Inside the Green Box: A System Dynamics Model of Innovation at a Large Firm

> Just as energy is the basis of life itself, and ideas the source of innovation, so is innovation the vital spark of all human change, improvement and progress.
> – Ted Levitt

How does innovation within a company really work? That question has bedeviled researchers and practitioners alike ever since Schumpeter popularized the term Creative Destruction in 1942 and Christensen put forth the theory of 'disruption from below' in 1997. There are many perspectives one can take when trying to answer this question, but one of the most interesting and relevant perspectives on innovation is the perspective of that complex, dynamic, system, the firm. It is also the one of the most difficult systems to understand.

In a research effort by McKinsey they claim that companies who master eight 'innovation essentials' can achieve 2.4 times the economic returns over those who don't. They do this by excelling with their innovation portfolio (the green box) and within this green box, with breakthrough innovation.

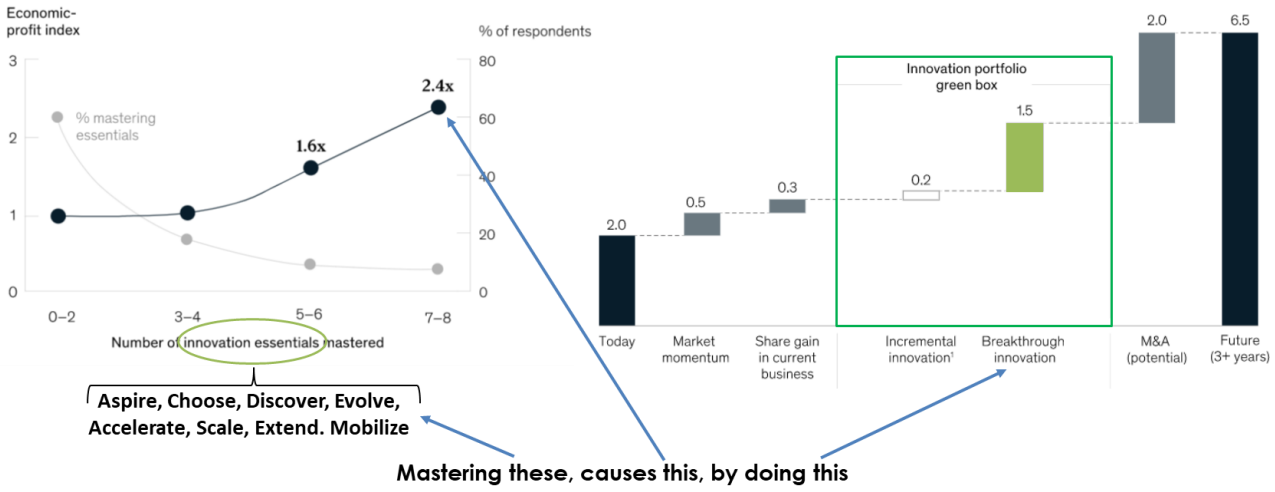

Figure 1 – The Green Box

The eight 'innovation essentials' that drive growth through breakthrough innovation are:

Aspire, Choose, Discover, Evolve, Accelerate, Scale, Extend, Mobilize

One can immediately see a problem. These eight innovation essentials (the articles contain much more extended descriptions) are 'just' words. Words are important. They can motivate, direct, inspire, and lead people to change their behavior and to design different systems. But the question facing practitioners is how can these eight essentials be manifested in the real world? What does 'Aspire' mean in terms of the systems, processes, methods and tools a company can design, build and deploy. You can hire a consulting company to help figure this out. We decided to build a model of innovation to see what terms like 'Aspire' mean in the real world.

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Why Model? Why This Model?

There are many ways to examine a complex system such as innovation within a firm. One is to use surveys and in-depth interviews. Another is direct observation. The gold standard would be an experiment: change one thing in a running system and see what happens – but in practice this is impossible. Another method is to build a functional **model** of the system and see what insights it can reveal.

System Dynamics Modeling championed by Jay Forrester in the 1950's is one of the most useful tools for doing this. These types of models have found use in numerous political, economic, social, technological, environmental and business situations to understand the dynamics of systems that have complex and non-linear interactions and outcomes. Innovation is such a system.

One of the objectives in building a model of innovation is to examine what is behind the outcomes and behaviors people and companies experience in real life. Insights can be gained into what works, what doesn't and why. A model opens the 'black-box' of innovation and lets one examine, and play with, the internal structure and dynamics to see what makes a difference. Of course, a model is an abstraction of the real world. It simplifies an extremely complex system so that it can be investigated, understood and matched against real-world experience in order to make both the model and the real-world system better. The key is to construct a model that is thorough enough to reflect the reality of organizational structure and function, yet simple enough to build and run.

The model is strictly focused on what happens inside a firm. The model boundaries are firm's boundaries. What happens outside the firm are externalities. For example, the model does not consider where ideas come from, only their input characteristics and probabilistic distributions. The model does not consider the ecosystem – competitors, suppliers, markets or customers, etc. – only the distribution of outcomes. The model does not even consider individual opportunities – how they are developed, how good they are or how much revenue they generate – only how distributions of opportunities collectively flow through the system. All these rates and distributions can be set by the modeler to investigate different innovation system dynamics.

The model was built using parameterized inputs and internal structures that can be mapped to real-world influences. Expected outcomes were never considered or 'built in'. One of the key tests of a model's usefulness is if it creates surprise outcomes and this was the case here. It is impossible for any human to predict the behavior of a model as complex as this that has multiple reinforcing and balancing feedforward and feedback loops that create non-linear outcomes.

The model translates input ideas into output adoption through a series of complex interactions that represent the actual innovation processes occurring within a company. These include knowledge acquisition, decision making, resource allocation and other processes – all of which are subject to probabilistic variation.

This is not a predictive model, but one that yields insights into how the structure of a system creates certain performance/behavior outcomes. The model's outputs are not specific predictions but rather *dynamic behaviors*. There will always be uncertainty around parameter estimation, but the general behavior of what happens and why it happens is explicitly represented in the model.

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Validation of the model is not done through quantitative means or back-testing. Rather, it is done by comparing model behaviors to real-world behaviors. For example, the model says that strategic opportunities often get 'stuck' in a stage-gate process. Does this really happen? Examining actual companies provides an answer.

The model was constructed by interviewing experts in corporate innovation who gave detailed information used to create and validate the model structure and assumptions.

The model was tested with other standard validity methods [14, 15]. The dynamic equations were reviewed for consistency with the Causal Loop Diagrams and expert narratives. The model was checked for consistency of units throughout. When tested, the model generated reasonable behavior for a wide range of parameter values including for extreme conditions (i.e., parameter sweeps and sensitivity analysis).

In addition, the model was tested with case studies to confirm whether the model created output behavior that is consistent with the case parameters. More rigorous testing could be done by scoring specific companies to see how accurate the model is.

