Innovation Pipeline Management: Lessons Learned from the Federal Government and the Private Sector

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1. Introduction and Goals

The Assistant to the President, Chief Technology Officer, and Associate Director of Technology at the White House Office of Science and Technology Policy (OSTP) asked the IDA Science and Technology Policy Institute (STPI) to examine innovation pipelines in a range of public and private organizations and to identify practices that may be relevant to a broader set of government innovation programs.

There are several government initiatives to promote innovation, both within and across government agencies. Some are intended to eliminate waste by bringing in a "skunk works" style external group along the lines of Technology Fellows programs or the Food and Drug Administration's Entrepreneurs in Residence. Other involve providing innovation funds within agencies to promote new ideas for fulfilling the organization's mission and providing better services at a lower cost, such as the Department of Education's Investing in Innovation (i3) fund.

We examined a subset of government funding programs in detail to see if lessons from these programs and others in the private sector could be replicated in government funding organizations to help them better manage their innovation processes. Table 1 includes a non-exhaustive list of Federal Agencies and programs (old and new) with approximate funding levels in 2011.

Table 1. Federal Agency/Programs and Funding

Agency/Program Name	Approx Funding (2011) USD
ARPA-E	173M
CDC Innovation Fund	1M
CMMI	1B
DARPA	3.1B
Investing in Innovation (i3)	150M
NASA Innovation Fund	50M
ONR Rapid Innovation Fund	24M
Social Innovation Fund	13M
VAi2	100M
Workforce Innovation Fund	380M[a]
TOTAL	$4.99B

Sources: See Appendix A.

[a] Requested for FY2012.

Using information from a review of the literature and discussions with innovation leaders in the private and public sectors, we identified practices that could serve as models for government agencies seeking to improve their innovative capacity by creating realistic visions, sourcing early stage ideas, implementing a phase-gate (or stage-gate) selection process, providing funding, and scaling-up the best ideas. The following sections summarize these practices. See Appendix B for details about our methodology.

Note that the practices showcased here are illustrative only; innovation is a broad and fluid concept, and not all practices can be transferred between the private and public sectors or between different agencies with different missions. While we acknowledge this potential for non-transferability, we present these general practices from the public sector and private industry together by innovation pipeline stage and allow readers to examine the practices most relevant to them through detailed discussion summaries in Appendix C. We begin with a brief definition of the term "innovation pipeline."
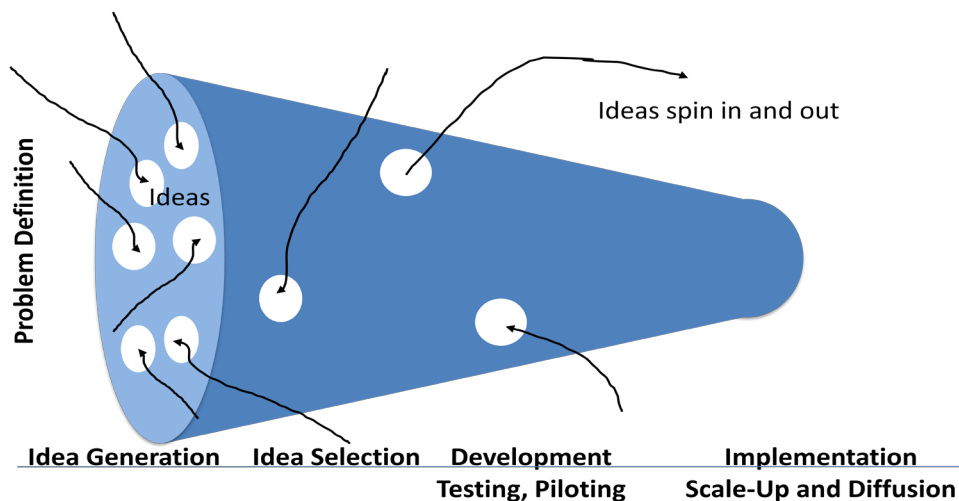
2.   Defining the "Innovation Pipeline"

While it is by no means a linear process, innovation is typically visualized as a "pipeline," which includes inputs, processes, and outputs. The term "innovation pipeline management" is an umbrella term used to describe the process used to analyze and manage early-stage concepts (O'Connor and Ayers 2005; Paulson, O'Connor, and Robeson 2007; Rosenø 2008).

These activities are generally described as an arrangement of phases that could be distilled down to five general categories: visioning and problem definition; idea generation; idea selection; developing, testing and prototyping; and implementation, scale-up and diffusion. Some experts characterize the pipeline as a "funnel" (as distinct from a straight-lined "tunnel"), with a high number of ideas in the early phases, combined with mechanisms to develop, evaluate and select the most valuable ideas (Hayes 1998, Jost, Lorenz, and Mischke 2005). The funnel highlights the boundary of the organization, and emphasizes the stage gate process of the innovation. In recent years, the process has been viewed as being "open" with ideas coming in and out of the system at all phases—see notional "holes" in the diagram below (Chesbrough 2004). Figure 1 presents these ideas in a notional diagram. Despite the linear look, the process is a continuous cycle with feedback loops between each stage, and where learning occurs through up- and downstream activities.

Note: Feedback loops between stages are implied, not shown.

Figure 1. Notional Innovation Pipeline

These phases are not always distinct or separate, but it is worth considering them separately, as such a conceptualization reinforces that the innovation process does have different stages, and that it is possible that different skills and methodologies will be needed at each stage. For example, idea generation is often about creativity, whereas idea selection needs to be informed by careful analysis, understanding of the problems at hand and the strategy and constraints facing the organization. Successfully scaling up, commercializing, or diffusing ideas depends on being able to distill the core attributes of the innovation, how and why it worked, and understanding what key aspects need to be replicated for it to succeed in different contexts.

The latter stages of the pipeline tend to require greater focus on project management skills whereas earlier phases require greater focus on managing how new ideas are generated and converted into implementable plans. The actual implementation of these phases is highly dependent on the organizational goals and culture.

3. Leading Practices by Innovation Stage

A. Problem Definition

> **Problem definition** refers to up-front articulation of the vision of an agency or program. While this stage is not always exclusively separated from idea generation, some conceptualizations of the innovation pipeline include a specific stage before ideation where a problem statement and boundaries are introduced that will guide the innovation process (Bonvillian 2011).

The innovation process starts with a pre-ideation visioning or problem definition phase, during which the goals and expectations of the process are articulated. Visioning brings focus to the innovation activity, ensuring that it is aligned with the organization's goals and mission and beginning to define milestones and targets for different aspects of the innovation. Different organization types can lead to different goals of the visioning process: within government, DARPA leaders, for example, define a challenge based on a mission need, whereas businesses typically target a gap in the marketplace. However, a common characteristic of a well-executed visioning process is the management of uncertainty by starting with a partial vision and gradually refining into a more developed idea and program. Visioning is typically led from the top, but can be executed through a grassroots process where different people bring different expertise to help define different pieces of an innovative idea.

This section briefly describes the visioning process at two government (Defense Advanced Research Projects Agency (DARPA), Department of Energy's Sunshot Initiative) and two private sector organizations (Boeing and Apple).

Practice # 1—The Defense Advanced Research Projects Agency (DARPA) was established in 1958 to "prevent strategic surprise from negatively impacting U.S. national security, and create strategic surprise for U.S. adversaries by maintaining the technological superiority of the U.S. military."[1] Carlton (2010) and Bonvillian and Van Atta (2011) describe the unique approach in which DARPA develops its vision:

- **Articulate the challenge rather than a technology solution.** DARPA leaders do not articulate an overarching vision; instead, they articulate challenges. These challenges, which are discussed internally on a rolling basis, focus on the prevention and creation of threats that are relevant now, and in the near future. Based on this identification of the articulated threat, the Agency Director hires a program manager who refines the vision

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[1] DARPA website: http://www.darpa.mil/our_work/.

of the challenge—this refining and fine-tuning of the vision occurs primarily at the program level rather than the Agency level (see Figure 2).

