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Innovation Games: A New Approach to the Competitive Challenge

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Innovation is often perceived as an unmanageable phenomenon. Bets are placed on new products with the hope that a few winners will compensate for the many losers. At best, sophisticated selection procedures impose a certain discipline and provide guidance for containing costly errors. The research that we have conducted yields a more nuanced view.

Innovation, we have found, becomes manageable when managers move away from universalistic prescriptions and recognise that different rules and practices apply in different contexts. Our main argument is that both executives and public officials need to learn from the new realities of innovation. Instead of being a uniform process, innovation takes place in seven distinct 'games', focusing on market creation, market maintenance and innovator support.

Rules for managing innovation are neither generic best practices that can be applied universally, nor narrow industry-specific recipes. Instead, distinct contexts call for specific strategies and rules to create and capture market value. Thus, innovation games are not predetermined sets of rules but leave ample room for creative competition and collaboration.

Our approach urges business executives and academics to reassess the validity of conventional approaches, no matter how well established. Managers should worry far less about imitating industry best practices, and more about correctly gauging strategic issues. The first order of business for all players should be to turn potential negative-sum games into positive-sum games.

Introduction

Many managers and analysts see innovation as an unmanageable phenomenon, riddled with great uncertainty and risk. For them, innovating is like playing the tables at Las Vegas. Success requires multiple bets, in the hope that a few winners will more than compensate for the many losers. At

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best, some rigorous selection methods attempt to impose various degrees of structure and discipline on the screening process as a way to avoid costly errors.

For many managers, innovating is like playing the tables at Las Vegas

A study that we have conducted in collaboration with the Industrial Research Institute yields a more nuanced view. In spite of all the uncertainties, innovation becomes a manageable process when managers stop relying on universal prescriptions and instead recognise that different sets of rules, capabilities, and practices apply in different contexts. Innovative success is never random: it follows multiple logics and paths.

The ‘games of innovation’ perspective proposes that different patterns emerge and coexist as a result of contextual conditions and production technologies calling for distinct but persistent rules of action. Our central thesis is that firms that achieve high levels of performance, not by adopting ‘best practices’, but by adapting their strategies, capabilities and practices to the requirements of value creation and value capture in the innovation game(s) in which they have chosen to compete.

The purpose of this paper is to present our empirical findings about games of innovation. The first section outlines the limitations of universal models of innovation and sketches the new realities of innovation processes. The second section proposes a parsimonious set of ‘games’ for a better understanding of innovation-based competition. In the third section, an empirical taxonomy of seven different games illustrates the distinct dynamics of innovation. The persistence of games and the migrations of sectors, industries and firms across games are described in the fourth section. To conclude, the key lessons of our approach for business academics and executives are presented.

Theoretical approaches to innovation: conventional and unconventional

The conventional approach to industrial innovation builds on Schumpeter’s view that entrepreneurial creative destruction has been replaced by the management of innovative activities in large firms through internalised R&D processes.[1] Given their market positions, incumbent firms have the resources to invest in R&D, develop steering practices and build competencies to launch successful new products.

This conventional model entails several assumptions, however. Products are fully developed before they are launched. Markets are exogenous spaces waiting to be filled with offerings that meet pre-existing and discernible customer needs. Markets select products strictly on the basis of relative merit and utility. The capture of value relies on strong intellectual property protection, often resulting in temporary monopolistic positions.

On the basis of the presumed validity of these assumptions, managers are encouraged to search and adopt universal best practices. We will argue instead that widespread imitation of ‘best practices’ can be self-defeating, resulting in entire sectors being trapped in competition that leads to little growth. Each game entails a distinct logic of innovation, calling for specific strategies and rules. Recent studies are at odds with the assumptions underlying the conventional model, and highlight significant new realities that will help us gain a better understanding of innovation. Below, we consider some aspects of the conventional approach to innovation, and contrast them with these new realities.

Widespread imitation of ‘best practices’ can be self-defeating, resulting in entire sectors trapped in competition that leads to little growth

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From self-contained artifacts to systemic products

Products in the conventional approach are viewed as self-contained artifacts, while in reality they are increasingly systemic and bundled with services: airplane building and banking networks, for example, blend goods with services.[2] Systemic products are built from complementary and specialised modules coordinated by an integrating architecture to perform specific functions. Product delivery involves many specialised firms — some producing components, others managing coordination and fostering integration.

From closed to open systems

When products are built as closed systems, integrators control the architecture and pre-specify its evolution. A closed approach does not prevent some components from being developed by external partners or outsourced, but this is done on a contractual basis according to specifications issued by integrators.

By contrast, an open approach focuses on the management of a core platform while letting complementors and third-party suppliers innovate independently. The core platform tends to be stable, while innovation thrives at the periphery.[3] Innovation is thus decentralised and relies on the inventive resources of complementors. In this fashion, the level of energy can be much higher, and independent efforts can trigger multiple paths of innovation.

