CPM Scheduling and Pull Planning: Two Pillars of the Bridge to Innovation

Introduction

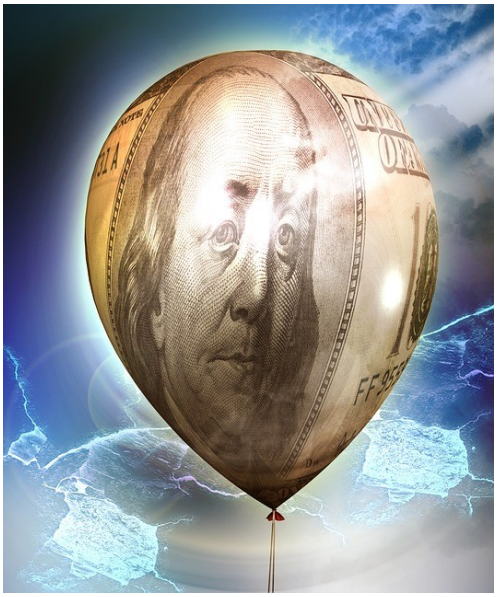
In business, there are misperceptions of and a need for innovation, especially in the construction industry, which trails behind other industries. Causes of this failure to innovate are examined. Two competing planning methods are presented as supporting pillars that will mitigate these factors, providing a process and an environment—the bridge to innovation that nurtures the many forms of thinking necessary for strategic innovation.

One pillar of the bridge, CPM scheduling, is shown to promote the control needed to keep projects on track and reduce risk, preventing an avalanche of challenges that could leave little time for anything but reacting. The CPM master schedule, schedule updates, and documentation build upon what is known to provide a reasonable security from which to launch creative thinking and give purpose to innovation.

The other pillar, pull planning, is shown to produce a high-quality CPM schedule, and when done regularly throughout the life of the project, it encourages creativity among all key project participants.

The proper blending of both methods becomes the framework for the bridge, allowing companies to continue their journey from the shores of the status quo to the unknown future of projects and the industry.

Innovation Misperceptions



Because innovation involves introducing something new, it requires creativity. Most consider creative thought to be the playground of thinkers like Albert Einstein, Bill Gates, Leonardo da Vinci, Benjamin Franklin, Marie Curie, and Jane Austen.

However, this is not true. New ideas from so-called average people pop up by the thousands every day. Everyone has creative thoughts, or the occasional lightbulb, but few know how to encourage, nurture, and harvest them. Only a small percentage of them become noteworthy, and even fewer motivate changes within an organization.

So, why bother initiating changes to encourage innovation that may only clutter up the project management process with untested ideas? The majority already deal with ongoing delays and challenges; they are expected. The resulting higher costs and lower return on investment (ROI) than projected are accepted. They are normal.

The Need for Innovation

Innovation requires thinking differently. Creative, associative, and critical levels of thought must be added to the analytical and lateral way of thinking (imaginenatincomau, 2016). All these thinking processes are parts of and steps toward innovation. They are only a handful of the gazillion ways of thinking available on the internet. Why are people writing about, researching, and reading about different ways of thinking? People want to be better problem solvers and innovators. They recognize the need.

In the world of business, 90% of companies surveyed place a priority on innovation (SHUKLA, 2017). It drives wealth creation. Without it, there is no strategy in strategic planning and no sustainable business growth (SHUKLA, 2017).

Unfortunately, the construction industry has been behind the curve on all forms of innovation compared to other industries. According to the 2016 Global Construction

Survey, only 8 percent of respondents are classified as innovative with cutting-edge technologies (Geno Armstrong, 2016), and about 20 percent aggressively disrupt business models. Sixty-nine percent are considered followers (Geno Armstrong, 2016).

Productivity of time and return on money invested in projects are declining. Architects, engineers, builders, and developers continue to flounder in inefficiency, amounting to billions of dollars in waste paid for by the public and owners. Because of the inherent fragmentation of the industry, no one player can significantly influence or initiate the necessary change (Yetmen, 2014).

Though it is gaining momentum in some areas, the construction industry is complacent with the status quo in areas of project management processes and must learn the value of and become skilled at innovative thinking. It is vital for the following reasons:

- **Unforeseen trouble**

Stuff happens. Though it can significantly reduce them, no amount of project planning will prevent all problems. Too many factors are beyond the project team's control. The muddle arises when experience fails to offer solutions, and creative thinking skills are rusty or nonexistent. Innovative thinking and the innovations that result can more easily resolve problems with improved processes, techniques, and tools.