Source: Carlton (2010).

Figure 2. Level of Visioning at DARPA

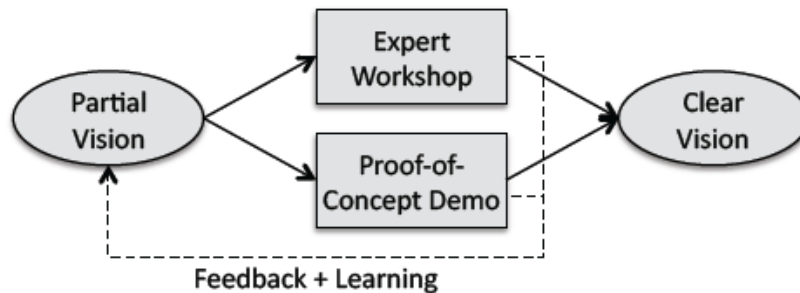- **Clear dimensions of the vision.** Since its early days, DARPA created a catch phrase known as "DARPA Hard." A DARPA Hard vision has four attributes (Carlton 2010), as depicted in Figure 3. It typically addresses a "wicked problem"—by focusing on these types of problems at DARPA, program managers ensure that they push the limits of innovation sought. It is actionable—program visions are intentionally grounded in reality because they are expected to improve and extend the limits of existing technologies. It is multidisciplinary—program managers redefine problems outside of usual boundaries, drawing from more than one discipline. Last, but not least, it is far-reaching—DARPA program managers think big, and plan long-term in order to have a broad impact in society.

Source: Carlton (2010).

Figure 3. Emergent Path to Vision

- **Iterative development.** Typically, the DARPA Hard vision is set through its program managers, who are hired deliberately for their visions of technology, even if partially formed. DARPA leadership recognizes the limitations of their initial missions, and program managers use two primary mechanisms—expert workshops and proof-of-concepts—to go from partial into clear visions. Through expert workshops, program managers engage their networks, and the networks serve as a way to gain perspective through dialogue among trusted colleagues. Proof-of-concepts explore and test the

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feasibility of an emerging idea. Each proof-of-concept serves as a directed demonstration, a way to demonstrate feasibility and test early intuition before undertaking a new technical initiative. (Carlton 2010, Bonvillian and Van Atta 2011).

Practice # 2—The Sunshot Initiative at the Department of Energy (DOE) provides a public sector example of effective visioning to similarly define an ambitious quantified innovation problem. Sunshot's stated goal is to reduce the installed cost of solar energy systems by 75% over the next decade (to $1 per Watt installed) to achieve full competitiveness with fossil fuels for electricity generation. Starting with this broad goal of aggressive cost reduction, DOE convened experts from the solar industry, consultants, academia, and the public sector through a series of workshops to discuss how realistic such a large cost reduction was and how quickly it could be achieved. The department convened these diverse experts to discuss not only the cost reduction goal and timeline, but also organizational structure to help solve the crosscutting problems to achieve the goal. After the initial scoping workshop, Sunshot has continued to engage external experts on visioning for different subparts of the overall innovation challenge, such as for different types of solar generation technologies and components. Similar to Boeing's strategy of engaging diverse experts within its organization (see below), the Sunshot Initiative shows how engaging a diverse set of experts can lead to specific goals and timelines for innovation projects.

Practice # 3—At Boeing, the world's leading aerospace company and the largest manufacturer of commercial jetliners and military aircrafts, visioning begins through gap identification by senior leadership, who utilize Intellectual Property and R&D strategies to identify gaps the company may wish to move into. A manager may identify a new business area for the company, and she moves to gather market information to identify the potential. However, importantly, at this point the idea may lack vital content, such as a marketing or manufacturing strategy, a feasible delivery timeline, even whether someone else in the company is already working to move into the market. The "idea fragment" thus needs further definition that can only be achieved through interaction with others in the company who may be experts in these different areas. These new interactions may bring different ways of thinking, new "idea fragments," and different pieces of information relevant to more fully defining the innovative idea and the process to make it work.

Boeing utilizes ideation software to bring together relevant experts in these different areas of the company around the manager's "challenge question" about how to target her innovative idea fragment. By encouraging interaction with a diverse set of experts in different parts of the business, the original idea fragment can become more refined and eventually turn into a cluster of idea fragments that can help bound a plan including initial estimates of cost, market size, and date of delivery. Previous iterations of Boeing's innovation system allowed employees to bring any type of idea into the process, but this led to a fragmented set of ideas that lacked an integrated strategy and the support of senior management. The new process brings together

management support and experts on the ground to identify an achievable innovation goal with quantified targets and deadlines that can be developed further down the pipeline.

Practice # 4—Apple Inc., one of the world's best-known technology companies, has become a leader in innovation by changing the way that people interact with the technologies that they use. This has enabled them to create new markets at the convergence at the communications, music, and entertainment industries in ways that no one had done before them.

Apple's success in defining a vision comes from a keen sense of the customer and the market by immersing themselves in the customer environment and asking lots of "why" questions to explore the ins and outs of customer decision making (Breillatt 2008). Apple's innovation process does not go the conventional route of gauging customer needs by market research, but by studying the behaviors of those who they think will be their early adopters, and focusing on removing barriers to technology adoption from their perspective. The company also has a significant number of collaborations that allow it to move beyond a loosely complementary set of products and services towards a unified solution that allows their customers to use their products seamlessly. Thus, Apple's innovations reflect their vision of tapping into the "latent" needs—existing, but not yet articulated—of their customers.

B. Idea Generation

Idea generation or ideation refers to finding, adapting or creating the original set of ideas. Working within the vision/problem definition, different members of the innovation team add different ideas for accomplishing the innovation goal.

Ideas for new business products or government services can come from either inside or outside the innovative organization. In general, ideation from inside an organization can lead to small changes in how a product or services made or delivered, since the organization's employees have detailed knowledge of these processes. External ideas can be useful for plotting new courses of action, new products, or new processes for an organization to achieve. An organization may be biased toward the status quo, and outsiders can bring fresh perspective on market or service opportunities.[2] There are notable examples of both grassroots and outside idea generation practices in the public and private sector.

Grassroots idea generation, a process which allows employees who may not be in decision-making positions to bypass management approval and initiate or follow through on an innovative idea, does much to infuse a culture of innovative thinking and risk taking within the organization. However, grassroots idea generation can only lead to innovation when employees

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[2] Government agencies can make innovative use of procurement instruments to bring in a diversity of ideas than is possible with the status quo. For example, the Department of Veterans Affairs' VA Innovation Initiative (VAi2) switched from the use of Request for Proposals (RFP) to Broad Agency Announcements (BAA) to solicit proposals to address specific challenges. This switch allowed them to define their output requirements, rather than the methods to get there, thereby increasing the quality of proposals received.

are encouraged to act on their ideas. This section provides brief descriptions of ideation practices at Health and Human Services, Amazon, Procter & Gamble (P&G), and Apple.

Practice # 1—The HHSinnovates program in the Department of Health and Human Services provides one example of grassroots idea generation. HHSinnovates is a program aimed at recognizing and fostering a culture of innovation, while making use of technology platforms to overcome the challenges of implementing the program across a large and varied agency. The goal of the program is to highlight innovation occurring within HHS and spotlight and incentivize innovators via recognition from agency leadership. An integrated IT platform also provides an agency-wide repository of innovative ideas that everyone can access, may use and perhaps expand upon.