From rationally planned products to prototyping

In the conventional model, products are fully developed and in many cases certified by public regulators before market launch. Customers select complete products. By contrast, in open systems the first generations of systemic products tend to be incomplete prototypes, proposed with the intention of attracting the interest of innovative buyers and potential complementors. Early buyers trigger demand, which induces complementors to develop the components that make further growth of markets possible. Prototypes evolve: high levels of performance are reached several months or years after initial product entry.

In open systems the first generations of systemic products tend to be incomplete prototypes

From pre-existing markets to market creation

In the conventional model, markets pre-exist. Market research can uncover customers' needs and estimate market sizes. Buyers make autonomous and well-informed adoption decisions: the complexity of products is generally hidden. By contrast, with systemic products, markets do not pre-exist: they emerge as customers progressively discover their needs by experiencing new systems and prototypes. Markets become actualised in response to redesigns, buyers' learning, and the co-evolution of systems and their complements.[4]

From internal integration to ecosystems

In the conventional model, innovative activities are generally conducted in-house. By contrast, when products are systemic, innovation is a collective effort in which networks of firms form ecosystems of complementary and supporting organisations.[5] With systemic products, effective innovation involves outsourcing, collaborations and alliances with coordinators.

Networks of firms sharing parts of the innovation process usually trigger dynamics of interaction that can differ substantially from rational planning. The interactions of specialised firms under the sponsorship of an orchestrator may lead to generative and independent innovations that are far different from, and often superior to, initial designs.[6]

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From meritocratic selection to hyperselection

In the conventional model, products are selected strictly on the basis of relative merits and utility. Only the best, as rationally determined by buyers, are selected according to attributes of quality, costs, functionalities and so on. Closed systems are also selected by businesses on the basis of merit.

By contrast, with open systemic products, especially in information technology, selection is a highly social process often leading to hypergrowth, hyperselection and decay. Buyers lack information, are unaware of complementors, and are uncertain about the technology: they thus risk committing too early. As a consequence, buyers tend to rely on the choices of others. Choices may converge in one direction thus triggering extremely rapid growth, or growth may fail to materialise for lack of commitment.[7]

From capture through IP to strategy and muscle

The capture of value in the conventional model relies on strong intellectual property protection, especially patents that confer a temporary monopoly. However, in most competitive contests, patents are often entry tickets to cross-licensing rounds. Value capture tends to be achieved not through intellectual property protection but on the basis of competitive advantages arising from economies of scale, reputation and marketing muscle. In information industries, cumulative effects and control of the architecture can trigger winner-take-all rewards.

Value capture tends to be achieved not through intellectual property protection but on the basis of competitive advantages

With these new realities, theories have difficulties coping with the variety of innovation forms. Multiple paradoxes come to the fore. For instance, the more a technology such as the Internet is used, copied and licensed, the higher the value can be. Instead of orderly meritocratic selection, choices may lead to hypergrowth or decay, rejection of superior solutions, and lock-in on inferior solutions.[8] These counterintuitive dynamics compel us to extend our understanding of innovation beyond the science-based model.

Games of innovation

The work presented here originated in a keen awareness of the need more effectively to capture empirically the varied ways in which innovative firms collectively shape, and are shaped by, their competitive and collaborative contexts and rules of engagement. Instead of a single science-based pattern, multiple logics are at work. Constructs such as 'strategic groups' and 'industry best practices' have proved to be too static, too descriptive and too self-referential to be truly useful. We propose a typology of games to provide a synthesis.

A definition of games of innovation

Before defining games of innovation, let us stress that they are not game-theory constructs. Formal game theory is a set of analytical tools for understanding interactions between a limited number of players and options.[9] Games, as we view them, are patterns of innovating that involve many interdependent players, persist over time and are strategically complex. Obviously, games of innovation are not comparable to sports plays with set players and exogenous sets of clear rules.

'Games' are patterns of innovating that involve many interdependent players, persist over time and are strategically complex

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We advocate a holistic and open-ended understanding of industrial innovation. We define games of innovation as a multi-level construct. Games are:

* Coherent sets of strategies and rules that managers develop to make decisions about innovation in the different contexts in which they compete. As strategies and rules, games of innovation are neither universal best practices nor generic industry recipes, but cognitive frameworks that emerge as managers learn to compete in their specific contexts. The different logics of innovation generally transcend the preferences and actions of any single player, no matter how prominent.
* Ecosystems of firms that compete and collaborate, thus triggering positive dynamics of growth or negative evolution toward decay. As emergent collective processes, games usually do not follow established blueprints determined by contextual conditions, but are flows of strategic moves, entrepreneurial initiatives and interactions among interdependent players. Paraphrasing Winston Churchill, one could say that firms collectively fashion their innovation games and, thereafter, are fashioned by them. Games may evolve toward healthy performance, just as they may fall into collective traps of passivity or hyper-competition.[10]
* Sets of public or private institutional arrangements necessary to sustain the different patterns of innovation. Firms rarely innovate alone. Universities, science-and-technology communities and entrepreneurial start-ups provide pertinent knowledge. Financial resources and strategic advice come from venture-capital and innovation-support agencies.[11] Customers often provide firms with the problems to solve, as well as aspects of the solutions.[12]

Firms rarely innovate alone: universities, science-and-technology communities and entrepreneurial start-ups provide pertinent knowledge

A typology of games

Despite their open-endedness, games are bound by some basic economic and technical forces and tend to follow a small number of trajectories.[13] In 1984, Keith Pavitt identified four trajectories of innovation: supplier-dominated, scale-intensive, specialised suppliers, and science-based.[14] Others, such as Michael Best,[15] Michael Storper and Robert Salais[16] have proposed the concept of worlds. We extend Pavitt's seminal work by incorporating the new realities of innovation.

