Pathway to Innovation

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The drive to innovation as a source of growth and competitiveness is prompting company executives to revise their company structures and processes in order to enhance their level of innovation effectiveness. For this to be useful, the innovation process needs to be understood within the context of their specific business environment and their company goals, strategies and resources. Merely mimicking another successful company's approach could be counterproductive if the drivers, requirements and gaps are significantly different.[1]

Though innovation can occur via both planned and unplanned routes, it is difficult to design for that which is completely unknown. However, by understanding key facilitators of the innovation process and incorporating critical behavioral as well as structural factors, probabilities of success could be substantially improved for deliberately designed innovation projects. The change in the underpinnings and fundamentals of the organization would also better prepare it for recognizing unplanned opportunities and taking advantage of them in a timely fashion.

II - Definition of Innovation

We start by suggesting a working definition for innovation to guide us:

Innovation is the generation, selection and implementation of new ideas into profitable reality

This definition suggests that innovation consists of several components:

Creativity: The generation of new concepts or new ways of looking at and resolving old problems

Vision: The ability to see how these ideas could play themselves out in the marketplace over the long term. This is necessary to select areas of focus for the company's

project portfolio based on early judgments of value potential and probability of success.

Finishing: The problem-solving skills to reduce selected ideas to practice and capture their value in the marketplace by overcoming the inevitable obstacles and issues.

Figure 1

III - Innovation String

There is a common misconception that innovation consists primarily of an inspirational event where the idea or concept is created followed by the perspiration necessary to implement the idea in the marketplace. In reality, bringing a successful new product or process to market requires a sequence of numerous innovations, some large and some small, where the creativity, vision and finishing processes are applied repeatedly throughout the sequence. We refer to this model as the "innovation string," and the entire organization from research to manufacturing, sales to logistics must be fully engaged to be successful on a regular basis.

IV - Pathway to Innovation

In this discussion we will not focus on the details of brainstorming, decision-making and problem-solving methodologies, but rather on the holistic picture of how a company could set up their projects to 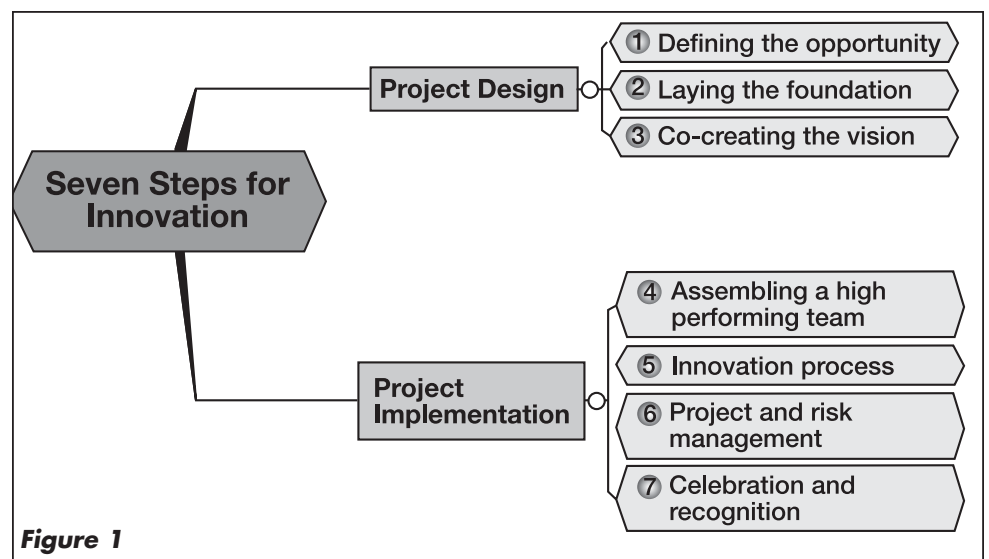better prime them for innovation. We will attempt to establish common principles that are key enablers and things to avoid. These principles are summarized below in seven elements that should be considered in designing and implementing projects. Three of them focus on project design and the remaining four on project implementation:

Project Design:

(1) Defining the opportunity

(2) Laying the foundation

(3) Co-creating the vision

Project Implementation:

(4) Assembling a high performing team

(5) The innovation process

(6) Project and risk management

(7) Celebration and recognition

V - Designing Projects for Innovation

(1) Defining the Opportunity

Much of the success of a project (or lack thereof) is due to the up-front thinking done before any technical work has begun. The first key question that needs to be addressed is: Are there clear current or potential market needs in this area that are not being satisfied that this project will address? The answer to this question is critical in defining the incentive for the project. Customers and stakeholders should be engaged to understand the underlying fundamentals, competitive topography and evolving needs in the marketplace in order to make a reasonable judgment on market potential.