An HHSinnovates contest typically solicits ideas that originate from collaborations among HHS employees, and can potentially be scaled-up or have broad applicability across the entire agency. The visibility afforded by the contest has allowed some ideas to become bigger than originally anticipated (such as the "text4Baby" service administered by the National Healthy Mother Healthy Baby Coalition) or find a much wider usage across the agency (such as the National Database for Autism Research (NDAR), a data repository and portal which is used by several divisions within the HHS).

Practice # 2—In the private sector, the online firm Amazon.com Inc., a multinational electronic commerce company and the world's largest online retailer, is an example of how grassroots innovation can be incentivized and rewarded from senior management. CEO Jeff Bezos is a champion of small innovations that can increase efficiencies and reduce costs of delivering Amazon's products to its customers. Employees are incentivized to move forward on their innovative ideas quickly without waiting for management permission through a "Just do it" award that is presented to an employee for implementing a well thought out idea to increase efficiency. Because senior management is involved, employees know that they will not be penalized if their idea does not work perfectly. Management makes it clear that it is continually trying to remove barriers to innovation, so new ideas are always welcome.

Practice # 3—Proctor and Gamble (P&G), a Fortune 500 American multinational corporation that manufactures a wide range of consumer goods, uses its Connect and Develop program to look outward and tap a vast proprietary supplier network, web-based talent markets, entrepreneurs, academics and government labs to connect with external sources of new ideas. An internal analysis of customer needs and adjacency maps results in technology briefs that define the specific problem the company is trying to solve. These briefs are then sent to networks of technology entrepreneurs and supplier networks worldwide who tap into a wide range of government and private institutions to identify promising product ideas and technologies for the company. In this way, P&G is able to leverage the talents of a potential 1.5 million researchers and idea generators in its worldwide network, in addition to its 7,500 strong research staff. The company then applies its own R&D, marketing, manufacturing, and purchasing ideas to further

develop the sourced ideas, and create better and cheaper products in a shorter timeframe (Huston 2006).

Practice # 4—Apple Inc.'s strategy for idea generation (and indeed selection) follows a non-linear, emergent process, walking the line between creativity and product strategy. The process draws on intense brainstorming sessions by Apple's design and product teams where the emphasis is on no-rules-involved creative thinking alternating with solution-focused production meetings. The production meeting is used to ground the ideas in some structure, rules, and limits, which are deemed essential to focus the problem solving process. This process allows the different people within the company to present diverse views, while at the same time moving the ideas towards a cohesive concept. This way, an overall product strategy emerges out of directed creative thinking, keeping options open to the best extent possible while slowly moving towards a production mindset as the process progresses.

C. Idea Selection

Idea selection refers to picking which ideas to pursue for further development. In most cases, the selection phase refers to a process designed to elicit progressively more detail about a concept. The intent is to gather the necessary and sufficient information to justify allocating the minimum funds to advance a concept to the next phase or relegating it to the repository. Each of the selection sub-phases are increasingly more costly, in the sense of the level of effort required.

A large number of ideas from an initial solicitation typically need to be down-selected to a tenth or less. The initial stages of the innovation pipeline, particularly the idea selection process is about managing uncertainty (as opposed to product strategy, which is about managing risk[3]). The idea selection process is typically staged, with increasingly detailed criteria and rigorous questioning as the concept is transformed into a viable strategy. Three idea selection strategies in government and the private sector are summarized below.

Practice # 1—Procter & Gamble (P&G) has a corporate innovation fund to for supporting early-stage innovation. A new idea is typically funded following a staged selection process during which the innovating team is asked to pitch their idea to senior management, facing increasing rigor in criteria and questioning as the ideas move up the chain. The team initially has 90 days to "stage gate" the idea to the CTO and the innovation program managers, by answering "killer questions" about the value of the idea to the company.

The close involvement of senior management during the selection process has two big advantages, among others: from their position at the "seams," senior leadership is often able to see a broader applicability for a new concept than people who are closer to the idea might. They are also able to foster the development of a new idea in a business unit or organizational group

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[3] Risk and uncertainty are distinct concepts. Typically, risk involves both a perceived uncertainty by the individual concerned, and *exposure* to that uncertainty. From this vantage-point, risk is defined as "exposure to a proposition of which one is uncertain" (Holton 2004).

where it is not overwhelmed by "corporate antibodies" or if it does not fit into the existing culture.

Practice # 2—A key to ensuring a competitive selection process in the government is transparency. A culture of transparency can do much to encourage innovation from within, and ensure that the best ideas go forward. As part of the 'Open Government Initiative, the Department of Education launched "data.ed.gov" as a portal to publish data about its grant programs, allowing the education community to access and analyze the data on their own. The first competitive grant program featured on this portal is the Investing in Innovation (i3) Fund which establishes a "pipeline" of funding to generate new innovations, rigorously validate the effectiveness of promising programs, and scale the most effective across the country.

The i3 program solicits proposals from state and local educational agencies, nonprofits and school consortia; the applications are rated in a peer review process by an external group of reviewers. The program has embraced an unprecedented culture of transparency by providing detailed information on all the applications on their open government website at the close of the contest application deadline (Table 2 below lays out the Fund's evaluation criteria). For the highest rated applications, a detailed narrative, including reviewers comments and raw scores are also made publicly available on the open government website. In addition, i3 encourages public-private partnerships by requiring its grantees to obtain a set amount of matching funds as part of the award criteria.

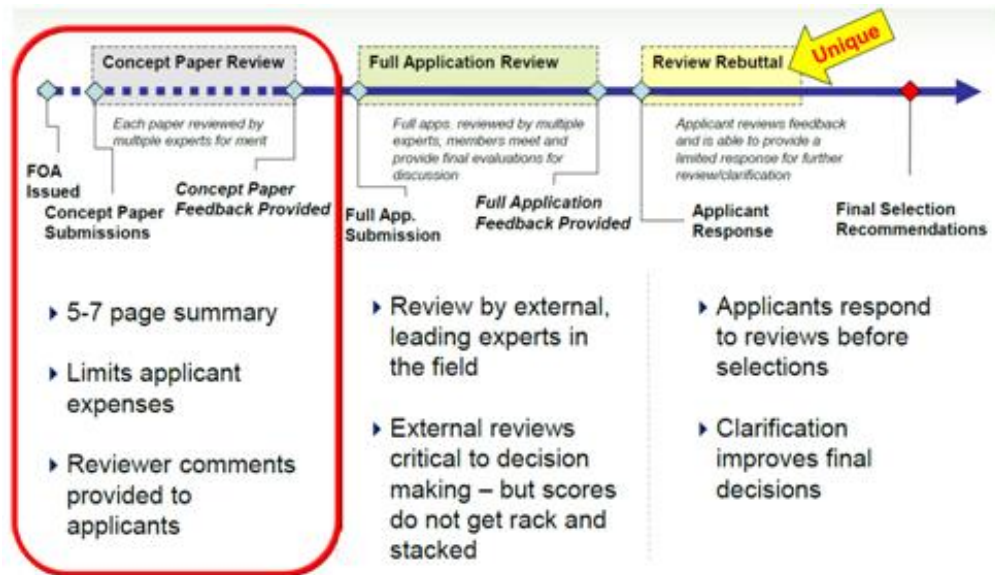**Table 2. i3 Selection Criteria and Weights**

Selection Criteria	Development	Validation	Scale-up
A. Need for the Project	35	25	30
B. Quality of the Project Design	25	25	30
C. Quality of the Project Evaluation	20	25	20
D. Quality of the Management Plan and Personnel	20	25	20
Total Points	100	100	100

Source: http://www.aasa.org/uploadedFiles/Policy_and_Advocacy/files/i3-at-a-glance_FY2011.pdf.