The *a priori* typology that best represents the new realities of innovation is illustrated in Figure 1. Two contextual dimensions are used to build a typology:

i. Value creation. The horizontal axis extends the concept of product architecture to three distinct categories of exchanges between buyers and producers: simple stand-alone products, easily

Offer / Market	Stand-alone products	Integrated closed systems	Open modular products
Market creation	Patent-driven discovery	Systems integration	Platform orchestration
Market evolution	Cost-based search for efficiency	Strategic consulting and systems engineering	Customised mass production

Figure 1. A typology of games of innovation

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marketable to all kinds of buyers; closed integrated systems, designed with and for expert buyers; and open modular systems, in which a platform leader coordinates the complementary offers of independent component suppliers into evolving products and services.

ii. Market evolution. Two stages are analysed in the vertical axis: first, a market-creation period, during which entrepreneurs bring new technologies and markets together; second, a market-maintenance period of growth, persistence and rejuvenation, during which large and small firms compete for market shares.

The six predicted games (see Figure 1) are patent-driven discovery, systems integration and platform orchestration for market creation, and cost-based search for efficiency, strategic consulting and systems engineering, and personalised mass production for market maintenance. Table 1 describes the key elements of the six games: logic of value creation (e.g. strategies and rules), value capture (e.g. mechanisms for appropriation of profits) and ecosystems (competitors and complementors).

The hypothesis to be tested was whether or not large numbers of firms actually behave in ways that reveal the presence of six distinct games of innovation. Furthermore, we wanted to discover whether these games differ statistically from one another. In order to test this hypothesis, we used the data gathered in the MINE (Managing Innovation in the New Economy) research program at Ecole Polytechnique in Montreal, Canada. The methodology for identifying the games is presented in Appendix A.

A taxonomy of games and their dynamics

A taxonomy is an empirically grounded classification. Seven distinct games were identified as statistically different at the $p = 0.01$ level. The first six games corresponded to the predicted ones. The

Table 1. The dynamics of value creation and capture in each game

	Logic of value creation	Value capture	Ecosystem	Representative sectors
Patent-driven discovery	• Relentless R&D • Capabilities	• IP • Portfolio of products	• Symbiotic firms • Public research	• Pharmaceuticals • Medical devices • Fuel cells
Systems integration	• Integrated solutions • Lead users	• Superior systems • Reputation	• Users • Contractors • Alliances	• F1 cars • Nuclear plants • PLM systems
Platform orchestration	• Open platform • Distributed innovation	• Platform hyper-selection • Merit for periphery	• Coalitions with component providers	• Internet • Mass software • Info-mediation
Cost-based search for efficiency	• Process streamlining • Cost cutting	• Economies of scale • Entry barriers	• Contractors and suppliers	• Mining • PSTN phone • Chemicals • Generics
Strategic consulting and system engineering	• IT & capital projects to improve productivity	• Cumulative experience, reputation • Project management	• Few key players • Multiple contractors	• Capital & IT projects • PLM, ERP, SCM, CRM
Customised mass production	• Unique brand • Scale economies	• System design • Critical components	• Supply chain • Innovative subsystems	• Automobile • Mass electronics • PC, watches

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seventh game, which we had not predicted, we called 'support for innovation'. Table 2 presents the most significant statistical results for each game:

* competitive contexts refer to the most salient factors emerging from the analysis
* innovation efforts focus on investment in R&D and staff time allocated to innovation
* innovation strategies refer to the most salient strategies used and
* performance is measured in terms of the contribution of innovation to profitability and annual sales growth.

Market-creation games

Patent-driven discovery

Patent-driven discovery games are closest to the conventional model of innovation. The characteristic traits of these games are the importance of frontier knowledge production, the need for superior expertise and the critical role often played by government certification. About 35 per cent of profits are attributed to recent innovations: a substantial part of innovation efforts is directed toward radical change.

Patent-driven discovery games are closest to the conventional model of innovation

Demand is exogenous, waiting to be identified by market researchers and filled with fully functional products. For example, buyers of pharmaceutical drugs, orthopedic devices, electric batteries, anti-virus software, and other products have well-known needs, and the task of market researchers is to find the attributes that best meet those needs. Market selection is meritocratic: buyers understand the functionalities of products and select them according to explicit performance/price dimensions.

The dominant rules for successful innovation are first, to recruit the best possible scientists and entrepreneurs who can participate actively in new discoveries; second, to assemble a balanced portfolio of internal and partnership research projects in search of superior, patentable, and certifiable solutions; and third, to conduct relentless innovation in projects.