Model Overview

The top-level structure of the system dynamics model (SDM) of an innovation system in a large firm is shown below both as a schematic illustration and as it is implemented in Stella Architect.

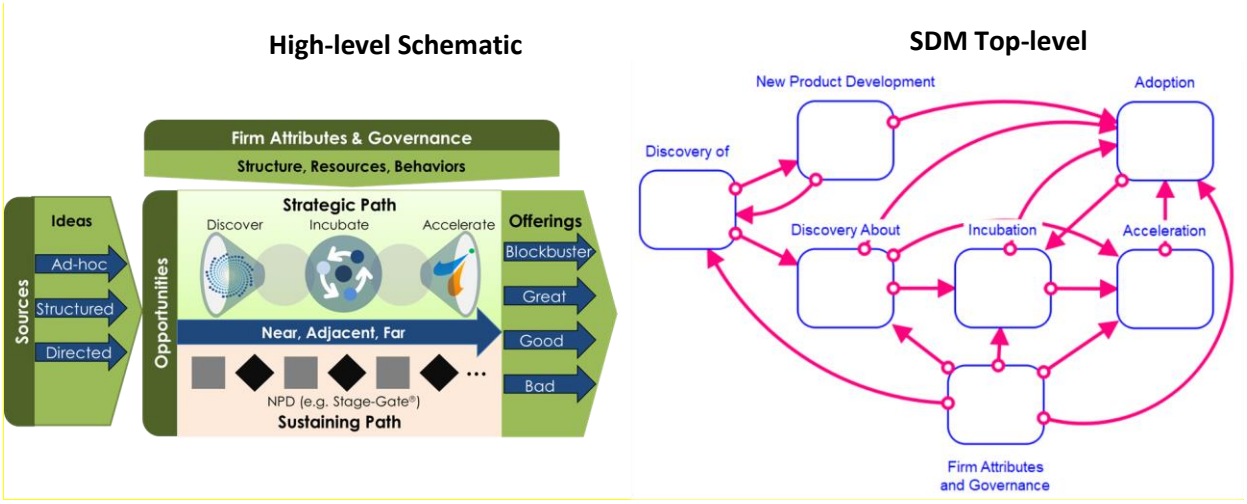

Figure 2 – Model Architecture

The model consists of 'stocks' and 'flows' with various feedforward and feedback reinforcing and balancing cycles. The main stocks are opportunities, knowledge, and resources (i.e., money and people). These flow through and accumulate (as stocks) in the system and are affected by various factors based on the type of opportunity, system structure and organization behavior.

For example, the model allows a user to specify how many ideas come into the innovation system (through channels) per unit time and the distribution of the ideas that come in - from sustaining to strategic. Likewise, the model lets the user define what success looks like as revenue generated in categories from Blockbuster to Bad. It is the probabilistic distribution that counts, which in turn is determined by the model rather than the specifics of any one opportunity. What the model does *not do*

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is track a specific opportunity as it proceeds through a specific sequence of steps and predict what will happen to it once it is launched.

No specific opportunity or person is individually represented, only the aggregation of opportunities and collective behaviors classified into discrete categories that exhibit probabilistic behavior. People are represented through the accumulation of knowledge (a stock) and their decision execution determined by probabilistic outcomes.

The major modules (subsystems, sections) include:

- **Input Sources** – The innovation input channels generate idea input into the system. Opportunity ideas can come from all over – people, teams, even AIs in the future – the system doesn't care. There are three input channels, ad-hoc, structured, and directed that reflect differences in input rates and the distribution of ideas types. Opportunity ideas input into the system is modeled in the 'Discovery-of' module (see below).
- **Firm Attributes and Governance –** Firm attributes and governance play an important role in the rates of knowledge accumulation, opportunity flow and decision error rate and velocity. These model parameters essentially represent the 'innovation maturity level' of the company. Firm Attributes and Governance is managed by the similarly named module.
- **Strategic Path –** The strategic path is one of two paths an opportunity can take through the system (see below). Strategic path opportunity flow, knowledge accumulation and decision making are modeled in the 'Discovery-About', 'Incubation' and 'Acceleration' modules.
- **Sustaining Path –** The sustaining path is one of two paths an opportunity can take through the system (see below). Sustaining path opportunity flow, knowledge accumulation and decision making is modeled in the 'New Product Development' module.
- **Offering Adoption –** Opportunities end up being launched (if they make it through), adopted and then generate revenue. The rate and mix of outcomes are the main outputs of the model. The level of revenue generation, e.g., offerings that end up being Blockbuster, Great, Good, or Bad, can be set but the % of each type is determined by the model. Market adoption is modeled in the 'Adoption' module.

Decision errors are a central factor in the model. Errors can be made to advance bad opportunities or to kill blockbuster ones (respectively, Type I and Type II errors). The decision error rate and decision velocity are two of the key factors in how the model differentiates between the sustaining path and the strategic path.

The innovation process is modeled as a series of transitions from nascent ideas to launched offerings. Instead of focusing on specific methods, tools, stages, and capabilities, the model instead focuses on the dynamics of knowledge accumulation, decision accuracy and velocity, resource availability, etc. Transition points (i.e., opportunities moving to the next development phase) are marked by decision events that commit (or take away) resources – people, time and money. These transition points are times and situations where the collective determination of the organization comes together to act. Of course, it is at these times where errors occur. Opportunities that should move on get sidelined and opportunities that shouldn't move on get advanced.

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The Two Pathways

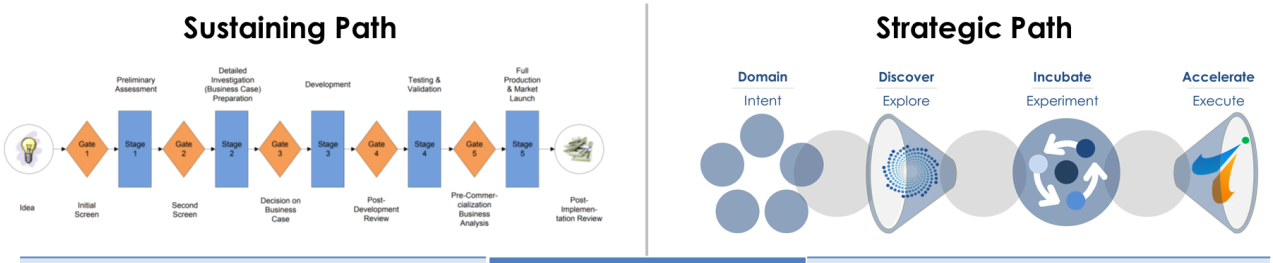
As shown in the schematic above, once opportunity ideas enter the system (in the Discovery-Of module) they can go one of two ways:

A. Into a new product development (NPD) pathway that models a Stage-gate® process

B. Into a strategic pathway that models a Discover-Incubate-Accelerate[1] process.

The strategic path can be turned off so that all opportunities flow through the sustaining path. This matches the system many companies employ that consists of only a New Product Development process based on a Stage-gate® methodology.