Practice # 3—Developing an increasingly rigorous staged selection process with feedback loops ensures a high level of quality and accountability from the selecting panel. The Advanced Research Projects Agency-Energy (ARPA-E), created within the Department of Energy (DOE) in 2009 as part of the America COMPETES Act to "foster disruptive innovation in the complex, established legacy sector of energy"—while still new, offers a model here—a review process that gives applicants the ability to interact with program staff and provide rebuttals of their application reviews.

Figure 4 illustrates the Agency's 3-stage selection process starting with a call for concept papers (which are selected for subject matter relevance) followed by a full-length application

submission. A unique feature of the review is the third stage, where the solicitation process is re-opened for the applicants to review all comments and provide a short rebuttal, which could include new data. This "second shot" and "feedback loop" makes the program managers more careful with respect to their review (since they know that their conclusions will be critiqued), and the agency better educated on technology developments. More importantly, it has resulted in a number of reconsiderations of application, as reviewers may not completely understand an innovative technology upon first view. By allowing the proposer to rebut reviewer comments, the agency will understand the technology and its risks better, improving the quality of the overall portfolio.

Figure 4. ARPA-E Idea selection and Review Process

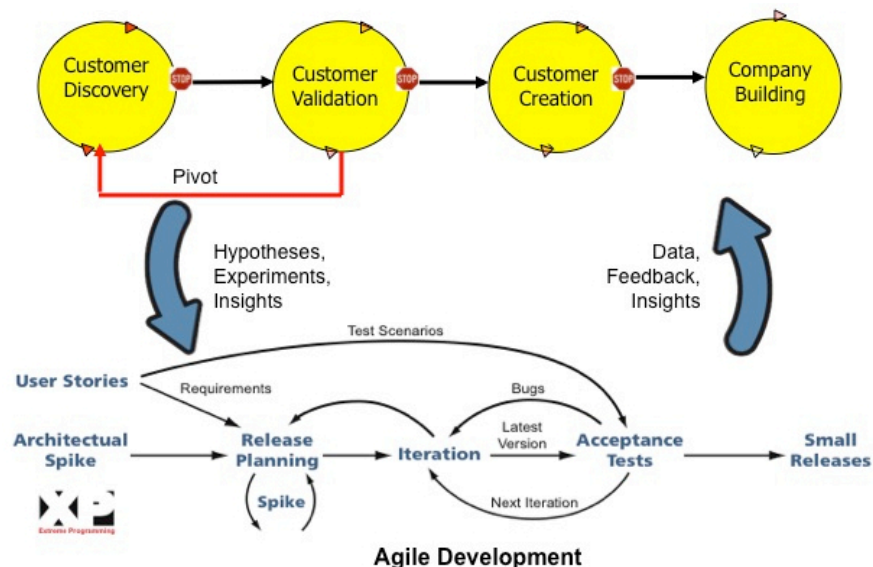## D. Development, Testing, and Piloting

Development, testing and piloting refers to the evolution of an idea or concept towards a viable product offering, which must then be piloted to an early-adopter community. Evidence of consumer interest or market need and alignment with organizational strategy are some of the crucial factors that launch a successful prototype from a pilot to an implementation and scale-up phase.

Because of increased access to open source, agile software, and iterative development in recent years, it has become possible to test and prototype faster with much less waste. This allows for hypothesis-driven experimentation, and its underlying concept is that of "build-measure-learn feedback loops"—take an action, make something, measure, have users respond, learn from data, use to impact next idea—on a fast turnaround basis (Ries 2011). This section

briefly describes approaches at Nordstrom, CMMI and ARPA-E. While all are nascent organizations, the practices are interesting enough to be highlighted.

Practice # 1—The Nordstrom Innovation Lab within the upscale department store chain Nordstrom, is an example of hypothesis-driven experimentation at a large corporation. The Lab is a collaborative workspace housed in the Office of the CIO, uses ideas from both the concepts of lean manufacturing and lean startup (See Figure 5), and tests its experiments with "customers using human-centered design strategies and tactics" (as described by Ries 2011). Only ideas with a high uncertainty associated with them filter down to the lab, and are tested on a short-turnaround basis (the longest experiment is four weeks long). In some cases, the lab sets up shop physically in a retail store for the entire week where they build products, test new features, and get feedback all out on the retail floor. By talking face-to-face with customers, salespeople, and managers in a physical store, the innovation team is able to identify an opportunity that they can execute against extremely quickly, in weeklong increments. These simple, rapid, experiments allow the Nordstrom Innovation lab to identify a "minimum viable product" (or process)[4] which can help test and prototype ideas quickly, taking weeks and months, not years. This allows services and products to be built on the micro scale level, and scaled up iteratively.

Once the lab shows an idea to be viable and feasible, the sponsor of the idea with the lab "pitches" it to the Innovation Committee (which comprises the senior leadership of Nordstrom). The Innovation Committee acts as a venture fund, and depending on the strength of the business plan presented, either funds the idea for scale-up or not.

Source: Blank (2010).

Figure 5. Illustration of the "Build-Measure-Learn" Feedback Loops

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[4] An MVP is that version of a new product that allows a team to collect the maximum amount of validated learning about customers with the least effort.

Practice # 2—CMMI's Pioneer Award initiative is an example of hypothesis-driven experimentation in the government. Established under the Affordable Care Act (2010), CMMI's goal is to transform the way that healthcare is delivered for Medicare and Medicaid patients by rapidly testing innovative care and payment models that are patient-focused and encouraging widespread adoption of practices that deliver better health care at lower cost. CMMI has launched a Pioneer Accountable Care Organization (ACO) initiative, which accepts solicitations from groups of providers who have experience working together providing care for patients.

Selected after a rigorous competitive process, the ACOs are required to demonstrate the effectiveness of their proposed innovative payment models and to demonstrate how they can help experienced organizations to provide better care for beneficiaries. The ACOs selected for the pioneer awards are given 18 months to implement their ideas on a small scale, at the end of which they are evaluated on raw data (claims data recording patient experience) as well as pre-set quality measures. At the end of the pilot phase, the most effective solutions will be scaled up.

Practice # 3—ARPA-E, while still a nascent Agency, emphasizes rapid diffusion of research breakthroughs via testing, prototyping and piloting through a process it labels ''Envision-Engage-Evaluate-Establish-Execute.'' (Bonvillian and Van Atta 2011)

In order to develop and test technologies, ARPA-E ''in-reaches'' within DOE to move its technologies into application, and has created ties to DOD for possible test bed and initial market capability. DOD and ARPA-E have recently collaborated on projects for use in military installations, such as battery storage and power electronics for micro-grids and highly energy efficient cooling (Hourihan and Stepp 2011).

ARPA-E program managers use aggressive milestones, which serves them well during testing and prototyping stages. They have regular contact—at least two site visits a year, and formal quarterly reviews with all awardees. In addition, they help identify and resolve technical issues, and hold annual community meetings. While in most research agencies, the job of the program manager is to select the awards, at ARPA-E, program managers view their jobs as technology enablers, helping stakeholders with implementation barriers. Constant monitoring and interactions enable the program officers to cut projects as needed. If the Primary Investigator (PI) starts missing milestones, the milestones are either renegotiated or given one more quarter before the project is terminated. To date, ARPA-E has stopped 6 out of 120 projects, although 20–40 percent of the projects have received some form of a warning regarding milestones.

E. Implementation/Scale Up

> **Idea implementation** refers to putting the ideas into practice, keeping the innovative initiative going and integrating it, which includes monitoring and adapting where necessary, and diffusion (sharing and spreading the ideas).

In terms of conceptualizing the pipeline, once the product or idea has been developed and tested, it moves from the innovation to the product pipeline. The final version of the product is piloted before a small test audience to gauge customer reaction before committing the resources to a full-scale roll-out, and at this point the organization draws upon its operational and managerial experience to successfully scale-up and/or commercialize the product.