The average expenditure on R&D is 29 per cent of sales, and 38 per cent of staff time is allocated to innovative activities. Profitable winners eventually lose their edge, as legal protection disappears. The ecosystem is composed of a few large competitors surrounded by symbiotic science-based firms (usually small). Opportunities, especially in early phases, are opened up by entrepreneurs who scout scientific territories with support from public agencies and corporate sponsors.

Large firms often set up venture-development activities to engage in surveillance of strategic opportunities, licensing in and out and deal-making. For instance, Johnson & Johnson focuses the bulk of its innovation efforts on investments in internal and external ventures: the firm's growth model is premised on leveraging externally developed technologies, licensing and acquisition activities, a portfolio of bets at the early stage, and internal discovery.

Sales have grown at an annual rate of 22 per cent in the recent past. Value capture is generally made possible by patents, regulatory approvals or uncontested product superiority. However, firms face major turning points when their key patents come to the end of their valid life. To survive, firms need to continue to invest heavily in R&D or migrate toward production of less innovative (and less profitable) products.

To survive, patent-driven discoverers need to continue to invest heavily in R&D or migrate toward production of less innovative products

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Table 2. Several statistically significant dimensions of games

	Competitive context*	Innovation efforts	Innovation strategies	Performance
Patent-driven discovery	• Knowledge production .38 • Rivalry −.29 • Regulation .40	• 29.2% R&D/sales • 38% staff on innovation	• Innovation projects • Regulatory management	• 35% profits from innovation • 22% sales growth/ year
Systems integration	• Knowledge .23 • Rivalry .01 • Dynamism .01	• 32% R&D/sales • 39% staff on innovation	• Users • Contractors • Alliances	• 41% profits from innovation • 23% sales growth/ year
Platform orchestration	• Dynamism .37 • Rivalry .21 • Knowledge .19	• 24% R&D/sales • 28% staff on innovation	• Coalitions with component providers	• 52% profits from innovation • 27% sales growth/ year
Cost-based search for efficiency	• Dynamism −.30 • Regulation .18 • Interdependence −.20	• 4.4% R&D/sales • 7.2% staff on innovation	• Contractors and suppliers	• 24% profits from innovation • 13% sales growth/ year
Strategic consulting and system engineering	• Interdependence .23 • Dynamism .29	• 8.1% R&D/sales • 12% staff on innovation	• Few key players • Multiple contractors	• 36% profits from innovation • 16% sales growth/ year
Customised mass production	• Rivalry .40 • Dynamism −.34 • Knowledge −.27	• 9.7% R&D/sales • 12% staff on innovation	• Supply chain • Innovative subsystems	• 30% profits from innovation • 18% sales growth/ year
Innovation support		• 19% R&D/sales • 24% staff on innovation		• 38% profits from innovation • 21% sales growth/ year

Source: MINE Research Program, 2007.

* A positive factor score, for example +.38, means that this dimension is above the mean for the whole sample and is significant at the $p = 0.01$ level. By contrast, a negative factor score, for example −.29, means that this dimension is below the mean for the whole sample and is significant at the $p = 0.01$ level.

Systems integration

Systems integrators build closed systems such as mainframe computers or flight simulators.[17] Increasingly, however, they are developers of information technology solutions. Tightly integrated products and services such as PLMs (Product Lifecycle Management) or ERPs (Enterprise Resource Planning) are built from interdependent components coordinated by a closed proprietary architecture. Within these systems, individual components cannot be easily modified or replaced.

Buyers need to perform complex tasks. They demand high-performance tools such as drug-design software systems, semiconductor design automation systems and design-engineering systems. The game of systems integration provides them with the tools. Closed-system tools are sometimes based on emerging science, but generally they build on well-established engineering principles.

Markets for integrated tools do not pre-exist but co-evolve, as systems integrators interact with lead buyers. These buyers continuously raise their ceilings of expectations and call for improving

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functionalities and reliability. Each improved version builds on accumulated experience and leads to the creation of wider markets.

Selection is highly meritocratic. Toolmakers create value by transforming familiarity with lead buyers' problems and accumulated engineering experience into long-term partnerships with buyers. Customer intimacy is necessary to structuring, understanding and solving problems. For instance, the collaboration between Toyota Motors and Dassault Systèmes has led to the development of tools that substantially reduce Toyota's design costs and time, while enhancing quality. Toyota reported that the use of PLM systems cut model-development costs by 43 per cent and development time by 44 per cent.[18]

Systems integrators invest 32 per cent of sales in R&D, not necessarily for patentable solutions, but for architectural integration and higher-performance versions. For instance, every two or three years, designers of chip-making systems develop new platforms, kits and tools for the manufacturers of integrated circuits used to build computers, telecommunications equipment, biomedical devices, automotive electronics and other products; 39 per cent of staff time is devoted to innovation. Systems integrators do not much rely on their ecosystems for innovating. They do most of their work in-house, contract with technical specialists and acquire some components. They also enter into alliances with buyers and consultants to reach new markets.