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The second key question is: Could these needs be translated into technical objectives that fit with the company's strategies, business model and technical competencies? This determines whether this is a challenge that the company is set up to tackle. Even if the value of the prize is high, if company capabilities have to be generated from scratch, the likelihood of a timely innovation is low.

The answers to these questions allow assessment of the risk-reward balance (i.e. what is the potential value of a successful outcome against its probability of success and cost). There is no simple model to calculate what constitutes a good project, but collecting this information is necessary to exercise good judgment while managing risks and uncertainties.

(2) Laying the Foundation

Even when the required expertise for an opportunity generally matches the company competency profile, a significant innovation will require venturing into unknown territory and stretching existing capabilities. Time needs to be allotted for the discovery process to expand the knowledge base and develop innovative concepts if valued solutions are to be created. Beginning the innovation process once the problem is publicly known and market opportunities have crys-

tallized limits the time window available for invention because of competitive forces in the marketplace. This drives companies to incremental improvements because of real or perceived time limitations. Monitoring the marketplace regularly to identify opportunities early enables "Laying the Foundation" activities to be initiated with sufficient time to provide a competitive advantage.

Stage-gate Process for Core Businesses Projects

There is a danger that needs to be pointed out here. Stage-gate processes are ubiquitously practiced to manage research and development projects. Though detailed formats vary, most systems require quantitative financial justification of the reward and high probability of success to initiate a project and progress from stage to stage. These requirements are necessary to avoid large expenditures on speculative ideas and low value outcomes. Projects within the business and competency comfort zones are well served by this system.

It should be noted that this type of stage-gate process tends to be more tunnel-like rather than funnel-like as typically depicted in the literature. This is because the up-front requirements filter out projects that are risky. Thus, projects will rarely be stopped unless unexpected obstacles appear or market forces change. The down side of this system is that this encourages incremental thinking since the route to the answer and the solution to any obstacles needs to be clear at the beginning.

Stage-gate Process for Step-out Innovation Projects

Step-out innovation projects, on the other hand, will normally be accompanied by substantial uncertainty and risk and often cannot meet the requirements of this type of stage-gate process.[2] An alternative process that fosters concept development, exploration of non-conventional approaches and development of fundamental understanding of critical phenomena in new areas is required. The purpose of this system is to

build knowledge and develop options (rather than finished products) in high value areas where a potential market need is envisioned. University expertise could be usefully leveraged with this system to develop the critical knowledge base during this learning period.