In the public sector, scale-up and deployment are as much a function of policy and economy as technology or program structure. Thus, it is crucial for agencies to put in place policy mechanisms that support the scale-up process. This could range from building community support for product deployment to obtaining congressionally mandated authority to internally approve deployment. This section highlights emerging implementation-related practices at CMMI, DARPA, ARPA-E and P&G.

Practice # 1—In government agencies, policy and regulation play a central role during the deployment of a product or service. Therefore, a key to successful scale-up is to identify or establish a policy mechanism that can make this process efficient. The Centers for Medicare and Medicaid Innovation (CMMI) is an example of a fund that has a legislative mandate to quickly scale up and roll out an innovative program which has been demonstrated and validated.

The CMMI's Pioneer Accountable Care Organization (ACO) initiative awards groups of providers (ACOs) who have experience working together providing care for patients. The ACOs have 18 months to demonstrate the effectiveness of their proposed innovative payment models. At the end of the designated trial period, the successful programs will result in new across-the-board regulations in the way Medicare and Medicaid service providers deliver and are paid for their services. This roll-out of changes in health care policy is anticipated to occur in fewer than six months, a large part of the reason being that the CMMI has the legislative mandate to implement them.

Practice # 2—Agencies keen on scale-up and implementation can adapt several aspects of the DARPA model. Two in particular stand out. First is DARPA's role as a convener and instigator in the community of what Bonvillian and Van Atta (2011) term ''change-state advocates.'' Developing a broad community creates a close-knit network of individuals who know and trust each other, breaking down information/collaboration barriers. This community confluence, in turn, creates a connection with the private sector and its ability to spur implementation.

A related second is DARPA's funding approach. DARPA requires entities from multiple sectors including academic researchers, small companies, and ''skunk works'' operations of

larger corporate R&D shops to work together. This enforced partnership ultimately has the potential to improve the handoff from research to development and ease transition from research into implementation.

Practice # 3—Similar to DARPA, ARPA-E proactively seeks out "white spaces" where it can fill a vital gap in early stage research and development (Majumdar 2011). ARPA-E's focus is not simply on new technology, but rather a plausible pathway to implementation. Program staff generally has both academic and commercial sector experience, which ranges from work in venture capital firms and companies, to participating in technology-based start-up firms. This breadth of background in both academic and private sectors assists in understanding alternative commercialization pathways (Bonvillian and Van Atta 2011).

ARPA-E has taken other steps to accelerate scale up and implementation as well, starting with encouraging consideration of the implementation process in the selection of technology projects (at the visioning phase already, they evaluate the technology "stand-up" process and how that might evolve). ARPA-E, in effect, has added a variation to DARPA's famous ''Heilmeier Catechism'' by requiring program leaders to ''tell me how your story will end and how will you get there?'' (Bonvillian and Van Atta 2011).

Within the agency, a set-aside commercialization group works with project managers to move their technologies into implementation. ARPA-E has also held two highly successful community-building energy technology summits, which helped, among others, to develop broad support community. The 2011 summit brought together over 2,000 stakeholders from across the energy ecosystem—researchers, entrepreneurs, investors, corporate executives, and government officials—to share ideas for developing and deploying the next generation of clean energy technologies, and showcased more than 200 transformational technologies and organizations.[5] At pre-conference workshops and networking sessions, participants got the opportunity to share ideas with ARPA-E program managers, global industry leaders, and energy technologists.

ARPA-E encourages industry consortia around its projects and is planning to use prize authority (Bonvillian and Van Atta 2011). Similar to DARPA, ARPA-E awards create a "halo effect" around the awarded projects, and have encouraged VCs and other private funders to use the funding as a basis for identifying "the next big thing." Since its creation, ARPA-E's $360 million in public funding have leveraged $285 million in follow-on private investment (Hourihan and Stepp, 2011).

Practice # 4—In private companies such as P&G, once an innovation has been developed and prototyped, it moves from the innovation pipeline to the product pipeline. The product strategy phase includes manufacturing, marketing and other commercialization considerations. At this point, the innovation product is housed in one of the mainline business units, which is responsible for rolling out the product.

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[5] See http://www.energyinnovationsummit.com/about/.

F. Cross-Cutting Practices

Some practices are not unique to any particular stage, and apply across the board to all stages of the innovation process. One of the most critical of these is the nurturing of a culture of innovation. This is exemplified by Amazon.com where employees are encouraged to act upon innovative ideas, and "just do it" without needing approval from management. An important element of a culture of innovation is the acknowledgement that innovations will often fail; but if it has been a learning experience, then it is not really a failure. Strong innovators believe in 'Fail fast, learn your lesson and move on' as is practiced at Nordstrom.

Another cross-cutting element of innovation is the role played by highly motivated and qualified employees. DARPA and ARPA-E have built an almost mystical reputation of hiring world-class talent. Program managers are drawn from industry, universities, and government laboratories and R&D centers, mixing disciplines and theoretical and experimental strengths. This talent is further "hybridized" through joint corporate-academic collaborations (Carlton 2010). No special authorities have been used for making such hires, and this practice needs to be incorporated more generally in the government.

To nurture innovation across all stages, the participation of individuals who sit at the "seams" of organizations, and have a broad and integrative view of the organization as well as its challenges are essential. Such individuals can combine related ideas for broader applicability. P&G is a strong embodiment of this culture.

Since innovation is about managing uncertainty, it is, by definition, hard to measure. Innovation is also too uncertain to spend years perfecting an idea. Successful innovators in government and industry cite the importance of quick and ongoing measurement against a desired outcome, so that one can quickly re-assess strategies if needed. Companies like Boeing have developed an analytical valuation model for the non-linear, emergent process though which an innovation develops into a concrete product strategy.

At the other end of the spectrum, service providing organizations such as CMMI and Amazon develop quality measures of customer responsiveness (such as reduction in the number of complaint calls, claims information documenting patient care) based on the behavior of the people before and after the innovation. Whether qualitative or quantitative, the use of metrics is an important cross-cutting element of the innovation pipeline.

4. Summary

Building on a review of the literature and discussions with innovation leaders in the government and private sectors, we have identified practices worth considering and emulating for each of the stages of an innovation pipeline. While these practices are not directly transferable as-is, they provide useful food-for-thought as government agencies transform their processes and systems to adjust to the challenges of the twenty first century.

With respect to defining the problem and creating a vision, organizations interested in effective visioning do not make the process unfettered. Their focus can be challenge-centric (as at DARPA or DOE's Sunshot Initiative), user-centric (as at Boeing or Apple) or technology-centric (as at Sunshot). Gap identification is a critical part of visioning. As at Procter & Gamble and Boeing, insights are found in both adjacent spaces and with disruptive ideas.

For the ideation stage, innovative use of technology for idea generation (open platforms, prize administration) is useful, but only if incentives for participation are built into the platform architecture (as at HHSinnovates). To leverage their efforts, government agencies could take a page from Apple's iphone app playbook, build a platform, and attract others to build alongside and on top of what they are doing.

Idea generation is enabled with a lower barrier to entry, as with Amazon.com, where suggestions can come from anywhere within and outside the organization. Innovative use of procurement instruments, as with VAi2's use of BAAs, can lead to improvements in the quality and diversity of ideas.

In certain cases, the process of idea selection can be improved when decisions are made by limited-term staff that bring ideas from the outside, and are motivated to demonstrate value during their tenure, as with DARPA and ARPA-E. Given the uncertainty associated with innovation, final decision-making should be in the hands of a small number of in-house leaders with a strong incentive to see challenges addressed, as at P&G and the ARPA agencies. While fast and decisive decision-making is important, having transparency in the process is critical too, as at Department of Education's i3 program.