Value is captured by building proprietary systems; 41 per cent of profits come from innovation. Many systems compete and survive. Even marginal market positions are sustainable, if the tools embody specialised architectural knowledge and reputation. Sales grow briskly, at the rate of 23 per cent per year. Pressures to open closed systems are high. Some large customers insist on inter-operability and demand openness in spite of switching costs. However, opening up the architecture is not the ideal strategy for systems integrators, as profitability will tend to migrate toward component suppliers.

Platform orchestration

Platform orchestration games focus on the creation of new markets with open modular products, in areas such as personal computers, Internet-based businesses or info-mediation services. Open modular products appear when tightly integrated closed systems are broken up. The coordination of components to perform the intended functions is achieved through open platforms (the core), using standard interfaces to connect components (the periphery).[19] The core exhibits high user-switching costs and is therefore highly inertial, whereas peripheral elements have low switching costs and low inertia.

Demand does not pre-exist for new systems, but is the result of the co-evolution between buyers and the platform strategies of orchestrators. Buyers would like self-contained plug-and-play products but are instead offered prototypes. Early platforms are often baffling, as buyers are ill-informed and unable to assess performance and survival prospects. Early buyers, as a result, risk owning orphan products, while rational buyers wait.

The dominant rules of innovation are based less on scientific prowess than on the strategic leveraging by orchestrators. Intellectual property is not a critical concern. Participants in this game spend on average 24 per cent of sales on R&D; 28 per cent of staff time is devoted to innovation. The process of launching a new open platform requires persistence, resources and luck. Here are the key elements of this process:

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* The first generation is a barely functional prototype presented in the hope of attracting the attention, first, of potential buyers, and second, of entrepreneurs capable of furnishing the crucial but missing complements.
* Regardless of the promise and potential of the core, a platform leader will often have to stimulate market growth by subsidising early adopters and/or early complementors. Orchestrators will have to be ready to spend for as long as it takes for the platform to reach the stage of self-sustained growth.
* Orchestrators open the platform by means of generous licences, transparent interfaces or the ecosystems of third-party suppliers. During the process of growth, a contentious process of alignment of core architectures, peripheral components and standards takes place. Few firms have the resources to persist through the long and profitless stages of initial platform development.
* Beyond a critical threshold, network effects accelerate growth. Below this threshold, network effects act as a brake on growth. Product superiority and solid patents do not guarantee success. Instead, strong network effects result in winner-take-most platform battles in which fast-mover solutions are likely to leave little room for incompatible products and services.
* Platform orchestration becomes riskier when there is direct competition not only from established alternatives, but also from other emergent platforms. Network effects will likely cause the ensuing inter-platform battle to turn into a high-stakes contest for survival. A frantic race to stimulate buyers and enlist complementors speeds up the growth of promising platforms.
* Products are made by collections of interdependent firms coordinated by the platform orchestrator, who develops alliances with complementary producers. The purpose is to trigger positive feedback loops around their platforms.[20] Only one or a few platforms survive the contentious process, but many component-makers thrive. Managing the ecosystem is central to its success. Sales grow at the high rate of 27 per cent per year. Innovative products and services account for 52 per cent of profits.

Market evolution games

Cost-based search for efficiency

Products have become commodities subjected to substitution. Profits erode as imitators enter the fray. This game is widespread in capital-intensive sectors producing commodities such as generic drugs, PSTN phones, metals, industrial gases, aluminum, oil and gas, petrochemicals and electric power. About 24 per cent of profitability is attributable to recent innovations in processes and products. Incremental improvements, rather than the discovery of scientific knowledge, are emphasised.

Buyers seek the most competitive bids and are not particularly loyal. Market selection is based primarily on price. The dominant rules of innovation are, first, to pursue process efficiency relentlessly; and second, to develop new applications in order to meet the threat of substitutes. Investments in innovation are, on average, 4.4 per cent of sales for R&D: 7.2 per cent of staff time is devoted to innovation.

To maintain markets, some firms, in collaboration with equipment suppliers, develop solutions to customers' problems. For example, oxygen originally used for cutting and welding metals has found new applications in steelmaking, petrochemicals, health systems, semi-conductor foundries and biotechnology. Sales grew at an annual rate of 13 per cent in the recent past.

Firms in the ecosystems of large competitors tend to be specialised contractual suppliers and consultants. Competitors capture value by streamlining activities, building optimal scale processes and guarding industrial secrets. Late entrants may gain substantially if they have the marketing clout and the financial resources to attain optimal scale rapidly.

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Strategic consulting and systems engineering

This game concerns the extension of closed integrated systems to the building of mission-critical production or IT infrastructures of large operators. Major capital investments are made in sectors such as electric power, banking, retailing, financial services, manufacturing and communications. Operators need to buy such systems to meet customers' demand, radically transform their cost structures, and improve delivery of products and services. Projects to build such systems often put operators at risk because of the financial commitments, cost overruns and performance failures involved. Sales of such systems grow at a rate of 16 per cent per year.