The process is characterized by flexibility, simplicity and modest funding with the outcome focused on increasing the knowledge to assumptions ratio, and development and verification of concepts even if not yet practical. Potential impact and inventive logic are used to justify these activities rather than net present value expectations. The process is much more funnel-like, characterized by energetic learning with ideas being tested, discarded and redirected as new insights build.
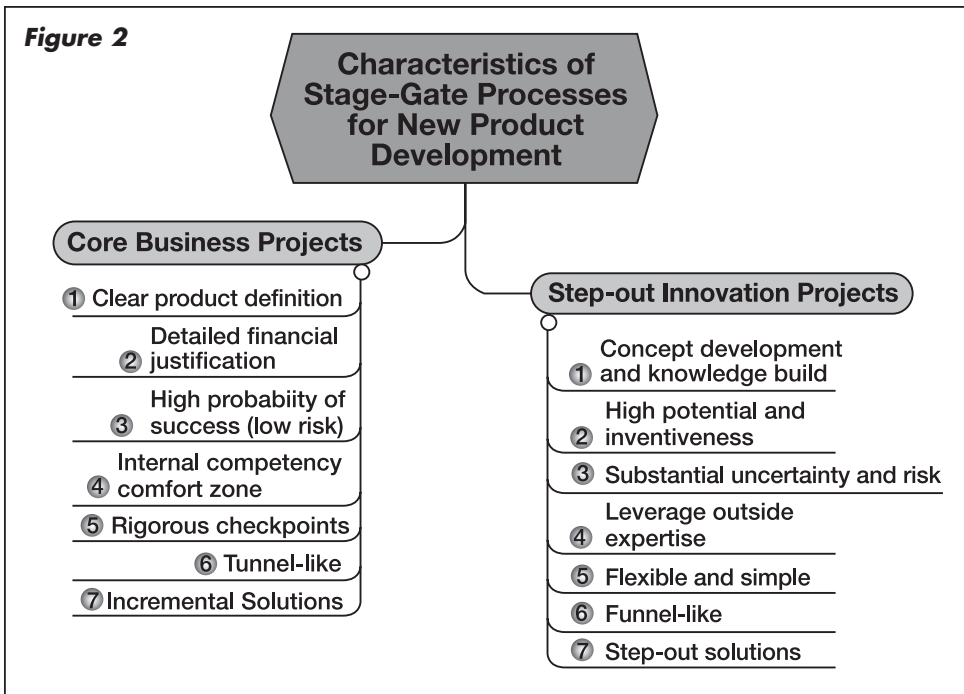
This exploratory environment is also an opportunity to engage customers and stakeholders in conservative industries to get them comfortable with coming trends and expected change. Customers and stakeholders who contribute collaboratively to the development of new knowledge or concepts tend to accept step-out solutions based on these concepts more readily. Customers can also help estimate the value of potential alternatives to enable better decisions when the reduction to practice phase begins. If successful, insights developed in these "pre-project" activities are more readily integrated into ultimate product design in the normal stage-gate system for product development, providing more innovative solutions.

Care must still be exercised to allow room for invention and reduction to practice in the normal stage-gate process using the concepts developed in the "Laying the Foundation" activities. This will be facilitated by the confidence in a potential solution built during the option creation phase. However, if a near perfect solution is expected, the "pre-project" stage will become very lengthy and require a high degree of funding, largely negating its value.

(3) Co-creating the Vision

With insights and inventive concepts from "Laying the Foundation" activities in hand, an innovative but realistic market vision can be formulated taking account of the potential properties and value of the nascent technology. Probability of success in realizing the

Figure 2

Characteristics of Stage-Gate Processes for New Product Development

Core Business Projects

① Clear product definition
② Detailed financial justification
③ High probabiity of success (low risk)
④ Internal competency comfort zone
⑤ Rigorous checkpoints
⑥ Tunnel-like
⑦ Incremental Solutions

Step-out Innovation Projects

① Concept development and knowledge build
② High potential and inventiveness
③ Substantial uncertainty and risk
④ Leverage outside expertise
⑤ Flexible and simple
⑥ Funnel-like
⑦ Step-out solutions

vision is greatly enhanced by driving to joint ownership of goals, decisions, successes and failures by the Marketing and Technology functions. This is best achieved by co-creating the vision from the dual perspectives of what product designs and performance features are possible to construct (Technology), and what could create and capture value in the marketplace (Marketing). The integrated ownership developed in this manner is much stronger than that achieved by step-wise alignment of functions. In our experience, this joint sense of ownership is one of the strongest factors influencing ultimate success in bringing innovations to fruition in the marketplace.

It is critical in creating this vision that representatives of all key stakeholders are involved. The vision must then be translated into clear objectives and success measures that are uniformly understood throughout the organization. Copying a large number of people with project documentation of objectives and plans does not achieve this goal, as different people from different functions will understand the same words very differently.

Success measures should be defined jointly and should include detailed targets, priorities and methods of measurement. What is necessary, and what is desired as a stretch, should be distinguished clearly. The bases and economic value of the targets must be credible and easy to understand, so that

everybody can realistically picture the value proposition and potential customer slate. Strategies could then be constructed on how to get there and what approaches and methodologies would be used. Involvement of a knowledgeable customer to continually provide input as the project progresses helps in key decision-making and maintains a sense of urgency.