Sustaining and strategic opportunity advancement is modeled as differences in the way the two paths handle knowledge accumulation (i.e., learning) and decision velocity and error rates. These factors influence each other – better decisions are made when more knowledge is available. These differences are listed in the following diagram.



Process centric, opportunity flows through stages	Focus	Opportunity centric, what opportunity needs
Project oriented. Opportunity = project	Orientation	Portfolio oriented. Multi-opportunity competition
Requirements 'known' up-front	Requirements	Requirements discovered during creation
Specification and design refinement	Scope for Change	Holistic shaping and redesign
Pre-determined sequence of action (control flow)	Flow	Action sequence based on situation (data flow)
Waterfall project management (Gantt charts)	Management	Agile project management (Scrums)
Specific, defined learning at each step	Learning	Broad, situational learning at each step
Looping back and iteration is difficult	Routing	Process loops and iteration built in
Issues are exceptions and pulled out of flow	Exception Handling	Exceptions are expected – part of the process
Transitions are expected	Transitions	Transitions are earned

Figure 3 – Sustaining and Strategic Pathways

The differences in the two paths of sustaining vs. strategic influence each other in subtle ways and are handled differently in the two paths.

- **Knowledge accumulation** is more difficult for opportunities that are farther from the core. It takes more time and the knowledge is incomplete and ambiguous.
- **Better decisions** are made when more knowledge is available. But when are decisions made? Do you wait until you know 'everything' (which may take forever)? Or do you decide to kill or advance an opportunity with only partial knowledge?

[1] The Discover-Incubate-Accelerate architecture is described in the book Grabbing Lightning by Gina O'Connor, et.al.

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- **Decision error rates** are higher for opportunities that are farther from the core and that have lower levels of knowledge.

In the sustaining path, the bias is towards waiting until all knowledge is available before deciding to advance or pause an opportunity. Once an opportunity moves on, it cannot move back.

In the strategic path, opportunities can advance with partial knowledge available, but they can also move back (or stay in place) to give time for additional knowledge to be acquired.

Stocks

In a system dynamics model, stocks accumulate something. They act as buffers as things (opportunities, knowledge, resources) flow through the system and are acted upon. As buffers, the rates of input and output of vary depending on model parameters, structure and operation. For example, a knowledge stock in Incubation accumulates knowledge until a decision can be made that releases opportunities to flow to the next component.

There are three main types of stocks in the model:

1) Opportunities

Opportunities come into the system as ideas and leave (if they make it through) as offerings that are adopted and generate revenue. Opportunities have two key attributes:

- Inherent **potential** – The inherent potential represents the economic value created three years after the opportunity is successfully developed and launched. There are four categories – **bad**, **good**, **great**, and **blockbuster** – which can be set by the modeler.
- **Distance** from the core – There are three categories – **near** to the core, **adjacent** to the core, and **far** from the core. The difference between the three are time delays, knowledge accumulation rates and the base error rate, all of which can be adjusted.

The inherent potential and distance determine how the opportunity flows through the two paths in the system. Knowledge acquisition, decision outcomes, and resource allocation are affected by these two opportunity attributes, which path they are on and where they are on that path.

2) Knowledge

Knowledge acquisition (learning) is a key determinant of an opportunity's forward momentum and decision outcomes. Knowledge stocks are a special resource. They accumulate at a rate based on time and resources (see below). The more knowledge, the better (there is no current mechanism for accumulating 'false' knowledge). The accumulation of knowledge stocks affects model operation in the following ways.

- When is a decision (to kill or advance) made? Is there enough knowledge to decide? If a decision requires 'complete' knowledge, then decisions are delayed and may never happen.
- What is the decision error rate (false positive and false negative)? Lower levels of knowledge result in higher decision error rates.
- As opportunities advance, the need for more specific and precise knowledge increases. It becomes harder to do (i.e., more resources/time are required).

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A firm's knowledge acquisition competence is affected by various attributes of the firm's innovation maturity level (see Firm Attributes and Governance on p.7). A more mature firm is more capable at learning.

3) Resources

Nothing happens without resources, and attention is the most precious resource. Attention depends on the number of people involved and the time they spend (of course, this will change as AI becomes more prevalent). The need for attention and resources required increases as opportunities advance. But resources are not always available – and this affects model operation in the following ways.

- Resources for corporate innovation efforts is fixed (i.e., the number of people and the operating budget). Resources required for incubating and accelerating new opportunities is variable depending on how many opportunities make it to incubation and acceleration.
- A company's commitment to invest in incubation and acceleration is a key factor in the model. Opportunities can get held up at major transition points (into incubation and into acceleration) if the company is not able to or willing to invest. The level of commitment is explicitly modeled in the flows between the modules and is affected by the company's innovation maturity level.

Resources directly affect the 'absorptive capacity' of the firm. Absorptive capacity refers to how many new opportunities a firm can 'absorb' in a given time period. It is effectively the limiting factor on how many new opportunity developments and launch projects can be done simultaneously (i.e., invest the necessary resources to make it successful).

The Modules

The model is comprised of seven modules (or sub-systems), each of which has its own internal structure and operation. These modules are interlinked and operate together to turn ideas coming into the system (in the *Discovery-of* module) into revenue generating entities coming out (in the *Adoption* module). The model does not incorporate any operational characteristics of the company (i.e., how good they are at executing) other than the fact that more mature companies make better decisions faster all through the system.

The seven modules are described in the following sections.

Firm Attributes and Governance

A firm's ability to do innovation well depends on a wide variety of factors that are not easily measured but nonetheless need to be quantified. For example, how is the company's 'culture' represented? How do you represent how fiercely the heads of the operating businesses will resist new opportunities and what their influence within the corporation is? These affect how the firm undertakes its innovation process and the level of its innovation capabilities. They influence the flows of knowledge and opportunities and the decision-making processes. In the model these factors are represented by the following:

- **Organizational Structure** – a set of five factors: (1) strategic clarity, (2) organizational influence, (3) systematized process, (4) metric clarity, (5) innovation expertise. These factors affect the learning rate and decision error rate of the opportunity flow.

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- **Organizational Mindset** – a set of four factors: (1) tolerance of uncertainty,(2) tolerance of errors,(3) freedom of operation,(4) commitment to the process. These factors affect the assignment of resources and the decision error rate of the opportunity flow.

The collection of these factors represents the 'Innovation Maturity Level' of the company.

The ability to learn is represented by having knowledge accumulation (i.e., learning) as a stock in the model. This, in turn, affects decision making – does the opportunity continue to be advanced or not. All of this occurs under constraints of resources available and the absorptive capacity of the firm.

Discovery Of

Ideas for new opportunities come in through three different types of channels and are triaged into either the sustaining path (*New Product Development*) or the strategic path (*Discovery-About*). The three channels are:

- **Ad-hoc** – Ideas for new opportunities come in from anywhere at any time – from a scientist with a new discovery to an executive golfing with a friend who mentions an idea.
- **Structured** – Ideas for new opportunities come in through designed mechanisms. This includes scouting, idea portals, hackathons, challenges, etc.
- **Directed** – Ideas for new opportunities are created with specific, targeted projects with a clear charter defining the domain and objective.