The dominant rule for innovation is a shared process of collective problem-solving involving large buyers, specialised consultants and engineering firms. In this collective process, knowledge emerges from the interactions that generate novel solutions and new knowledge. For instance, firms building petrochemical facilities do not rely only on their operational knowledge but instead tap expert engineering suppliers such as Lurgi, TO and IFP, and project management specialists such as Bechtel and SNC. Similarly, buyers of large IT systems use consultants such as McKinsey, IBM or CapGemini to tailor hardware, software and work practices to their needs.

The significant contextual dimensions of this game are high market dynamism and strong interdependencies among players. Instead of network effects leading to 'winner-take-all' scenarios, the interactions result in a deepening of knowledge that triggers very meritocratic choices. The ecosystem is composed of a limited number of strategy consultants, systems engineers and component suppliers.

Consultants must stay significantly ahead of buyers if they are to contribute innovative solutions. On average, 8.1 per cent of sales are invested in R&D and capabilities building; 12 per cent of staff time is allocated to innovation. Consultants interact with customers, complementors, networks of university professors, gurus, vendors and other players. Knowledge accumulation takes place through the formalisation of methodologies, the codification of past learning experience in archives or the building of knowledge or expertise systems; 36 of profits come from innovation. Sales have grown at 16 per cent per year in the recent past.

Strategy consultants capture value by improving their reputation, gaining experience, and thus securing further assignments. Reputation and experience are the dominant selection criteria. Engineering consultants capture value by building partnerships with operators, top-level consultants and product suppliers: all of them are involved in improving performance.

Strategy consultants capture value by improving their reputation, gaining experience, and thus securing further assignments

Customised mass production

Over the last 25 years, a significant transformation of mass production has taken place, as a result of innovations that have enhanced process flexibility and made customisation possible. Customised mass production is basically a battle of brands waged by assemblers catering to heterogeneous market needs, within the parameters specified by the dominant architectural platform. The significant contextual dimensions are high rivalry, interdependencies between value-chain players, but low market and technical dynamism.

When a battle for architecture is finally settled in favour of a set of coherent and stable choices, technical and market uncertainties fall and industry-wide learning can become cumulative. Mass production on a global scale is now possible, as interface standards have become transparent and stable. This game can be observed in automobiles, mass electronics and durable consumption goods. How it will be played out in information goods and telecommunications is still unclear. Similarities include the presence of assemblers, the need for an ecosystem of component makers and high customisation around brands, while differences include network effects, inertia and hyper-selection mechanisms.

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Customers want low-cost but differentiated products: the main trade-offs are style, price, performance and brand. Commoditisation is avoided, or at least postponed, through market segmentation and product differentiation. By catering to different market segments, not only are competitors staying away from each other but they may increase the size of one another's revenue pies.

The rules for innovating are basically to create and capture value by combining the unique design, styling and branding of assemblers with the process innovations of global component makers. Investment in R&D totals 9.7 per cent of sales, with 12 per cent of staff time allocated to innovation. Brand management and product design are at the core of the business model. Assemblers thus perform R&D activities mostly in-house, as design is so strategic for branding. Innovations in systems and components can be shared with specialists.

Innovation accounts for 30 per cent of profitability and sales grow at the rate of 18 per cent per year. Value capture by assemblers is the result of unique designs and branding in the marketing of products. Usually, industries where this game prevails are characterised by high barriers to entry, the need for tight coordination, and high levels of stability. The automobile sector, for example, has been in the customised mass production game for over 70 years, albeit with continuous performance improvements. Component-makers can capture value by reducing the costs and enhancing the performance of their subsystems. Suppliers of critical non-standardised components (such as Intel, which makes computer chips) can, however, capture substantial benefits for themselves.

Supporting innovation

A seventh game emerged from the cluster analysis. Innovating requires information, methodologies and strategic advice that are better produced by highly specialised organisations. A substantial group of public and private organisations, including Battelle, Forrester Research and the Frauenhofer Institute, provide various services to innovators. Many contract R&D organisations are repositories of specialised industrial knowledge that innovators do not own. Finally, government agencies and consultants provide advice about technologies, markets, partners and knowledgeable individuals, and facilitate access to publicly funded programs.

The dominant rule of innovation is the development of specialised technologies and methodologies for solving problems. Firms in this game spend 19 per cent of sales on R&D, and 24 per cent of staff time is allocated to innovation activities. Sales grow on average 21 per cent per year, and 38 per cent of profitability is attributable to innovations. Value capture is difficult in this game. Contract research and consulting are very competitive, low-margin activities.

Different games may coexist. Around 53 per cent of respondents play in a single game; other firms are diversified and play in two or more games. Just as a single game may cut across several sectors and industries, a single industry may contain multiple games. Many firms in the IT sector, for example, are involved not only as strategy or engineering consultants but also as mass software designers; some even build hardware.

Just as a single game may cut across several sectors and industries, a single industry may contain multiple games

Persistence of games and migrations across sectors, industries and firms

The emphasis on disruptions by Schumpeter and his followers assumes the inevitability of lifecycle evolution, from market creation to maturity and decline. Our perspective is different. Games persist over time and reproduce themselves. As long as contextual forces remain basically unchanged, the games persist. Knowledge and specific assets progress, but the rules remain basically the same. With the division of labour in innovation new games may appear.