- **Disruptive Changes in the Industry**

One example of disruptive change in the construction industry is “green” building. The increasingly environmentally and sustainability-conscious owners and users demand the wise use of resources to create healthier, high-quality, more energy-efficient homes and other structures (Green Building Solutions, 2018).

There are specialized software programs available that measure the life-cycle assessment, plus the environmental and economic performance of building products (Green Building Solutions, 2018). Moreover, organizations have risen to help industry experts develop high-performance, sustainable buildings by offering voluntary education and certifications in matters of “green” building and design (Green Building Solutions, 2018).

Innovation turns disruptions into an advantage, or even better, creates the disruption of the industry and allows companies to lead the way instead of being in pursuit of leading competitors.

- **Changing Customer/Owner Expectations**

"Green" thinking owners and users are not the only ones driving the need for innovation in construction. More owners, in general, are increasingly involved in the delivery process (Yetmen, 2014). If you are not an innovator in your industry, you will not be able to sustain company growth for long.

Innovation provides new ways to successfully engage owners/customers, fulfill their needs, and exceed their expectations, thus making their referrals and return for future projects likely.

- **Technological advancement**

The innovative few are forcing change with advances such as building information modeling (BIM), 3D printing, cloud collaboration, drones, self-healing concrete, smart buildings, modular construction, automated construction equipment, and exoskeletons that will enhance the strength of the worker (Cartwright, 2017) (Kaplanoglu, 2018).

Innovation enables contractors and others to quickly adopt, modify, and improve these advancements. It generates original advancements, too.

- **Tougher Competition**

Companies should not only learn to incorporate game changers but also proactively think of ways to improve these advances, adapting them to new processes and creating the next trend that will facilitate project delivery, safety, or quality.

The industry leaders in innovation are the first to incorporate their advanced technologies, tools, and processes, which save them time, improve their capabilities, efficiency, and return on investment. They have the advantage over their competitors.

- **Distinction**

United States ad expenditures in 2016 totaled $194.85 billion and are projected to reach $259.19 billion in 2021 (Media Advertising Spending in the US, 2018). Every advertising dollar spent by companies is spent to convince potential customers that their company's

services or products are distinct in a way that makes them stand out from their competitors.

Great service, timely service, friendly service, lowest prices, best value, honest service, knowledgeable service, user-friendly product, fashionable product, and the list goes on of distinguishing qualities proclaimed. These are all admirable, but most of the competition make such claims, so such qualities are not distinctive enough to win the lion's share of the market. Doing so requires innovation in technique, processes, tools, or technology.

- Customer Satisfaction

Because of tough competition and technology that offers increasing knowledge and choices, the market today is more customer-centered (imaginenatincomau, 2016). Owners and end-users expect more consideration of their wants and needs from builders, as well as greater value for their money. Brainstorming innovative ways to fulfill and exceed their expectations is required to build owner or customer loyalty.

- **Attract & Retain talent**

Without a playground to inspire ideas, a platform to voice them, and others to vet them, innovative ideas will remain dormant in untapped minds, or the innovative thinkers will move on to innovative companies.

A culture of innovation attracts innovative thinkers and gives them the opportunity to contribute their innovative thoughts to the company. Their ideas help resolve problems, improve how things are done, and invent new tools, equipment, designs, and more.

What Hinders Innovation?

There is a definite need for innovation, but creating an environment that promotes it and following through with new, untried processes, tools, technology, or materials is a scary proposition. Whether from fear or complacency, the following factors hinder innovation:

- **Fear of Change**

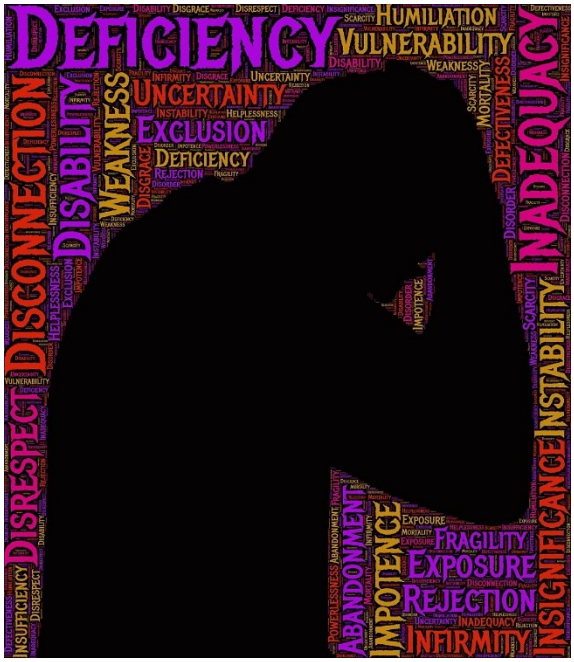
In her article, "Ten Reasons People Resist Change," Rosabeth Moss Kanter includes uncertainty, concerns about extra work, and fear of incompetence as among the ten. (2012).

- **Fear of Rejection**

Nobody likes rejection. When an idea or proposal is ignored or dismissed, the tendency is to take this personally because what one thinks or does is tied to the ego or self-esteem.

When the ego takes a hit, it hurts, so one avoids the opportunity to share creative insights to prevent the potential pain of a bruised ego.

If decision-makers are equated with doctors, some could be said to have terrible bedside manners. They are rude, abusive, or condescending in how they reject others' input. In which case, few would brave such negative behavior to provide creative input.



- **Lack of Confidence**

Because, as mentioned earlier, many equate truly innovative ideas with geniuses or great thinkers, when a thought or vision occurs to the average thinker, it is often dismissed before it is born. They doubt the idea's credibility or doubt in their own qualifications to present it.

- **Lack of Opportunity to Present Ideas**

Over a third of employees do not feel free to do anything new or risky (Playford, 2016). If there is no time within the day-to-day operations dedicated to creative thought and collaboration, there are no incentives to motivate employees to innovate, no support from leadership or management to encourage and engage with idea-producing employees, and little or no innovation from within the company.

- **Rut of Routine**

There is complacency in the construction industry. Some companies are very successful and feel no motivation to change the way things are done. Others may not be as successful, but they are hardened to their problems and have no desire to spend the money or effort to innovate. Still others struggle, but with profit margins so tight, they fear the additional expense of innovation.

- **Past Failures of Implemented Innovations**

The stakes are often high when trying something new. Failed attempts to implement new designs, processes, or technologies can leave a bad taste in the mouths of leadership and decision-makers, possibly even leaving them with empty pockets.

While it is only natural to be resistant to change, change will happen within every project regardless of feelings. Nurturing innovative thinking makes *change* the project's best friend instead of its dreaded nemesis.

How does a company take a leap of faith in innovation as a practice?

Organizations or teams do not have to blindly leap across the innovation canyon. There is a way to travel safely into the industry's future with open eyes.

The Bridge to Innovation in Project Execution

Why make a single jump, when building a bridge allows more people to travel more frequently across the divide? For innovation to *thrive* within a project management team, a secure bridge must be built from the status quo to the unknown. This bridge spans disruptive industry changes and project challenges to unknown solutions that reside along the highway of innovation.

Building this bridge within project management requires two strong pillars: Critical Path Method (CPM) scheduling and Pull Planning.

At first, these methods seem to be opposing forces that will tear the bridge apart. But further exposition will reveal how their strengths harmonize to anchor the project management team to sound principles, provide them with a venue for innovation, and support them through transitions, removing much of the fear.

CPM Scheduling appears too rigid to allow for agile innovation.

Critical path scheduling requires breaking a project into manageable tasks, assigning a "work duration," and applying network logic. This process results in a network that calculates and assigns start and finish dates to project execution activities and creates a document, digital and/or printed, for use by the project team to execute the project plan. The official schedule is the master schedule, which is often required by contract, is the master schedule and can only be changed through a process of approval.

These dates are as uncomfortable for the project manager, his team, and other work supervisors as corsets were for the wearers (mostly women) who wanted to appear to be in more control of their bodies than they actually were. For corsets to do their job, rigid material such as stiff linen or even whale bone was incorporated into them to cinch in waistlines (How Products are Made, 2018).

Being bound contractually to these dates gives the CPM schedule its reputation for rigidity.

Pull Planning appears to be too focused on the "next thing" and less concerned with the "big picture" of the master schedule.