The three channels reflect the relative mix and volume of raw opportunity ideas coming into the system. For example, the *ad hoc* channel typically has a very low 'yield' of far from the core, potentially blockbuster opportunities. Therefore, very few of the opportunity ideas coming in through the *ad hoc* channel will be strategic in nature (and go into the strategic path).

The Directed channel, however, is just the opposite. It is specifically designed to create strategic opportunities. Although the volume may be much lower, the yield of ideas that are potentially blockbuster opportunities farther from the core is much higher.

No matter which channel they come in through, all opportunity ideas are triaged into two paths, sustaining or strategic (see above).

New Product Development

This module models a classic Stage-gate® process based on advancing opportunities through a linear sequence of stages. The operation of this sub-system models the 'agile stage-gate' used by many companies today.

The module is essentially a series of time delays (the stages) that the opportunities go through before advancement to the next stage (the gate). Advancement depends on the level of knowledge accumulation. This accumulation occurs faster for opportunities that are closer to the core and sustaining. Opportunities that are farther from the core and strategic may get 'stuck' in the pipeline because they never get enough knowledge to get through a gate.

Discovery About

The first phase of the strategic pathway (Discovery) is modeled as a competition between many strategic opportunities vying for attention and resources to accumulate the knowledge they need to

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move-on to incubation (and experimentation). Unlike the linear progression of an opportunity through stages in the sustaining pathway, the Discovery-About module advances an opportunity, from a pool of potential opportunities, when it is 'ready'.

Opportunity readiness is determined by knowledge accumulation in four distinct dimensions – Organization, Demand, Design and System (see 'Uncertainty is the Innovator's Friend' for a detailed description). Unlike the sustaining path where, for example, a 'business case' must be created before development begins, the strategic path acknowledges that a business case may be *impossible* to create unless some in-market experimentation is done (during the incubation period). So, instead of getting stuck waiting for business case 'certainty', opportunities can proceed on to incubation even when there are unanswered questions.

Incubation

An opportunity transitions to incubation when it has accumulated enough knowledge (that is, its uncertainty has been reduced) and a decision is made that the opportunity has potential. Once it is transitioned, it needs to have additional resources and attention devoted to it and is therefore subject to availability of resources and delays in acquiring new resources.

The operating learning paradigm here is experimentation. There are 3 phases in incubation (early, intermediate and advanced, corresponding to Opportunity Readiness Levels 4, 5 and 6). These require increasing levels of resources to accumulate the knowledge necessary for the opportunity to continue advancing.

A certain number of opportunities will not make it through incubation either because it will be determined that they are 'bad' opportunities (or not 'good enough'), or that the company does not have the resources or the commitment to absorb an opportunity at present (i.e., to accelerate it).

Another thing the model accommodates is the different amount of time opportunities spend in incubation. The modeler can set the average incubation time (in months) for near, adjacent and far opportunities to approximate what has historically been the case for the company.

Acceleration

An opportunity enters the final stages of development and is launched. Experimentation is complete and the focus is on efficiency and preparing to scale. This is a relatively simple module just requiring time and resources to get through. Opportunities that are farther from the core and assumed to take longer and require more resources to accelerate.

One subtlety is that success in acceleration requires an organizational mindset to commit to the new opportunity. This is a place where the firm attributes and governance really make a difference. For opportunities near the core, there are no issues. For ones farther from the core, however, a 'home' needs to be found where they can be turned into real businesses. Existing businesses often explicitly or implicitly reject these types of new opportunities. The organizational mindset, the degree of resistance, makes a difference in the ultimate success of an opportunity making it through acceleration. These are both parameters in the model that a modeler can adjust to see what the effect will be.

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Adoption

The two paths, sustaining and strategic, come together once an opportunity is ready is to be launched into the market and start generating revenue. Adoption dynamics are relatively straightforward. There are four categories of growth rates – Blockbuster, Great, Good and Bad. There are also different adoption 'delays' for near, adjacent, and far opportunities. The modeler can choose values for all these parameters.

Hundreds of ideas flow into the system, but only a few opportunities come out. Did the right opportunities make it through? Ideally, every potential blockbuster idea that went into the system was recognized as such, nurtured and developed in the right way and was successfully launched. Unfortunately, that is not at all what happens. Recognizing a blockbuster opportunity and getting it through the system is fraught with obstacles and potential missteps. But the design of the system, and the innovation maturity level of the company, can reduce these obstacles and increase the performance of the system.

Model Operation

There are two primary dashboards used for setting the key parameters for a run[2]. The first dashboard lets a user set the firm attributes and governance parameters. The second dashboard lets the user set various parameters that influence input rates, value thresholds, delays, decision error rates, etc.

An execution panel lets the modeler run simulations and examine results. The modeler can run several scenarios in succession and see the differences in outcomes overlaid on the charts created by each run. In addition, the detailed outputs of each run are gathered in a spreadsheet that can be used offline to examine and evaluate outcomes.

Operating the system proceeds as follows:

1. Restore clears out all previous run results
2. Set the parameters using the two input dashboards (see below)
3. Run the simulation – see the output
4. Set the parameters to some other configuration
5. Go to 2 above
6. Compare the chart outputs
7. Dig into the various graphs, tables and excel outputs the model creates

There are an innumerable number of variations that can be run, so each test or experiment should vary a limited set of parameters to see what the effects are. The example given below shows three runs that result from the change of just two parameters: turning the strategic pathway from off to on, and changing the firm's innovation maturity level from 1.5 to 4.

The following lists the parameters that have the largest impact on the results (i.e., the ones that the model is most sensitive to).

[2] The system allows a modeler to manipulate a much larger number of parameters than the ones that are available through the dashboard. The dashboard parameters are the most important ones the model designer has chosen to make easily available to the model user.

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1. Presence of a Strategic Innovation pathway: **yes – no**
2. Organization maturity level and mindset: **1 – 5**
3. Volume of ideas input: **N per month** across 3 channels
4. Incubation abandonment rate (also called failure rate): **1% to 50%**
5. Level of learning capacity and expertise: **1 – 10**
6. Organizational efficiency (decision velocity, impedance, resource skill, speed of work): **1 – 10**
7. Resources available: **$** and **people**

Changing these parameters and examining the results provides insights into what is going on and what affects what.

Model Dashboards

The two model input dashboards available to the user are the *Firm Attributes and Governance* dashboard and the *Firm Data Input* dashboard.

Firm Attributes and Governance Dashboard

The nine Firm Attributes are shown in the following diagram. The five on the left are aggregated into a 'Organizational Structure' score that represents the level of organizational structures, systems and processes in place. The four parameters on the left are more behavioral in nature and are aggregated to form an 'Organizational Mindset' score. Together these represent the overall innovation maturity level of the company.