Persistence does not mean inertia, however. Decisions and actions reproduce the same patterns of innovation. Yet rules and practices are incrementally improved by taking account of the opportunities opened up by technical change, successful strategies and learning. However, sectors,

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industries and firms eventually abandon or change games as competitive conditions shift and no longer fit with specific assets, levels of investment and/or established rules. Migrations thus take place when players decide to change, or are unable to maintain, established rules of action.

Sectors, industries, and firms eventually abandon or change games as competitive conditions shift and no longer fit with established rules

Turning points may be triggered by endogenous events, (e.g., the emergence of a dominant design, the commoditisation of products, the opening of closed systems) or by exogenous events (a disruptive breakthrough, invasion by dominant players or a drastic change in government regulation). For instance, judicial and regulatory decisions in the telecommunications sector have fostered the entry of new competitors and unleashed a slew of technical advances. Today, new technical Internet-based options have displaced the old wired PSTN networks, and services such as YouTube, MySpace and Skype, which extend far beyond simple telephone conversations, are proposed to customers. Figure 2 describes the major migration trajectories between games. These migrations normally follow the four natural trajectories described below.

From discovery to commoditisation and back

Arrow A in Figure 2 indicates the migrations that take place when the key underlying patents come to the end of their valid life and products become commodities. A reverse migration occurs when players make discoveries that open up new opportunities and fields (see Arrow B). When this happens, the game returns to the relentless search. This dynamic fits the classic account of entrepreneurial innovation offered by Joseph Schumpeter.

From systems integration to system extension and back

Highly specialised integrated systems, designed initially for leading customers, can be offered in friendlier, partly open and more affordable versions to general business sectors. Arrow C pictures

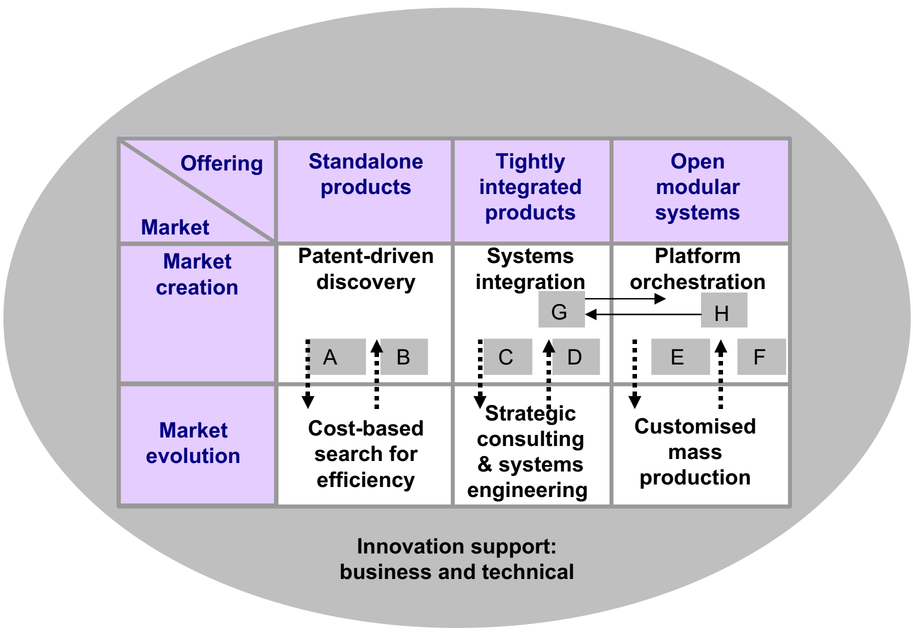

Figure 2. Migration paths

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this transition, while Arrow D refers to the reverse and rarer migration in which firms involved in broad deployment and extension of integrated systems develop best-of-breed applications.

From orchestration to customisation and back

Once platform choices are crystallised around one or a few dominant designs, basic functionalities are more than adequate. Buyers start demanding lower costs and variety. The migration toward customisation is described by arrow E. Arrow F refers to the backward migrations that happen when technical discontinuities help competitors develop new open approaches.

From closed to open systems and back

Early in their lifecycle, platforms are best kept closed, tightly integrated and centralised.[21] Only later, as uncertainty about optimal product configurations decreases, will it be preferable to open up and decentralise the platform.[22] This path is illustrated by arrow G.

Eventually, as radically new technologies loom on the horizon, innovators will revert to a closed platform and a centralised governance regime, in order to develop new functional and reliable systems (see arrow H).

Conclusions

Our approach urges academics and business executives to reassess the validity of conventional approaches, no matter how well established. The taxonomy we propose here is based not on *a priori* concepts but on extensive empirical measurements of the phenomena of innovation.