In the pull planning method, a variety of planning meetings are performed throughout a project's lifecycle and involve collaboration on the work plan through discussion and sticky notes (representing work commitments of the planners) on planning boards. Because these sticky notes are not easily documented, tracking and analyzing work progress, as compared to the master schedule, is often neglected, resulting in the actual work not being performed to schedule (Guevara, 2015).

This lack of measuring progress from the vantage point of the original execution intent has led some to regard pull planning as a too casual method to avoid project delays.

Fortunately, CPM scheduling is an excellent resource for planning, measurement, and analysis that anchors planning sessions to the project's intent and the owner's

expectations, thereby providing stability. Pull Planning's collaborative meetings are a flexible way to plan and provide a great venue for innovation.

Status Quo – Way things have always been done or are being done.

Status Quo is often seen in a negative light compared to innovation. However, it is the shore from which your team must begin building a secure bridge to innovation. Some processes and mindsets will have to change, but some should remain securely in place. Sound principles and common sense should not be thrown out simply because the old methods had some weaknesses. Wise innovation recognizes what is sound and what is not, then tweaks the old to make it better.

CPM scheduling, as it was established in the 1950s (Devaux, 1999, p. 109), was designed with simple basic principles as follows (What is a CPM Schedule?, 2018):

- Take a project, break it down into bite-sized pieces called activities.
- Represent how these activities connect by determining which activity precedes another.
- Assign start and finish dates as determined by the duration of the activity.
- Select which activity completions are critical to the timely completion of the project.
- Keep the schedule of activities updated according to actual build time progress.

The CPM schedule is a schedule of the execution of activities. It is a roadmap through time and expenses to communicate the plan to all project stakeholders.

Cartography is the science or art of making maps (Merrium-Webster, 2018). Cartographers gather, measure, and decipher geographical data for the creation and updating of the maps or charts needed for a variety of purposes, including educational and emergency response (United States Department of Labor , 2018).

CPM Scheduling is the science or art of mapping a project's execution plan; collecting, measuring, and analyzing construction activities into time-based elements; and updating the map as needed for planning, coordination, and communication among project players.

Imagine planning a cross-country road trip without a map, or taking a trip without access to one. Unless a traveler has a photographic memory or doesn't mind taking the "scenic" route, arriving at a desired destination within a set time frame is highly unlikely and very likely to be highly stressful.

In complex construction projects, photographic memories would be necessary for every team member to keep track of all aspects of the project, which the schedule provides. Even one person with a photographic memory would be of little value to the rest of the team. And yet, how many projects are constructed by a vague memory of the schedule, seldom referencing it during the project's execution?

The CPM Scheduling Method Incorporates 4 out of 5 Types of Thinking.

Early in the paper, five types of thinking were briefly mentioned as important for innovation. Four of them are used in CPM scheduling and require the CPM master schedule as a necessary tool in project planning and analysis:

- Creative thinking is a fresh way of looking at problems to find revolutionary, often disruptive, solutions through unstructured processes like brainstorming or structured ones that have rules designed to focus creativity on specific objectives (Creative Thinking, 2018; Kurin, 2014).
- Critical thinking is the clear and rational consideration of how to act or believe (Chan, 2018).
- Analytical thinking is gathering and organizing information to identify and break down complex problems into manageable pieces and draw relevant conclusions for useful solutions (Analytical Think, 2018).

- Lateral thinking is seeking solutions to problems by examining them from new or different perspectives (Defining Lateral thinking, parallel thinking, creativity and innovation, 2015).

Since utilizing CPM scheduling and referencing the master schedule are intertwined with these thinking skills, it follows that CPM scheduling is important to innovation.

The CPM Schedule serves as the Baseline for the project's intent or the company's mission.

With any project, there is a plan that guides its execution. The plan does little good if it is not communicated to those expected to carry out the work and its supervision. Blueprints are used to communicate the design and specifications of complex building projects. Surveyors, excavators, concrete crew, electricians, plumbers, etc., refer to them to know where they will work, what materials they will use, how their finished product will look, and how it will function within the structure. However, a blueprint is only a part of the execution plan.

The timing and coordination of work, the delivery of supplies, labor, and equipment are all necessary parts of the building process. The simplest way to plan and communicate time requirements is with the CPM baseline schedule.