Issues frequently arise during project execution having the potential to destabilize the project team, causing unnecessary anxiety. This could occur via organizational overreaction to unfavorable evolving information and results that produces a crisis atmosphere. Designated experienced Business and Technology champions that can position the interpretation of these issues with calmness and credibility, and propose ways forward, are indispensable and will anticipate and avoid many problems.

VI - Implementing Projects for Innovation

(4) Assembling a High Performing Team

Four areas should be considered when assembling a high performing team for an innovation project [3]:

Creativity: The continuous generation of new and useful ideas coupled with the

diversity of skills and experience to grow ideas into insight is essential. Though much attention is focused in brainstorming activities on opening thinking broadly to coax out more ideas, the limiting factor in successful innovations is often growing ideas from their fragile, ethereal state to insightful concepts that can be tested and acted upon. Care should be taken not to expend too much energy in managing and categorizing ideas when they are still in the early state. Instead, the focus should be on building and developing ideas until they are either discarded or transformed into useful kernels of insight.

Creativity needs to be exercised not only in the initial concept development mode but also in the reduction to practice mode. The team should be capable of continuous creative problem-solving from start to finish. Thus, a combination of abstract thinkers and pragmatic finishers is generally optimum for a high performing team.

Values: The team must be characterized by high ownership of, and commitment to the objectives, with a uniform clear understanding of the vision, targets and priorities. Team members must have the courage to challenge each other as well as accepted organizational tenets, and be willing to expose their data and fragile ideas to broad scrutiny and rapid testing. Courage should be coupled with the confidence to venture into uncharted territory and deal with adverse results and disagreements with calmness despite the passionate desire to succeed. High conflict, high respect debates characterized by openness in exchange of information and viewpoints should be commonplace in day-to-day activities. Decision-making and communication based on integrity and credibility must thread through all activities of the team, especially in flagging issues to management and in dealing with expectations that don't match initial promise.

Collaboration: Integration of functions, disciplines and experience can produce synergistic effects that are extremely powerful. The extent that this can be captured is related to the "oneness" of the team. Is the team a conglomeration of expertise that works together via formal mandate, or a seamless, unified unit that collaborates naturally? The former will not lead to substantial syner-

gies while the latter will.

Leadership: Leaders play a key role in the success of high performing teams by (1) painting a clear and inspiring vision that motivates the team, (2) creating a collaborative learning environment with the appropriate tools and processes that enable the team to innovate effectively, and (3) modeling its values.

In addition to painting the vision of the end zone, leaders must transmit a credible picture of strategies on how to get there given the unknowns (i.e. we can overcome these challenges!). Designation of clear accountabilities and responsibilities for the team so that everybody knows who is responsible for what activities and how decisions will be made is important in giving each team member a mandate to jump into the water. This is often overlooked, with undesirable "freeze-up" consequences.

In our experience, a joint sense of ownership (between the Technology and Marketing functions) is one of the strongest factors influencing ultimate success in bringing innovations to fruition.

Successful leaders focus more on enabling rather than managing the team. A key enabler is the creation of a natural, collaborative environment that facilitates cross-fertilization of ideas, and encourages reasonable risk-taking in the development of new concepts. Testing and advancing these concepts must be facile with the required facilities, methodologies or linkages in place, without bureaucratic encumbrances. Thus, "context" management should take precedence over task management.

Leaders must embody the team's values and model them consistently. Their influence will be mirrored in proportion to the respect and credibility earned via their actions. Leaders should be strong and visible team advocates, "shining by reflection" rather than via independent charisma. Guidance and challenge need to be provided periodically, but should be balanced with wide

latitude to team members to ensure that initiative is not stifled.

Leaders should drive the team to a solution of the problem rather than manage data collection. Hence, ideas must get tested quickly and rigorously to make decisions on areas of focus. Leaders sometimes need to act as insight managers, ensuring that learnings and their implications are linked together and acted upon efficiently. At gates where the project focus changes (e.g. product design to manufacturing), leaders can ensure that the transition from function to function occurs smoothly. For example, in a technology project, leadership typically flows from research to development to manufacturing and logistics.