Academics should develop an understanding of innovation and business strategy that recognises the systemic nature of products. Platforms are not products, modules are not systems, value nets are not value chains, and the decision to open a platform is not a mere engineering choice. Our approach suggests staying away from reductionist accounts of industrial evolution. 'Design rules' do not always emerge in R&D laboratories: often, they emerge as a result of negotiations, competitive battles and conflictive exchanges between buyers, producers, consultants and other relevant players.

'Design rules' do not always emerge in R&D laboratories: often, they emerge as a result of negotiations and conflictive exchanges

Managers, like academics, should view innovation as a task divided among many industries and sectors. They should worry far less about imitating industry best practices and more about correctly gauging the strategic issues that define their game(s). Managers need an architectural understanding of business strategy, competitive contexts and products. We advise them to develop a feel for the logic and tempo of game evolution. There are times to go with the flow, but there are also times to bet massively on a sectoral change of course. The actors most capable of quickly reading the emerging new plays will be those best positioned to exploit the early indeterminacy to their own advantage.

Business executives also need to develop a view of firms' success or failure that takes into consideration the collaboration of competitors and complementors. A sustainable innovation game is one in which all the major players involved can thrive. Healthy game dynamics are a collective necessity no less than a collective achievement. The first order of business for all players should be to turn potential negative-sum games into positive-sum games by stressing collaboration.

A sustainable innovation game is one in which all the major players involved can thrive

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Appendix A

Methodology for the empirical identification of games

To identify the games empirically, we used a broad sampling approach and field research conducted by the MINE (Managing Innovation in the New Economy) research program at Ecole Polytechnique in Montreal, Canada.

A grounded approach. Instead of limiting ourselves to the existing literature on innovation, we started with structured interviews with 75 CTOs and VPs of R&D in many industries and regions of the world. Sectors such as biotechnology, telecommunications, software, aerospace, aluminum, pulp and paper, engineering and construction, and multimedia were covered. Firms included Sun Microsystems, Synopsys, Air Products and Chemicals, Cambridge Technology Partners, Novartis, Armstrong etc. The issues discussed were: activities undertaken to create and capture value for customers through innovation; the pertinent strategies and practices; and the competitive contexts. After this initial round, a survey tool was developed.

Building the MINE survey tool. Combining observations from interviews and constructs from the literature on innovation, a measurement instrument was then designed. The survey tool is available at www.minesurvey.polymtl.ca. The following sets of variables were incorporated.

* *Contextual variables* focused on the buyers' expertise, product architecture, interdependencies between players, pace of scientific and knowledge production, economic and regulatory factors, competitive dynamics and pace of change and relative importance of products versus services sold.
* *Level of innovation efforts:* R&D over sales, proportion of staff time devoted to innovation, efforts to build strategic, marketing, technical and organisational capabilities, types of innovation sought, and direction of investments in innovation.
* *Value-creation activities:* cost reduction, engineering of products with reliability and safety, promotion of platforms solutions, gaining regulatory approvals, positioning as *de facto* standards, and so on.
* *Strategies for innovation*: sources of competitive advantages now and in the near future, competitive moves and collaborative moves. Strategic initiatives to renew competitive advantage and respond to changes.
* *Organisational design for innovation:* extent to which staff understand links between innovation and strategy, presence of management processes, rules that guide innovative action. Enabling roles played by partners in networks.
* *Practices for managing innovation:* exploration for opportunities, portfolio and pipeline management, project management and commercialisation practices.
* *Performance:* subjective (innovativeness relative to competitors, impact of efforts, contribution of innovative products and services to profitability) objective (sales growth, profitability and ROI over last three years).

Pre-testing of tool. A preliminary version of the tool was pre-tested with 100 firms. Items that did not exhibit significant variation or that were difficult to understand were reformulated and sometimes eliminated.

Identification of target sample. Using the North American Industrial Classification scheme, 20 sectors were identified. Lists of firms from around the world were built by consulting data banks, associations and stock exchanges. Efforts were made to cover all sectors, regions and sizes of firm. A team of 10 engineering students at Ecole Polytechnique was formed to solicit respondents directly on the Web, though face-to-face meetings or by fax.

Data gathering: The plan was to target 5,000 senior managers and obtain 1,000 respondents. Substantial efforts and various tactics had to be deployed. We were successful in getting responses from 1,000 single business firms, large SBUs and smaller firms. Our sample is geographically distributed as follows: Asia (250), Europe (200), North America (471), South America (52), other (27).

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Data analysis to identify clusters. The data were reduced and analysed in the following fashion:

i Data reduction was achieved through multiple principal components analysis to reduce the 335 items of the MINE Survey Tool to 29 principal components.
ii Multiple cluster analyses were performed using the Ward method: this method attempts to minimise the sum of squares within clusters and maximise the Euclidean distances between clusters. Many cluster analyses were done using value-creation and value-capture activities as well as a few decision variables.

A stable solution was achieved with seven clusters. We observed that solutions involving more than seven groups tended to be unstable, while solutions with under five clusters tended to form very large and difficult-to-interpret groups. We concluded that seven statistically different clusters was the most viable solution. ANOVA and T-tests were used to establish that clusters were indeed significantly different from each other at the $p = 0.01$ level.

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