For development, testing and prototyping, it may be useful to consider, as at Nordstrom and CMMI, the concept of making many small bets, and learning to fail fast and "pull the plug" if needed. This can be accomplished through hypothesis-driven experimentation with short cycles. At each of the stages, but especially toward the later ones, it also helps to set aggressive milestones, and de-fund projects that do not meet them, as is currently occurring at ARPA-E.

With respect to implementation, it is important to note that scale-up and deployment are as much a function of policy and economy as technology. So it is critical to build early linkages within the user-base and create "policy hooks" to integrate with broader/existing organization/system for quicker scale-up.

Table 3 summarizes these practices.

Table 3. Summary of Insights by Stage of Innovation Pipeline

Innovation Pipeline Stage	Practice
Problem Definition	• Visioning cannot be unbound—focused look in the challenge space or "latent" needs gives best results (Boeing, Apple) • Focus can be challenge-centric (DARPA), user-centric (Apple) or technology-centric (DOE's Sunshot Initiative) • Expert workshops and other stakeholder engagement can help create specific goals and timelines without bounding the solution (DOE's Sunshot Initiative)
Idea generation	• Use of technology-based platforms lowers barriers to participation (Amazon) • Incentive for participation—from internal or external stakeholders—are built in the system culturally and technologically (HHS*innovates*) • New ideas can come from "adjacencies" [similar solutions] (P&G)
Idea selection	• Implementation constraints are considered in project selection (ARPA-E) • External experts provide extensive input but have limited role in decision-making; process must nonetheless be transparent (i3) • Rebuttal from proposers leads to a stronger portfolio (ARPA-E) • Involvement of individuals at "seams" of the organization helps frame broader relevance (HHS*innovates*, P&G)
Developing, Testing and Piloting	• Hypothesis-driven experimentation (build-measure-learn feedback loops) leads to shorter cycles of "validated learning" (Nordstrom Innovation Lab) • Aggressive milestones set up-front enable subsequent review of projects that do not meet goals (ARPA-E) • "In-reach" (within agencies rather than outreach to others) can provide test-beds (ARPA-E, CMMI)
Implementation and Scale Up	• Incremental scale-up gives flexibility to work out bugs as program expands (CMMI) • Playing the role of convener and instigator in the community can push idea into field (DARPA) • Government funding's "halo" effect can draw VC and other funding (DARPA) • Finding a "policy hook" enables quicker scale-up (CMMI) • Working with the user-base can help integrate with broader/existing organization/system (i3)

Appendix A.
Sources of Funding Data

The sources for funding provided in Table 1 of the main text are as follows:

- DARPA—http://www.darpa.mil/WorkArea/DownloadAsset.aspx?id=2400 (page 13 "FY2011 annualized CR total"

- ARPA-E—http://www.aaas.org/spp/rd/fy2012/doe12c.pdf

- NASA Innovation Fund—http://www.nasa.gov/pdf/428439main_Space_technology.pdf

- ONR Rapid Innovation Fund—http://www.onr.navy.mil/~/media/Files/Funding-Announcements/BAA/2011/11-032.ashx

- CMMI—http://innovations.cms.gov/initiatives/innovation-challenge/

- CDC Innovation Fund—Discussion with John Kools, CDC

- Investing in Innovation (i3) —http://www.ed.gov/news/press-releases/twenty-three-investing-innovation-applicants-named-2011-grantees-pending-private

- VAi2—Department of Veteran Affairs Memo, Discussion with Jonah Czerwinski

- Social Innovation Fund—http://www.nationalservice.gov/about/programs/innovation_2011_grants.asp

- Workforce Innovation Fund—http://www.dol.gov/dol/budget/2012/PDF/FY2012BIB.pdf

Appendix B.
Methodology and List of Discussants

We followed a four-part approach to examine innovation pipeline management (IPM) related practices in the public and private sectors:

- We reviewed the literature on IPM to identify the different conceptualizations and phases of the pipeline. Based on the literature, we developed a model of the innovation pipeline, which served as the basis for further data collection.

- We conducted structured discussions with companies with the reputation of being innovative or having innovative processes, to learn how they manage their innovation pipeline activities. See Table B-1 for a list of discussants. Appendix C contains pictorial summaries of all discussions.

- Building on publicly available information and discussions with program staff, we sought to understand IPM-related activities within seven government organizations:

  – Advanced Research Projects Agency—Energy (ARPA-E)

  – Centers for Disease Control and Prevention (CDC)

  – Centers for Medicare and Medicaid Services(CMMI)

  – Defense Advanced Research Projects Agency (DARPA)

  – Department of Education's Investing in Innovation (i3) Fund

  – Department of Health and Human Services (HHS)

  – Department of Veterans Affairs' Innovation Initiative (VAii)

Table B-1. List of Discussants

Name	Organization
Private Industry	
1. Kim Rachmeler	Amazon
2. case study	Apple
3. Scott Mathews	Boeing
4. Steve Koonin	Formerly BP
5. Beth Comstock	GE
6. Mark Dean	IBM
7. Lisbeth Poulos	In-Q-Tel
8. *case study*	Microsoft
9. Henry Tirri	Nokia
10. JB Brown	Nordstrom Innovation Lab
11. Nathan Estruth	P&G
Private Sector Consultants	
12. Henry Chesbrough	Berkeley
13. Fred Dust	IDEO
14. Eric Ries	Lean Start-up
Public Agencies	
15. Shane Kosinski	ARPA-E
16. Arun Majumdar	ARPA-E (scheduled)
17. John Kools	CDC
18. Richard Gilfillian	CMMI
19. Ken Gabriel	DARPA
20. Ramesh Ramamoorthy	DOE
21. Henry Kelly	DOE EERE
22. Jim Shelton	Ed-i3
23. Cathy Conrad	GSA
24. Greg Downing	HHS*innovates*
25. Jonah Czerwinski	VAii

Appendix C.
Summaries of Discussions

Private Sector Discussions

P&G, Nathan Estruth, VP Connect and Develop (C&D)
Innovation Goal: new product, process and capability development

Visioning and Idea solicitation	Idea selection	Development, testing, prototyping	Scale-up / Commercialization
• Look internally and externally by leveraging networks of suppliers (with > 500 R&D staff), University and Government labs, VCs, entrepreneurs, web-based talent markets and competitors. • Specific problem "brief" circulated on network; P&G team also identify ideas in adjacent spaces • Ideas sourced on secure IT platform, so that no 2 suppliers can "see" each other • Sourced ideas logged into internal "Eureka catalog", distributed to managers	• C&D manager and CFO help teams make their case to Sr. management 　• 90 days to stage-gate idea 　• 2-3 "killer" questions • Match idea to business unit or house in new business orgs (FutureWorks) • CTOs and people sitting at seams try to frame idea up for broad applicability across several divisions	• Internal Corp. innovation fund, $15M, line item for company • Lots of little bets, < $3M per bucket, 2 yrs to develop • "Innovation Center Network" within company developed a "Home of the future" and "Store of the future" -- used by divisions to test ideas • Ideas housed in FutureWorks if very disruptive, or absorbed into business units at prototype	

Cross-Cutting Innovation Issues	• Staffing and Leadership: Led from the top; Venture fund led by 4 C-level executives. Leadership role crucial in pulling disruptive ideas beyond functional silos. People sitting at seams are able to frame ideas more broadly than those deep within the organization. • Metrics: Ideas sourced through external networks faster and cheaper to develop than developing internal solutions; tangible cost benefit seen. • Incentives: Incentives for managers favor external sourcing of innovation

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Apple case study
Innovation Goal: Focus on product design and user experience

Visioning and Idea solicitation	Idea selection	Development, testing, prototyping	Scale-up / Commercialization
• Focus on innovative user experiences, i.e. changing the way that people experience the technologies they use • Innovation leaders immerse themselves in the customer environment, and ask lots of "why" questions to understand customer decision making • Study the behavior of early adopters and barriers to technology use • Approach their products with a systemic frame of mind, looking to develop a "total solution" rather than loosely complementary set of products.	• 10 to 3 to 1 down selection: For any new feature under consideration, Apple designers are expected to present 10 different mock-ups; the 10 are winnowed down to 3 and finally to 1 • Paired brainstorming and production meetings – alternate creative thinking with grounding the ideas in some structure, rules and limits • Innovation team meetings with stakeholders within the organization to get everyone's buy in	• Designers build pixel-perfect mock-ups; involves a huge amount of time and work, but removes all ambiguity and surprises • Intense focus on user experience and removing barriers to technology adoption in product design	

Cross-Cutting Innovation Issues	• Staffing and Leadership: Innovation vision and focus led from the top; leadership involved in details of innovation process • Metrics: •Portfolio Management: Apple focuses on a small group of products relative to the size of the company, which is inherently risky. They approach their products with a systemic frame of mind, looking to develop a "total solution" rather than loosely complementary set of products.