The CPM facilitates the logical planning of future actions because it establishes the genealogy of a project's activities based on logistic, strategic, geographic, or resource dependencies (Murray B. Woolfe, 2007, p. 25). The breakdown of actions into a trackable line of events affords ample opportunity to identify sticky pieces of the plan before they happen during execution (Murray B. Woolfe, 2007, p. 25).

The personification of a CPM schedule could be a choreographer, who coordinates the dancers during rehearsals for their on-stage performance, making sure they do not collide into each other and are in precise positions to support each other (Murray B. Woolfe, 2007, p. 25). If each dancer performs well, the choreographer makes the dance production pleasing to the audience.

The CPM schedule is a tool for measuring progress, reporting the progress or lack of it, and analyzing the value of implementing innovative changes in time and costs. **It gives project teams the stability to innovate by providing direction, points of reference, and a clear, established purpose when done well.**

Since its creation, CPM scheduling has evolved with advances in software, changing user needs and wants, and efforts to integrate it with cost, scope, and risk tracking. It can greatly help or hinder the timely, efficient execution of the project, depending on the accuracy of the input, which in turn depends on the experience, knowledge, wisdom, and skill of the person or persons who put it together. And even when the best CPM schedule in the world has been produced, it will not help keep a project on track if its purpose is not appreciated or used properly (Murray B. Woolfe, 2007, p. 1). The major issues of CPM have never included its basic principles, but are the data and logic of its users and its utilization (Murray B. Woolfe, 2007, p. xxxvii).

The issues that might cause anxiety in trusting a CPM schedule are usually only a problem when this pillar stands alone without the support of proactive involvement, collaboration of project players, and the project knowledge integration required for an accurate schedule.

The Unknown — Solutions, Improvements, and Totally New Tools.

From the status quo shore and pillar of CPM scheduling, to traverse the canyon of unfamiliar challenges and changes, another pillar is needed to safely connect the team to innovation. Pull planning is that pillar.

Pull planning offers:

Collaborative meetings to establish how the project will be executed

In pull planning meetings, the last planners—the supervisors/managers who show up each day with their workers who will be performing the work—come together to plan how work will be done and coordinated to complete a project (Pull Planning, 2018). The process arises from the master schedule when the work breakdown structure and activity details are established according to the collaborative input of the last planners (Rodriguez, 2017).

During the early part of the project design process, project work stages and their completion dates are defined. Working backwards from the completion date, the last planners use sticky notes on planning boards to determine activities, sequences, hand-

offs, and milestones for each stage so that work is released upon completion (Introduction to Pull Planning, 2018). Activity durations are determined without slack or risk allowances; the logic is then re-examined to possibly shorten the durations, and the earliest practical start date is established.

The durations are prioritized by uncertainty and risk, and time is added to them accordingly to provide a buffer. The team decides if these buffers will allow them to complete their work within the milestone. Otherwise, they plan again or move the milestone, if possible (Introduction to Pull Planning, 2018).

Collaboration of key project players to make course corrections

Pull planning does not just occur in the early stages of the project. Throughout the project's life, daily/weekly meetings, or check-in sessions, bring together key players to examine task completions, during which tasks or commitments are adjusted by further pull planning if necessary (Introduction to Pull Planning, 2018). Weekly plans for the current or next segment of work are made, and the schedule is updated accordingly (Rodriguez, 2017).

In these meetings, the experience and skills of the last planners are drawn upon by project management to propose solutions to any trouble spotted in the sequence of upcoming tasks. Therefore, the project's success does not depend solely on the experience and skills of the project management team in analysis and problem-solving.

An environment that stimulates innovative thought for ways to improve processes, techniques, and solutions to never-before-experienced problems.

Though pull planning can and should utilize all five thinking skills referenced in this paper, the one unique to pull planning, as opposed to CPM scheduling, is associative thinking.

- Associative thinking is making associations between a given subject and all existing pertinent factors *without considering past experiences* (Kilistoff, 2008).

The collaborative heart of pull planning stimulates innovation as planners strive to improve performance, quality, methods, and reduce waste and costs. And the meetings provide a venue for sharing ideas with peers and for receiving management support.

The pull planning process is the pillar that connects the project team to innovative thinking, while the CPM scheduling process is the pillar of standards, measurement, and reference from which the need for innovation and the direction of innovation come.

There are two pillars, but not a complete bridge yet. There must be something that connects the two, enabling the company or team to make repeated travels to innovative destinations. The bridge between the pillars is the seamless integration of CPM scheduling and pull planning into project management by the project team. They are the structural steel of innovation.

