic views. Text messaging, use of emoji and other communication tools are used to express their feelings, mindsets, and desires. In project control we need the status of the project, but an emoji or a text saying "good", "nice", or "ok" will not suffice. Clear, well written messages are essential for inclusion in the weekly and monthly reports. The PCM should write the procedure and get it approved by the PM, EM, CM and Client. "The Practical Project Control Manager Handbook", by Jeremie Averous (4) is an excellent resource book to an aspiring or experienced PCM looking to manage commendably large and small projects located anywhere in the world.

Develop and install an Intranet using the World Wide Web software to communicate within the project team, Client, Stake Holders, and construction team. The Intranet will be accessible only by personnel assigned to the project. The written procedure should clearly delineate Change Order processing, internal and external communication procedures, schedule and cost

updates, trend procedures, resources used on the project, reporting criteria and occurrence, and planned weekly and monthly meetings with the team and with the Client. Other valuable information such as on International projects, the foreign exchange rates, import duties, taxes, GDP, escalation rates, inflation rates, interest rates, and others needed to successfully complete the planned project should be included. All progress photos could be displayed on the monthly reports. All this information must be uploaded to the Intranet based on the Cloud.

Advances in Project Control

Earned Value (EV)

The progress of the project is measured by the performance evaluation and the earned value system. This can be programmed in the scheduling software to yield results as soon as an activity is complete. The system can produce the cumulative total value to determine the performance of the planned activities. Data will come in from all disciplines by Friday evening, allow the system programmed to compute the values by Sunday night (giving time for late entries), Monday morning everyone can view the score on their cell phones or tablets. Meetings will last less than an hour to talk about: actions that need to be taken on shortage of personnel, late deliveries, or construction problems, like: excessive rain, flooding, or severe heat.

Cloud Computing (5)

From desk top computing to cloud computing, there has been a major shift in the manner in which project control information is handled. It allows people to share, work, and comment on information from remote areas of the world accessing the data via the Cloud. It is essential that all data provided should be accurate and traceable. Password protected access to the Cloud is essential to view and enter requisite data on schedule, cost, budget, change orders, equipment purchase orders, planned delivery dates, and budget estimate. On the Cloud, create folders to save: Scope, Estimate, Budget, Schedule, Cost, Change Orders, Drawings, Sketches, etc., for easy access instead of searching for a particular document on the Cloud.

Drones in Construction (6), (7)

The drones are used to complete the traverse along the proposed highway or street system, record existing terrain information in photos and convert them into site maps. GIS information drones are



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used for Construction inspections, aerial views of completed projects, and sequential erection for structural steel erection. This information in the form of photos taken by the drone could be included with the dates for information of all stake holders on the project. Monthly reports should also be included, as they become a part of the history of the Project for permanent data storage.

When maintenance work is performed on high rise buildings or offshore production facilities drones can be used to record the work in progress. Logistics, transportation of materials from storage areas, erection of concrete and steel work in the field can be monitored and videoed by the drones. The videos could be studied in the office to determine any bottleneck for lifting; and difficulty in sequence of operation could be explored, remedied or improved.

Many uses of the drones could be found in several literatures available online.

Block Chain Technology (8, 9, 10)

Blockchain Technology which is under development and used by many businesses to save and store data with a date stamp and linkage, prevents from writing or changing the data entered. It is a virtual lock to the data storage system. This Blockchain Technology could be used to save the Baseline Schedule, Cost Estimate, Original Budget, and Planned Scope of Work in a secure place so that it can be used to measure deviations, increments, and other data over the execution phase of the project to identify changes to many of the matters on the project. The data could be stored on the Cloud so that it is available for all Stake holders. This is one of the acceptable methods to create and store the history of the completed project.

Supply Chain Management (11)

The new name for Procurement of Materials, ordering of equipment, supplies, manufacturing of equipment, testing, packaging, shipping, and storage is called Supply Chain Management. Several software and courses are available to understand the concept of Supply Chain Management. We are familiar with the “Surveyor’s Chain”, “Gunter’s Chain”, or “Civil Engineer’s Chain” that consists of 66 links or 100 links of equal length that measure exactly 66 feet or 100 feet. Similar Links exists in the Supply Chain, but not of equal value. The concept is that all operations in the supply chain environment are well connected like the steel chain. If a link is broken the state of the successor links has

to be computed to determine the feasibility of completing the chain of events and logistics on a project. The PCM could obtain necessary information on the status of equipment purchases like: cost, schedule actual, etc. from the Supply Chain Coordinator to update the schedule, cost, and forecast of budget at completion.

Scanner and Wi-Fi Connections (12)

Drawings, bid documents, and specifications can be scanned and converted to portable document file (PDF) format. Once the documents are saved and received at the user end they can: open and read the document, make corrections, sign and save and resend the document for final storage or distribution. Wi-Fi connections are available for downloading on cell phones, iPads, Laptops.

No more printed copies to mail or send via a courier. Each person has the capability and capacity to store many documents for later use, to read or to comment and share with others in the group seamlessly.

Actual Hours Spent on Drawings

The draft person should log on at the start of work, working on a drawings, specification sheets, or sketches. Log off easily when taking a break, then log back on and continue the work. The computer system and software will keep track of the real time spent on the drawing from beginning to end. There are several software available in the industry to achieve this goal in the office.