In summary, leaders must inspire and enable the team, manage the context, model the values, and drive to a solution with consistent clarity of vision of the project goals and strategies.

Team Composition: A high performing team should be diverse in a range of dimensions covering technical and behavioral factors as well as experience. The team should be multidisciplinary and multifunctional from beginning to end but with uniform, broad ownership of goals and targets. A combination of new hires and experienced professionals can provide an influx of new ways of thinking while maintaining a stable knowledge base able to stay the course during periods of high uncertainty.

With increasing global focus, it should be noted that remote collaboration can be difficult, and co-location is desirable especially for the highly fluid discovery stage of a project.[4] New virtual collaborative tools help significantly, but the transmission of information and its associative "feelings" are still a challenge. In any event, timely, frequent communication at several levels is necessary to

compensate for not being together.

Team Dynamics: Not all high performing teams fit the "lovey-dovey" model where all members genuinely respect each other and enjoy working together. A creative and tumultuous team with lots of debate could be very productive, provided the challenges are harnessed to capture the fruitful diversity of perspectives without a debilitating impact on team dynamics. High ownership and motivation linked to a clear understanding of value and direction must be maintained throughout as these are the key drivers to bring the project to closure.

The team needs to maintain a sense of urgency throughout the project with a strong problem solving mentality. A "get it out fast and optimize later" strategy should be adopted where possible, but discipline needs to be exercised to ensure ultimate closure on gaps in knowledge and performance. Rapid scale-up is a valuable way of learning about processing issues early, provided it can be done safely.

The team needs to feel empowered to make decisions with access to all relevant information. The general rule should be that the team recommends the path forward and management endorses or provides a detailed explanation as to why not. The team should not expect management to make decisions for them.

(5) The innovation process

A successful innovation generally requires a string of creative ideas and mini-innovations across multiple dimensions over the entire cycle of the project. Thus, high energy and ownership must be maintained throughout the project. It is generally a good idea to keep the original inventors in the loop to the end, as they will have the highest degree of ownership and insight to solve problems that occur down the chain.

Innovation cannot be orchestrated but must be nurtured and facilitated. We can sow seeds, fertilize the soil, water the plants and provide lots of sunlight, but innovation must be allowed space to sprout. To provide a fertile environment for innovation, the following four elements should be considered [3]:

> *People need to have the right skills, must be motivated and feel empowered.*

> *Structure and culture must be supportive of*

new ideas, tolerant of risk and able to respond quickly to opportunities.

Processes need to be enabling and not bureaucratic.

Technology tools should facilitate information access and rapid decision making for swift and continual innovation.

Business or manufacturing constraints are sometimes viewed as inhibiting innovation. These could include a long list of requirements such as low cost, broad activity, no deleterious side effects, long shelf life, environmentally friendly process, secure supply chain and logistics, timing, etc. In actuality, bringing a product to market successfully requires clear understanding of the relative importance of each of the constraints up front. This enables the team to define their strategy for innovating within the multiple constraints, to provide solutions that will meet market needs practically.

(6) Project and Risk Management
All projects and especially complex interactive projects benefit from application of project management tools to link activities, understand constraints and priorities, and manage work flow. It should be noted that though these tools work very well for development or manufacturing projects, they are generally not designed for the highly fluid discovery environment where activities are very dependent on unpredictable results. Some adjustments will likely be required in using standard project management tools for the early discovery stage.[5]

Timely, clear communication to the rest of the organization is imperative because of the tendency to assume the worst in the absence of information.

Because of the high level of uncertainty, this team should be multi-functional to view issues from different perspectives and address tactics, issues and differences of opinion. A clear conflict resolution process should be in place and a final decision maker identified with clear authority. This team could also help build and capture combined organizational insight which could be used subsequently on other projects.

management of the value of goods received is a means of encouraging even higher levels of giving. Thus, the prime purpose of recognition should be to acknowledge the value and impact of a contribution. Recognition must, therefore, be consistent, timely, personal and genuine to be credible and send the right message.

① **Creativity**   ④ **Leadership**
Six Elements of a High Performing Team
② **Values**   ⑤ **Team composition**
③ **Collaboration**   ⑥ **Team dynamics**

Figure 3

After a successful project where many of the above elements came together fruitfully, management should consider how best to re-invest in this potent tool rather than simply disbanding the team and starting over again.