Integration of CPM scheduling with pull planning into everyday project management works in this way:

The team's first pull-planning meeting should occur during project planning.

The supervisors, forepersons, or managers who are the last people to plan the work of the project are included, along with the project management team, in this meeting to determine the activities and their durations, as well as the transition from construction to operations (hand-offs) (Rodriguez, 2017). Milestones and critical milestones are identified, and the frequency and purpose of meetings throughout the project life cycle are established. Based on the information provided at this meeting, the CPM master schedule is built.

The team actively uses the CPM schedule to spot the need for change.

During weekly and other pull planning meetings, the CPM master schedule is referenced to determine the progress of the project's scheduled activities. Delays in progress indicate that changes to the execution plan may be needed, including changes to techniques, build methods, or tools used to accomplish the work. Also, meeting participants are encouraged to examine current work plans and explore improvements in the process to achieve shorter durations, better safety, or higher quality.

The team then draws the cream of innovative ideas to the top of the solutions and improvements list using the CPM schedule to find which ideas best fit with the original plan and are executable within the allotted time and budget. The selected solutions and improvements will be documented and submitted for approval.

Ongoing meetings continue using the CPM schedule to examine progress, stay aligned with the project's plan and intent, and provide the scheduler with the information needed for schedule updates and reports.

All key stakeholders and decision-makers receive timely reports based on information from these meetings to communicate the project’s true progress and any necessary changes to the plan, to be reflected in the master schedule. All innovations, processes, challenge solutions, and project statistics will be documented for lessons learned.

Coordinating the use of CPM schedules with pull planning sessions promotes all five types of thinking mentioned earlier in the paper. Creative, associative, analytical, critical, and lateral thinking can manifest during pull planning sessions. However, for innovation to be most useful during the project and to the construction industry, CPM schedules, documented progress, and analytical reports are necessary for both perspectives and focus.

Summary:

Innovation is desired by 90% of companies surveyed (SHUKLA, 2017), but the construction industry falls behind other industries in innovation. There is a general lack of motivation to change the status quo.

However, the industry needs innovation, and those within it could benefit from the benefits of innovative thought processes, such as creative, associative, critical, analytical, and lateral thinking. Some benefits of innovation are:

- Solving or preventing unforeseen trouble
- Adapting to or creating disruptive innovations
- Meeting changing customer/owner expectations
- Adopting, modifying, improving, or creating technological advancements
- Becoming the tough competition
- Being distinct from competitors
- Exceeding customer/owner expectations for satisfaction and returning business
- Attracting and retaining innovative thinkers

Innovation inhibitors are:

- Fear of change
- Fear of rejection
- Lack of confidence
- Lack of opportunities to present ideas
- Rut of routine
- Past failures of innovation implementation

To build the bridge to innovation, which provides the benefits listed and overcomes the inhibitions, CPM scheduling and pull planning methods are both required. Each becomes a pillar of support for this bridge.

Figure 1 – Integrated Bridge of CPM Scheduling & Pull Planning (Quill)

The CPM scheduling provides a secure launching point from the status quo and a guidepost for the bridge's structure. Pull planning provides flexibility in structure and a secure environment that nurtures innovative thinking. Their smooth integration as one method for project planning, scheduling, and project controls becomes the steel frame and unencumbered road for continued travel toward innovation.

During pull planning sessions, the CPM schedule helps provide a snapshot of the project as it was intended, as it is, and as it is expected to become. It is a map for navigating the project's execution. With this information, the last planners then plan their next steps, accordingly, applying the discipline of the CPM schedule to their plans to keep the project's actual execution in line with its scheduled execution. It offers motivation for innovations that will exceed the schedule's expectations. Therefore, the CPM baseline schedule, though rigid in its structure, promotes positive flexibility among innovative pull planners.

Regular pull-planning meetings encourage cooperation and input from project participants. The valuable information provided by the CPM schedule, updates, and reports will inspire innovation that is relevant to the project, the organization, and/or the industry.

Ultimately, project delivery is proof that innovative ideas work or fail. But with a bridge of support consisting of an entire team of experts in their field, providing input on the viability of new ideas, a quality schedule for a map, and measured progress reports, the chances of successful implementation are far greater than the chance of failure.

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