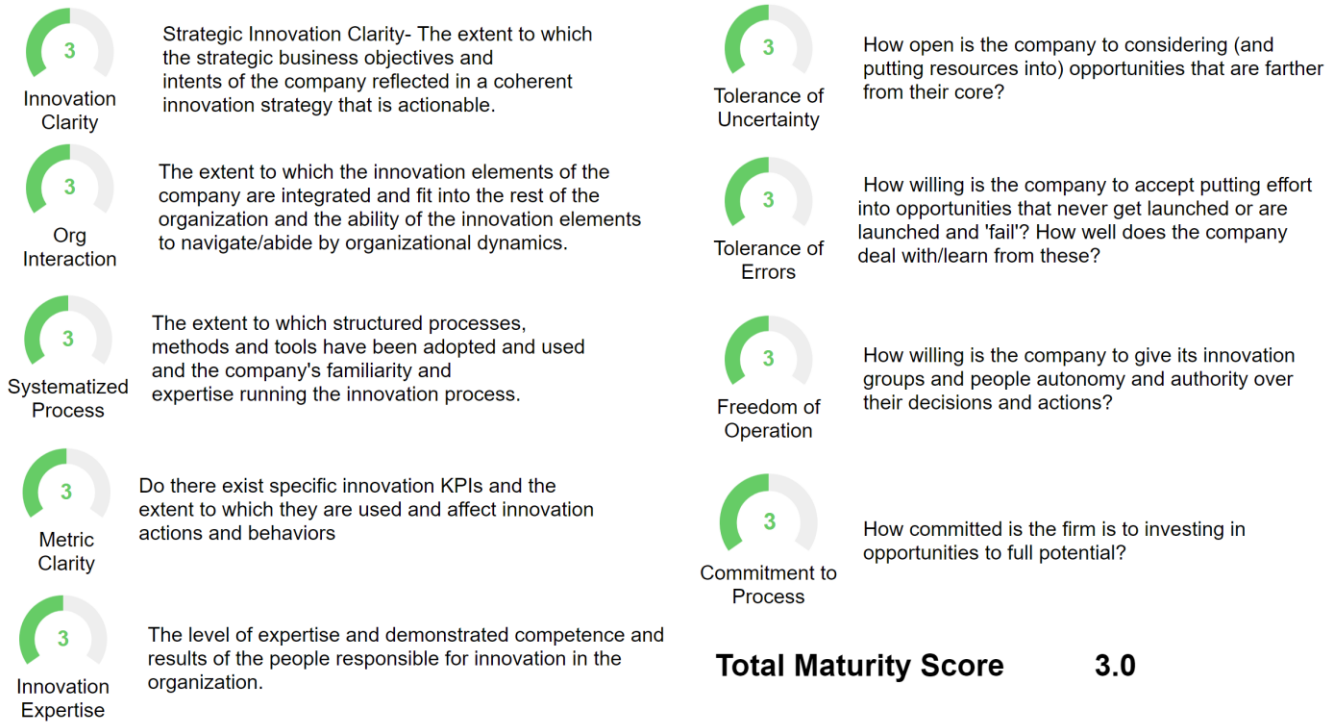

Figure 4 – Firm Attributes and Governance Dashboard

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The two scores, Organizational Structure and Organizational Mindset, are used at various places in the model to affect the rates, levels and distributions of various stocks and flows. In general, the greater the structure and mindset scores are, the more effective and efficient are knowledge accumulation, decision velocity and error rates and opportunity flow.

Firm Data Input Dashboard

This dashboard controls the key runtime parameters of the model. It lets the modeler set the input flow rates and channels, the resources available, the levels of what constitutes a good or great opportunity, the base error rate, and timeframes for different opportunity types. The dashboard is shown below.

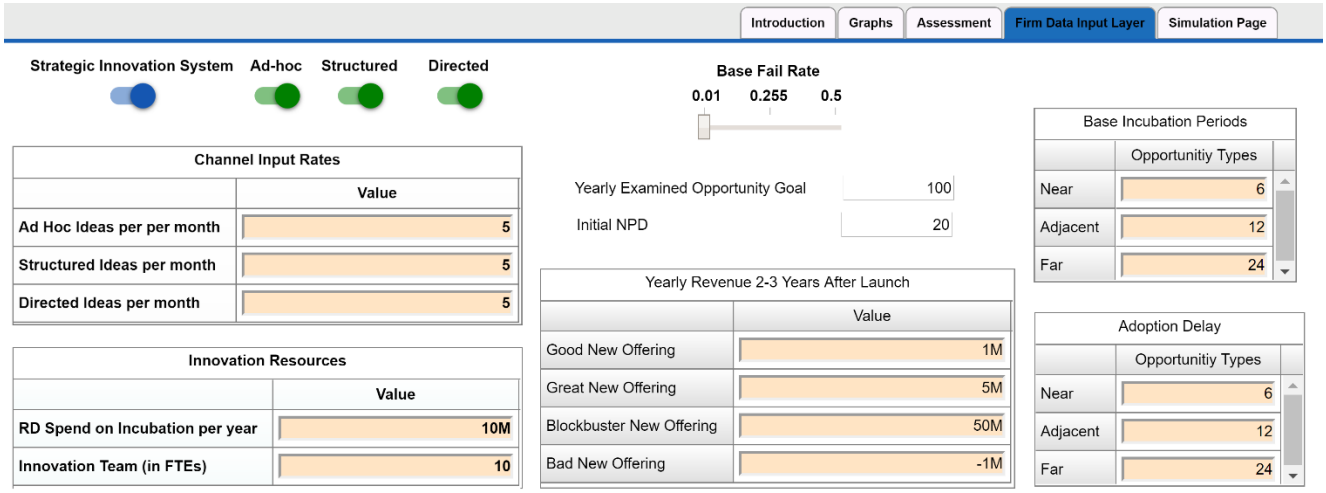

Figure 5 – Firm Data Input Dashboard

The various controls are:

Strategic pathway on-off: Turns the D-I-A pathway off or on. When the pathway is turned off, all opportunities flow through the NPD pathway. When it is turned on, input opportunity ideas are triaged into wither the NPD pathway or the D-I-A pathway based on their attributes (inherent potential, distance) with an error rate affected by innovation maturity level.

Input channels on-off: Let's the modeler easily turn specific input channels on or off. (You can also get the same effect by setting input rates to 0.)

Input rates: The monthly number of opportunity ideas that come in through each channel. At present, the distribution of opportunities per channel is fixed (it can be adjusted inside the model). The ad hoc channel has a high percentage or sustaining opportunities close to the core with a large percentage of that have an inherent value of bad and good. The structured channel has a distribution of opportunities that is equal parts sustaining and strategic with the mean centered around adjacent and inherent value between good and great. The directed channel has a distribution that is skewed towards strategic opportunities that are farther from the core and have a higher percentage of opportunities that have an inherent value that are great and blockbuster.