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In-Q-Tel, Lisbeth Poulos, COO
Innovation Goal: Bring in IT products to help the IC stay ahead of the curve

Visioning and Idea solicitation	Idea selection	Development, testing, prototyping	Scale-up / Commercialization

• Outward focus, cast a wide network, face to face with over 750 start-ups/year
 	
• Emphasis on competitiveness and dual-use
  • Look for companies that generate VC interest
  • Look for products being developed for commercial markets
  • Platform technologies
 	
• Constant contact with customers (CIOs of IC agencies) to assess needs
	• Several rounds of technology due-diligence, go from 750 to 100+ firms
	
	• Look for near-finished, proven, viable products
	
	• Customer feedback: "**Interface Center**" – small group from CIA DS&T group test and down select to 20 products
	
	• 10% high-risk, 50% mid-range and 30% opportunistic investment
	
	• Feedback process
		• In-Q-Tel partners with firm to develop technology to needs
		
		• Takes small financial stake (licenses, equity) so long as other VCs also investing
		
		• Technology piloted within CIA DS&T; customer funds pilot process
			• Successful pilots go through procurement and scale-up within customer organization

Cross-Cutting Innovation Issues	• Staffing and Leadership: All have VC backgrounds, high experience in technology and investing • Metrics: Several metrics for each pipeline stage. Try to measure what is needed to close the gap between current state of product and what the customer needs •Portfolio Management: Take on technology risk, but not financial risk. Make sure that product has commercial pathway so that other VCs will also invest. (1:12 investment ratio of In-Q-Tel to other investors)

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IBM, Mark Dean
Innovation Goal: Stay ahead of technology and market trends

Visioning and Idea solicitation	Idea selection	Development, testing, prototyping	Scale-up / Commercialization

• Two ongoing large programs, Global Innovation Outlook and Global Technology Outlook generate most of IBM's innovations
  • GIO: internal + external participation (VCs, academics etc), discuss business, customer and tech trends
  • GTO: internal only; longer study of trends; highest impact on IBMs technology strategy
 	
• Innovation Jam: 2-day facilitated online conversation wide network (employees, customers, researchers)
	• GIO and GTO idea selection done by senior management, but process is matrixed.
	• Innovation Jam:
	  • Initial round of text mining software to identify and cluster key elements from thousands of postings
	  • 50 Sr. executives to down select to 30 "Big Ideas" of which 10 funded.
	  • **Sr. management able to combine related ideas into major initiatives (seams)**
		• New ideas start out in emerging business organization, and eventually moved to business units
		
		• Projects funded may be raw research ("Big Bets", > 5 yrs), Applied ("Grand Challenges", 3 yrs) and Development (2 yrs).
		
		• Matrixed management with 2 Sr. VPs per project
		
		• Quarterly milestones	

Cross-Cutting Innovation Issues	• Staffing and Leadership: Top leadership involved in innovation strategy; selection and management by Sr. staff; matrixed to access cross-divisional expertise and checks and balances. • Metrics: Start with objectives that are measureable (does not happen in government). Re-assess if objective not met. •Portfolio Management: IBM hedges their bets on high-risk, high cost ventures; eg. two competing projects funded for post-CMOS technology till at least one proven to work.

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Amazon.com, Kim Rachmeler
Innovation Goal: New process efficiencies to cut costs and deliver time

Visioning and Idea solicitation	Idea selection	Development, testing, prototyping	Scale-up / Commercialization
• Process efficiency ideas come from the bottom but must be supported at the top. • Employees should be encouraged to push ideas to their superiors • Ensure employees in the field have a way of getting information and ideas to managers at headquarters, such as through Kaizens	• CEO has competition to "just do it" and move on innovative idea without waiting for permission. • No punishment if the idea doesn't work—it just must be well-thought out	• Failing quickly is very important—learn lessons and move on. True failure is not learning.	

Cross-Cutting Innovation Issues	• Staffing and Leadership: Leadership and encouragement at the top. Leaders have to eliminate barriers to innovation • Metrics: Metrics important but can be misleading—what reduces one metric can be an overall good but you won't know if you don't measure the other important metrics. • Incentives: eliminate disincentives to try new things • Portfolio Management: Have to be ok with failure, and government often has a problem with this.

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Microsoft Idea Management System
Innovation Goal: Grassroots innovation for business ideas

Visioning and Idea solicitation	Idea selection	Development, testing, prototyping	Scale-up / Commercialization
• Management poses a challenging business question after soliciting proposals from business units • Ideas collected through an online idea management system that supports submission, discussion, scoring, and dissemination • 2 to 3 months for employees to submit/comment. Can vote up but not down. • Designed to foster meaningful interaction between employees • Employee voting needs to include business-relevant criteria in addition to originality • Crowdsourcing can lead to unexpected collaborations across departments.	• innovation group down selects to a manageable number (ie 20) to move forward • Innovation group works with business units to down selecta further step based on feasibility (ie 10) • Idea generators interact with innovation group and business units throughout selection process	• Top ideas are prototyped by the idea generator working with the business organization to refine the idea • Ideas tested within the business unit to judge effectiveness	

Cross-Cutting Innovation Issues	• Staffing and Leadership: grassroots innovation comes from people furthest from decision-making and resource allocation. Corporate-wide program should be designed to eliminate organizational barriers. • Metrics: have tested around 100 prototypes, and six have been absorbed into product streams • Incentives: employees didn't have a great incentive to participate (particularly taking time away from "day job", need more recognition and/or prizes. Also need motivation for developers to look at good ideas that didn't necessarily win. • Portfolio Management: generally the selected ideas were already on the company's product roadmap, but submitted ideas gave new perspectives

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Scott Matthews, Boeing (discussion focused on visioning and ideation stages)
Innovation Goal: Improved selection of ideas entering product development gate

Visioning and Idea solicitation	Idea selection	Development, testing, prototyping	Scale-up / Commercialization

• Visioning: developed by manager who wants to move into a new product space through gap identification
• Specific technical problem ("challenge question") posed to employee community
• Ideation implemented and managed internally through ideation software
   • Company-wide social networking tool to engage 1000+ employees
   • Automated "idea fragment" collection and cataloguing;
• Ideas clustered around concepts by technical experts, and concepts move on to idea selection phase with initial cost and market estimates
	• Phased selection process based on options valuation- and pricing
	
	• Selection process comprised of:
	   • Raw ideas clustered into strategic thrusts
	   • Marginal proof-of-concept
	   • Each cluster evaluated in phases as product strategy developed
	
	• Incremental investment strategy: keep early evaluations fast and cheap; keep options open as long as feasible
	