VII – Pathway to Innovation: Summary and Conclusions

(1) Make sure you are working the right thing

(2) Lay the foundation for the organization and industry

(3) Co-creation is preferable to step-wise alignment

(4) Everybody needs to fully understand the vision and bases

(5) Importance of team values and organizational context

(6) Leaders must enable the team, model the values and drive to a solution

(7) Continually innovate throughout the project

(8) Manage the risk
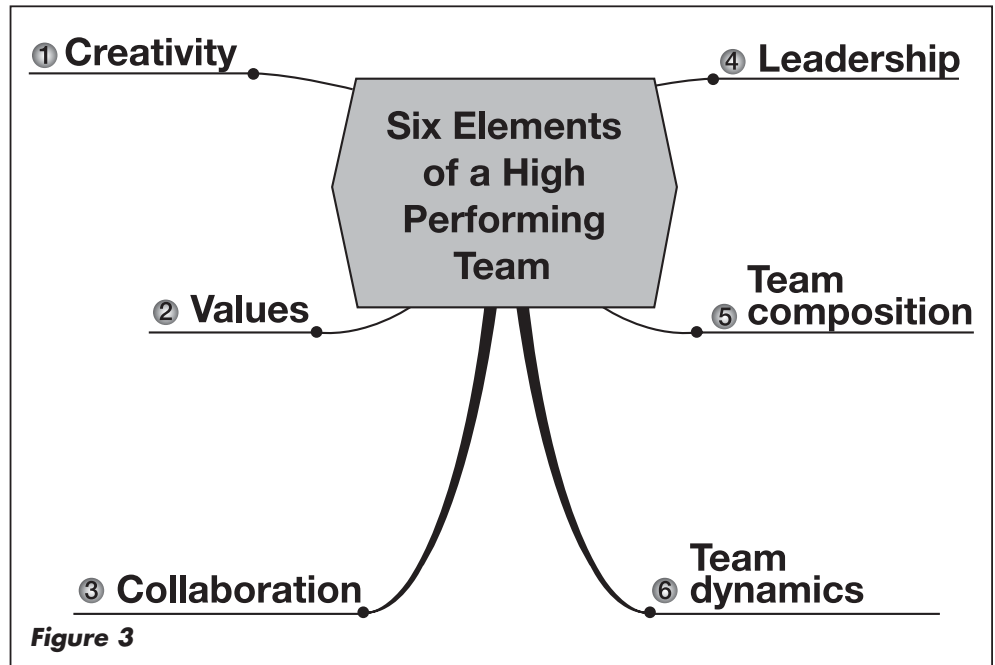
(9) Recognize and celebrate ■

A key enabler is the creation of a natural, collaborative environment that facilitates cross-fertilization of ideas, and encourages reasonable risk-taking in the development of new concepts.

Step-out innovation projects typically generate significant risk because they venture into areas outside of the organizational comfort zone. A risk management team is essential to identify all areas of uncertainty, and make judgments on what level of risk is acceptable. The team should also track what is being done to mitigate each risk area and increase the knowledge to assumptions ratio.

(7) Celebration and Recognition
Recognition is key to maintaining organizational vibrancy, and its impact is often overlooked or underestimated. In my experience, the prime motivator of most colleagues is not to "take" from the organization but rather to "give." Most colleagues desire to make an impact of value, and acknowledgement by

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Jack Emert *(j.emert@infineum.com)* is Chief Scientist for Infineum Ltd, a joint venture of ExxonMobil and Shell Chemical in the lubricating oils and fuels additive business. Jack received his PhD in organic chemistry from Columbia University. Upon graduation, he joined the faculty of the chemistry department at Polytechnic University where he established a research group designing systems to control the rates and course of chemical reactions. In 1981, he joined Exxon Chemical Co. where he led R&D teams developing a range of additive products for automotive lubricants. He has recently been engaged in study of the innovation process, using his experience to identify best practices for new product development. He is author or co-author of over 90 US patents, with products deployed in about one quarter of all the cars and trucks in the world.

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