Innovation resources: The number of people dedicated to running and maintaining the innovation system (usually a Corporate Innovation Group) and the funds available for investing in new opportunities, primarily in incubation. These determine the firm's absorptive capacity – how many opportunities can be advanced in the different phases per unit time.

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Incubation Abandon Rate (also called Base Fail Rate): The nominal rate of opportunities that 'fail' in incubation (i.e. don't make it through to acceleration). This represents the overall 'failure rate' of the innovation system since any opportunities that make it to acceleration (and that make it through NPD) will be launched.

Yearly opportunity goal and Initial NPD: Allows the user to 'prime' the NPD path so that it doesn't start from 0. Allows runs to start with opportunities already in progress.

Yearly revenue levels: Lets the user set the nominal value for Blockbuster, Great, Good and Bad opportunities. Blockbuster ones should be set to a yearly revenue lever that approximates the best thing your firm has ever launched. Good level is the value a typical product or service offering is expected to generate. These values should be calibrated to historical values, not aspirational ones.

Base incubation periods: The average time spent in incubation for near, adjacent and far opportunities. This will be very different for different industries and companies.

Adoption delays: The length of time it takes for adoption to 'take off' (i.e., exhibit a positive inflection point). This adoption delay can be set for near, adjacent and far opportunities. It is usually assumed that far opportunities will have a larger adoption delay.

Many more model parameters could be promoted to 'dashboard' level in future iterations of the model.

Output Charts and Tables

Once the parameters are set, the user uses the Simulation Page as shown below. The graphs shown in these examples are from a run whose parameters are depicted in figures 4 and 5.

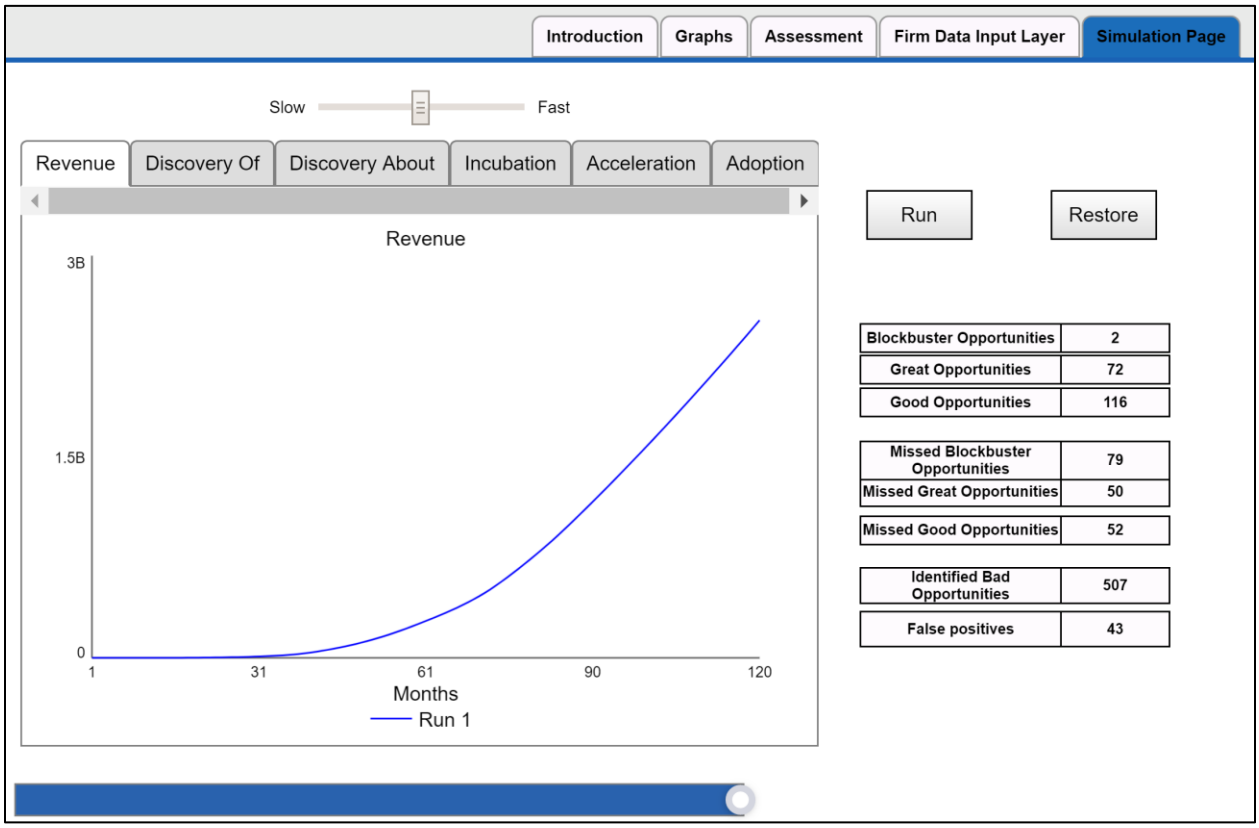

Figure 6 – The Simulation Page used to run simulations

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The five tabs across the top let the user view various aspects of the system. The Revenue tab is the final output of the system and shows revenue growth based on the number of Blockbuster, Great, Good and Bad opportunities that are launched.

The other four tabs show the flow of opportunities through the other modules of the model. Examples are shown in Figure 7. In general, an increasing slope means that opportunities are getting backed-up in the system. Also note that there is a ramp-up time before the system gets to equilibrium. This is an artifact of starting the system with almost no opportunities already in it.