Building Information Modeling (BIM) (13)

Building Information Modeling (BIM) is an intelligent 3D model-based process that gives architecture, engineering, and construction (AEC) professionals the insight and tools to more efficiently plan, design, construct, and manage buildings and infrastructure. The model allows a virtual view of the designed building, bridge, or high rise structure.

Architects can make better informed design decisions to improve building performance, incorporate lighting, ventilation and adequate safety features, collaborate more effectively, and communicate with other disciplines throughout the life of the project

Mechanical, Electrical, and Plumbing (MEP) discipline engineers could improve design quality, avoid conflicts in structures, efficiently use space,



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and collaborate in real time with the team to support the project delivery process.

Infrastructure and civil design engineers could function intelligently, developing connected workflows to help improve predictability, productivity, and profitability. A virtual view will show the pipe to pipe interaction between various utilities in the structure

Physical plant plot plan and equipment layout engineers can easily manage the design and construction of intelligent piping, structures, and processes more efficiently and collectively throughout the project. This includes: pre-commissioning, commissioning, and turn over the facility for full production.

Construction Manager could effectively digitize the planned work at the construction site and connect project information from design through construction and through turnover of the facility

Structural Engineers can explore how to use structural design and detailing software to improve the quality, safety, and effectiveness of the built structure to support project delivery.

PCM cost and schedule team should keep pace with all the discipline personnel and obtain reliable data on cost, schedule, and budget to keep the Client informed at all times.

Automation of Manufacturing Facilities

Automated manufacturing is a manufacturing method that relies on the use of computerized control systems to run equipment in a facility where products are produced. Human operators are not needed on the assembly line or manufacturing floor because the system is able to handle both the mechanical work and the scheduling of manufacturing tasks. The automation of existing facilities to stream line production and maintenance of equipment and other ancillary items is to be well planned, cost estimated, and prepared a schedule drawn to closely follow the plan for automation. The computerized system had to be designed, hardware and software procured, and synchronized with existing operational control to obtain maximum efficiency on streamlined production at minimum increase in cost.

Risk and Safety Management

While performing the engineering and design, the engineers should continually evaluate the risk and safety of the designed structure. The expected

impact of the finished buildings, bridges, and other entities on the environment, neighborhoods, watersheds, rivers and streams, land use, and the society at large must be evaluated and prioritized. It can be accomplished by using the drones to evaluate and correct the deficiency in the design and drawings. Risk management involves identification of risk, evaluation of the risk on schedule and cost, risk mitigation, and risk awareness in future activities at the site. With high speed communication every person on the project team will be informed of the expected risk within a fraction of a second. This means the solution could be developed and communicated to the field much faster than before.

Construction Management (14, 15, 16)

Construction Management is much more rigorous and requires constant supervision and assignment of work on a daily basis for craft personnel working on the site. Discipline Superintendents and skilled laborers would all carry tablets and cell phones. Communication with personnel is quick and effortless. Barcode on various pieces of hardware, equipment and erected structures will assist in scanning and recording in the database. No need to generate a log book or write in a record book. Photos taken with cell phones or videos of installation will be the best method to save the data and transmission to the Client office or project cost engineers and schedulers. From the issue at the warehouse to final installation, the material or equipment can be tracked and saved in the database for use by the Construction Manager, Construction Planner, and PCM. Material management at the construction site has become a standard operating procedure with software available in the industry. Actual work completed at the site could be informed via the cell phone instantaneously and uploaded to the Intranet.

Document Control (17, 18)

Document Control is an essential part of Project Management, Project Control, Finance, and Accounting. Data storage, retrieval, and distribution could be maintained with a variety of software available; that could be profitably used on small and large projects. The software can be customized to the needs of the team, stake holders, and project personnel.

Pre-commissioning and As-built drawings

While the project is in the construction stage, an engineer and a draftsman should be assigned to



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create as-built drawings to record changes from original design and the substitution and changes to location of equipment or supports. The feedback to the construction scheduler will provide for actual completion dates and quantities of foundations, structures, erection of steel, equipment, and other construction related items. This information will be saved on the Cloud based Intranet for access to all stakeholders. Photos will add additional validity of the pre-commissioning at the plant floor. All handling of the data or drawings will be done on their personal tablets or cell phones.

Commissioning, Testing, and Turnover ⁽¹⁹⁾

Commissioning of the plant, infrastructure, or facilities require a well-chosen and methodical start up plan to test its ability to operate in full production mode. Drawings stored on tablets help save the data while commissioning and no need for hard copies of equipment or circuit diagrams. Photographs can be taken instantly with the tablet or the cell phone that records the date and time stamp. The Vendor, Suppliers, Discipline Superintendent, Construction Manager Representative, and Client Representative would all be on the same page on the tablet or cell phone. No need to carry rolled up crumpled drawings, specifications, and start up sequence lists in a binder. Communication with their respective offices, PM, or Client is quick, generating an immediate action and response.

Conclusion

Project Management and Project Control methodologies and the software to support the efforts are speedily available with many vendors. It is the responsibility of the PM, PCM, and CM to acquire the software that is most suitable and usable on the specific project and train their personnel. Updates and new software techniques have changed the manner in which projects are organized, designed, engineered, procured, constructed, documented, and completed to the satisfaction of the stake holders on a project. All the more with the Cloud Computing, cell phones, and tablets projects can be handled from any part of the globe. Communication and access to information, data collection, and storage is possible with a click of the mouse or the touch of a screen! With a large amount of information, data, and records available at the disposal of the PM, PCM, and Client, it is advisable to train and lead their team in careful use and analysis of information.

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