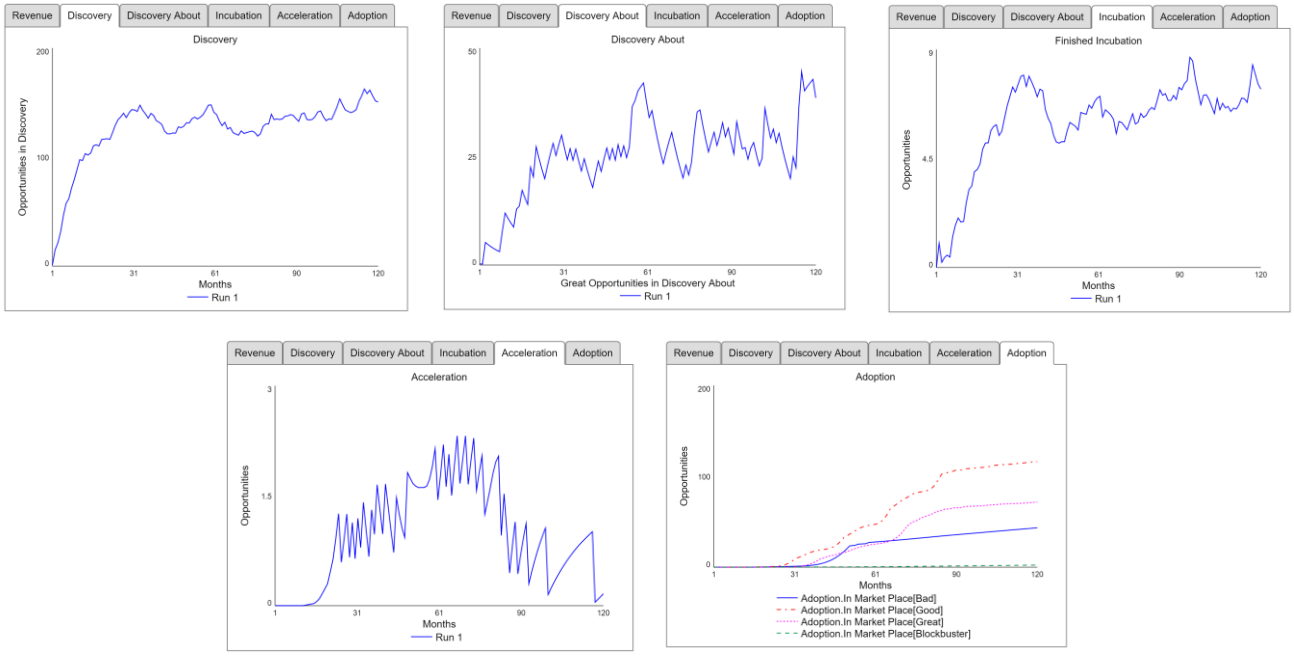

Figure 7 – Simulation charts showing opportunity flow through the system

The final component of the output consists of a table that enumerates the opportunities that made it through the system and the ones that didn't.

Blockbuster Opportunities	**2**
Great Opportunities	**72**
Good Opportunities	**116**

Missed Blockbuster Opportunities	**79**
Missed Great Opportunities	**50**
Missed Good Opportunities	**52**

Identified Bad Opportunities	**507**
False positives	**43**

Figure 8 – Table of opportunities processed by the innovation system

The elements of this table are:

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- Top 3 rows – The number of opportunities that were launched in each category
- Middle 3 rows – The false negatives opportunities that should have been launched but did not make it through either because of lack of resources or bad decisions.
- Identified bad opportunities – Correct decision not to advance the opportunity
- False positives – The number of 'Bad' opportunities that made it through and were launched

In addition, an Excel spreadsheet called '**Model Output**' is created that contains much more detailed data about each run that is done.

Example Results and Analysis

The following graph shows the revenue growth of three different scenarios. For all three runs, everything was kept the same[3] except for turning on the strategic innovation path and increasing the innovation maturity level of the company (see below).

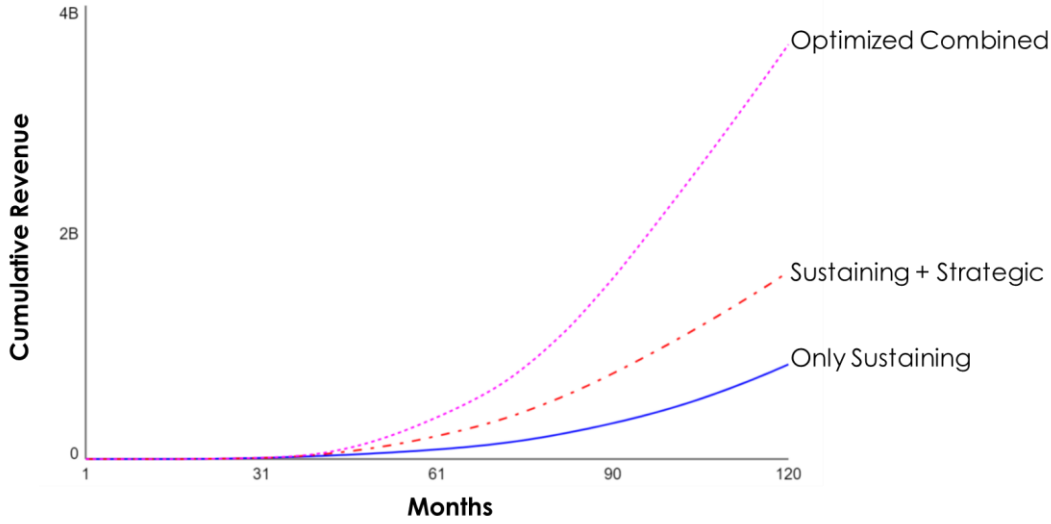

Figure 9 – Three runs of the Model

In these runs, a certain percentage of initial opportunity ideas (in this case 80%) are sustaining and the rest are strategic. These ratios can be adjusted by type of input channel. In all three scenarios discussed here, the ratio of sustaining to strategic opportunity ideas entering the system was approximately 80/20 percent. The system was run with an input rate of 5 new ideas a month in each of the three input channels and nothing in the pipeline and no backlog (these can all be adjusted).

The model can be run using just the sustaining path or with both sustaining and strategic paths. Initial opportunity ideas are triaged into the 'correct' path (there is an underlying error rate) where they move through the process.

The three runs all use the identical starting conditions and model parameter values except as follows.

[3] This included the number of ideas input per month, distribution and values for implicit value and distance from core, base error rates, time delays for different opportunity types, innovation resources available, and many other parameters.

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- **Only Sustaining** – A company has only one path for bringing new ideas to reality and all opportunity ideas flow through this path (a new product development process based on Stage-Gate®). The firm's innovation maturity level is set to 1.5 (out of 5). This is a common level for Fortune 500 firms.
- **Sustaining + Strategic** – A company has created a separate, strategic path so that opportunity ideas can be triaged into the appropriate path based on their attributes, e.g., their uncertainty level and distance from the core. The firm's innovation maturity level remains set to 1.5 (out of 5).
- **Optimized Combined** – Everything remains the same as the Sustaining + Strategic configuration except that the firm's innovation maturity level is increased to 4 (again out of 5).

The following tables provide a look at what's behind the revenue curves shown in Figure 1. The rows in the tables represent the outcomes of opportunities that have gone through the system.

- **Good, Great, Blockbuster** – opportunities that have made it through to launch and adoption and are generating (positive) revenue
- **Missed (Good, Great, Blockbuster)** – opportunities that would have generated revenue but that never made it through the system either because of lack of resources or a false negative decision
- **Identified bad opportunities** – opportunities that were appropriately weeded out during the innovation process
- **False positives** – bad opportunities that made it through to launch and adoption and are generating insufficient revenue

Only Sustaining
Firm Attributes & Governance = 1.5
Strategic System = Off

Blockbuster Opportunities	0
Great Opportunities	27
Good Opportunities	129
Missed Blockbuster Opportunities	63
Missed Great Opportunities	158
Missed Good Opportunities	132
Identified Bad Opportunities	433
False positives	3

Sustaining + Strategic
Firm Attributes & Governance = 1.5
Strategic System = On

Blockbuster Opportunities	2
Great Opportunities	43
Good Opportunities	76
Missed Blockbuster Opportunities	79
Missed Great Opportunities	73
Missed Good Opportunities	75
Identified Bad Opportunities	392
False positives	58

Optimized Combined
Firm Attributes & Governance = 4
Strategic System = On

Blockbuster Opportunities	5
Great Opportunities	96
Good Opportunities	145
Missed Blockbuster Opportunities	66
Missed Great Opportunities	15
Missed Good Opportunities	16
Identified Bad Opportunities	530
False positives	21

Turning on the strategic innovation path had a significant positive effect on value creation as did increasing the firm's innovation maturity level. The difference in value creation comes about because of the increased ability to identify and launch blockbuster and great opportunities.

The following diagram shows the effect of turning on the strategic path on the opportunity backlog.

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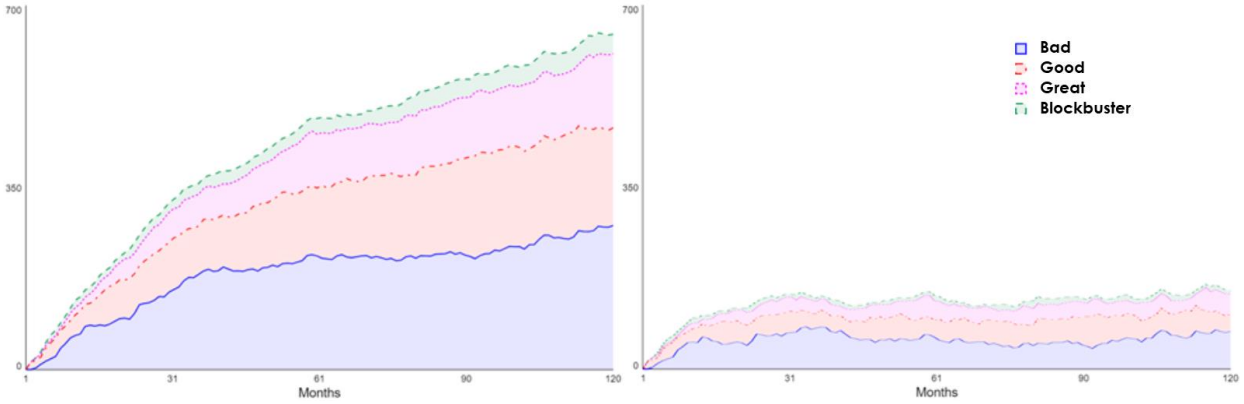

Figure 10 – Opportunity backlog without and with the strategic pathway turned on

The left chart shows the system operating without the strategic pathway turned on. As can be seen, opportunities pile up over time and do not make it through the system. On the right is the system with the strategic pathway turned on. Opportunities make it through the system and do not accumulate.

Insights and Analysis

Examining the output charts and tables gives an indication of what is happening within the system. Examination of internal model intermediate outputs sheds further light on what is happening just with these three runs varying only the two parameters Strategic pathway on-off and Organization Maturity Level. The following table summarizes what the model shows is going on.

	Without a Strategic Path	With a Strategic Path
Input Bias	People submitting new ideas to the system self-sensor.	People feel free to submit ideas that are further 'out there'.
Competition for Attention	Uncertain opportunities further from the core get killed or stalled because they are much less common and are drowned out by the larger volume of sustaining opportunities	Uncertain opportunities are competing for attention and resources with others like them. They don't need to contend with the vast volume of sustaining opportunities.
Difficulty of work	No ready support for iterations, pivots, redesigns and longer delays and time until launch. Issues get handled as exceptions.	Iterations, experiments, pivots, etc. are built into the process and don't require exception handling.
Decision Uncertainty	The right metrics aren't in place. Information is incomplete and ambiguous resulting in subjectivity and cognitive biases slowing decision making down and increasing errors.	Decision-making is designed for decisions under uncertainty and incomplete information. Competition creates options. Cognitive biases are minimized.

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Organizational Acceptance	There is no good 'landing place' and an opportunity may find a business unprepared or uncommitted. Pushback from the business torpedoes even the best strategic opportunities.	There are multiple possible paths to sustainability that may not involve an existing business. Transitions done when both the opportunity and the organization are ready.

The model shows that a company achieves much higher growth if strategic opportunities have a strategic path to follow from idea to reality – and that sending opportunities down the pathway THAT IS suitable for their uncertainly level is critical. The model reveals other observed behavior as well:

1. Putting strategic opportunities (especially ones farther from the core) through the sustaining path 'gums up' the sustaining path making it more difficult for sustaining opportunities to make it through. The main reason for this is that a lot of resources can be spent on strategic opportunities that ultimately get rejected or sidelined. These are resources that could have been better spent on accelerating sustaining opportunities through the pipeline. Because the sustaining path is 'biased' against strategic opportunities, very few false positive errors are made, but this is at the expense of a lot of *false negatives* including potential blockbuster and great opportunities.
2. Turning on the strategic path does two things. It enables the sustaining path to only deal with sustaining opportunities (with some minor misidentification rates). It shifts the more uncertain, harder to understand and assess opportunities over to a new Discover-Incubate-Accelerate strategic path where knowledge accumulation and decision-making processes are designed for experimentation and iteration.
3. Firm attributes and governance matters. A company's innovation maturity level, culture and mindset affect the speed and quality of knowledge accumulation and decision making and makes a big difference on economic value creation, even with everything else being equal.

This one experiment using the model has created several insights that can now be validated by looking at the actual outcomes and behaviors of specific companies and the innovation systems they employ. On first pass, these results look reasonable based on interviews and project engagements with numerous Fortune 1000 companies.

Conclusion and Future Possibilities

In the system dynamics model created to examine how innovation happens at a firm, initial ideas enter the system and are turned into opportunities that flow through a system where knowledge is gained, uncertainties are addressed, decisions are made, and offerings are launched into the market. The ultimate measure of the model's operation is if the mapping of input flow to output results resembles what is seen in the real world. At first approximation, this seems to be the case.

Some pertinent aspects of the model are:

- **Input flow** – initial ideas come from many places. The quality of these flows matters.
- **Decision errors** – False positives and false negatives are common. Tools for reducing these rates (i.e., improving governance) will have a significant effect on outcomes.

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- **Resources** – The availability of resources, especially funds to invest in incubation, is critical.
- **Outcome distribution** – Blockbuster opportunities are rare and have the most difficulty making it through. Better mechanisms for identifying and promoting these will have a huge effect.
- **Development path** – Having a separate strategic pathway makes a big difference.

This model is by no means definitive. It is instead a first approximation of innovation dynamics that was built, in part, to see if these types of approaches can be valuable in examining how innovation happens at large firms. The initial evidence is positive. More work needs to be done both using and improving the model to see what it says about innovation in the real world and being able to translate the numerous ambiguous terms, definitions and descriptions used by innovation practitioners into precise structures, processes and behaviors that can be addressed through new approaches and tools.

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