	• Architecturally, user interface elicits increasing detail about concept with each phase		

Cross-Cutting Innovation Issues	• Metrics: High quality ideas (as measured by 6 quantitative attributes) delivered to product development gate

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Nokia, Henry Tirri, CTO
Innovation Goal: new product development

Visioning and Idea solicitation	Idea selection	Development, testing, prototyping	Scale-up / Commercialization
•Concept innovation best done through crowdsourcing, technology management requires more focused domains •Nokia manages innovation through its global research arm, each manager in charge locally	•Concept innovation best done through crowdsourcing, technology management requires more focused domains •Nokia manages innovation through its global research arm, each manager in charge locally •Don't allow committee to decide—people are risk-averse so committees average to incrementalism.	• Over-handling of R&D can be worse than under-handling • Feedbacks are harder in large bureaucracy • Services/software are cheaper to prototype and test	• Need to be careful what gets scaled—government will have customers for even inferior products

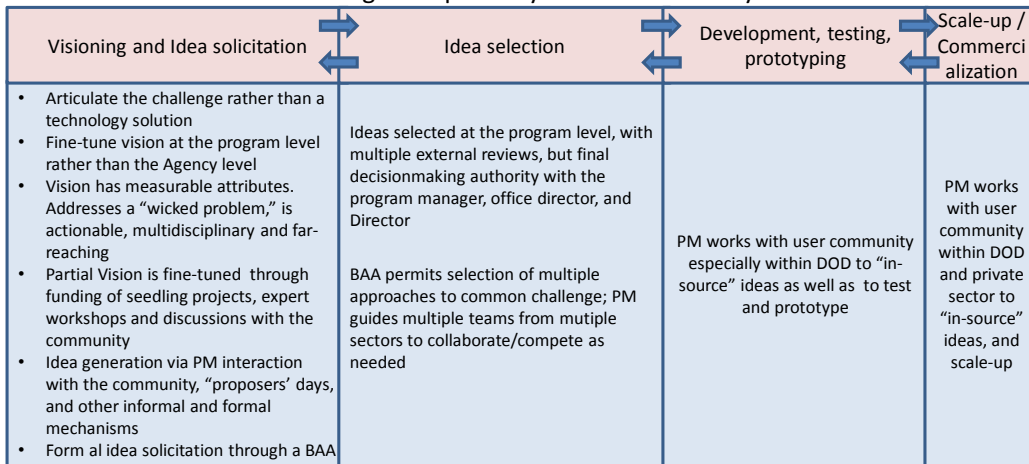| Cross-Cutting Innovation Issues	• Staffing and Leadership: Need the right people at the top, including C-level. Small group with technology experience is better, changed out on a regular basis. • Metrics: incentives are dependent on measurement. Metrics vary by project, but stack height of final reports is not a good metric ever. • Incentives: Incentivizing harder in government, so need to ensure people are getting positive feedback for innovation

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Public sector discussions

DARPA

Goal: Maintain the technological superiority of the U.S. military

Visioning and Idea solicitation	Idea selection	Development, testing, prototyping	Scale-up / Commercialization
• Articulate the challenge rather than a technology solution • Fine-tune vision at the program level rather than the Agency level • Vision has measurable attributes. Addresses a "wicked problem," is actionable, multidisciplinary and far-reaching • Partial Vision is fine-tuned through funding of seedling projects, expert workshops and discussions with the community • Idea generation via PM interaction with the community, "proposers' days, and other informal and formal mechanisms • Form al idea solicitation through a BAA	Ideas selected at the program level, with multiple external reviews, but final decisionmaking authority with the program manager, office director, and Director BAA permits selection of multiple approaches to common challenge; PM guides multiple teams from mutiple sectors to collaborate/compete as needed	PM works with user community especially within DOD to "in-source" ideas as well as to test and prototype	PM works with user community within DOD and private sector to "in-source" ideas, and scale-up

Cross Cutting	• Many unique features: a flat, non-hierarchical organization, with empowered program managers, a challenge-based ''right-left'' research model, emphasis on selecting highly talented, entrepreneurial program managers who serve for limited terms, projects focus on ''high-risk/high payoff'', selected and evaluated on what impact they could make on achieving a demanding capability or challenge; initial short-term funding for seed efforts that scale to significant funding for promising concepts, but with clear willingness to terminate non-performing projects • DARPA has the ability to undertake multigenerational technology thrusts, build an advocate community, and leverage these connections to implement technologies within larger innovation elements downstream from DARPA. (From Bonvillian 2011)

ARPA-E
Innovation Goal: Transformational energy research unsupported by industry and DOE

Visioning and Idea solicitation	Idea selection	Development, testing, prototyping	Scale-up / Commercialization
• Leadership decides on broad topic area, then seek out Program Director (PD) to lead area from academia or industry. • PDs research a particular area in broad topic to find white space between DOE and private sector. Workshop and formal pitch to senior leadership • Call for papers with a brief technical summary allowing flexibility in proposals • Proposals are 5-7 page concept papers	• PD chooses which concept papers to encourage to write a full proposal • 4-5 weeks to write a full application • Review panel performs reviews of full proposals • Applicant can then rebut review comments (4 days, 3 page) • PD makes the final call on funding—review panel are advisory only if too risk averse or not risk averse enough	• PD sets aggressive milestones for project • If project begins missing milestones, get a letter that they are on verge of termination • Stop projects if they don't get performance up	• Comm. Group at ARPA-E to create opportunities in VC, licensing, foreign govts, and DOD • Some tech handed off to DOE

Cross-Cutting Innovation Issues	• Staffing and Leadership: Hire accomplished researchers and empower them to work hard for temporary appointments, paid above traditional civil service pay scale. Small total staff—30 total, of which 6 are commercialization. Team works closely—no departmental silos. • Metrics: Have stopped 6 of 120 projects so far, but 20-40% have received the letter that they are missing milestones • Incentives: cut off funding quickly if not performing

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Education, i3
Innovation Goal: Scale-up of non-incremental approaches, products and processes

Visioning and Idea solicitation	Idea selection	Development, testing, prototyping	Scale-up / Commercialization

• 3 tiers of proposals sought:
  • Scale-up grants to take proven solutions to scale
  • Validation grants to demonstrate proven concepts
  • Development grants for valid hypotheses that need testing (these ideas come from the IES)
 	
• Ideas sought to address challenges in program evaluation and level of technical assistance
	• 49 ideas selected out of 1700 applicants	• Resistance to competitive procurement process a big barrier here
		
		• Institutional resistance to demonstration fund; tendency is to lower overhead by allocating to deployment rather than innovation demonstration
		
		• Stop projects if they don't get performance up
			• Fragmented customer base makes this a challenge

Cross-Cutting Innovation Issues	

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HHS: HHS Innovates

Innovation Goal: reward risk-taking by recognizing scalable innovations

Visioning and Idea solicitation	Idea selection	Development, testing, prototyping	Scale-up / Commerci alization
•No visioning because program is designed to highlight innovations already happening within the agency •Contest solicits ideas with a demonstrated proof of concept and the potential for scale across all of HHS	• Ideas collected via online system, submit background/rationale for innovation, impact, lessons learned, potential for scalability across HHS • Initial scoring by panel review, best posted online for crowdsource voting • Highest vote totals go to Innovation Council who picks several to show Administrator, who picks winner • Winners invited to HHS HQ for awards ceremony and receive $2500 cash prize	• Ideas must have been piloted within previous 30 days	

Cross-Cutting Innovation Issues	• Staffing and Leadership: Senior support very important, from Administrator down • Metrics: ~10,000 votes cast per year by HHS employees • Incentives: Cash prize and recognition from Administrator

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DOE Sunshot (interview focused on visioning and ideation)

Innovation Goal: 75% reduction in installed cost of solar power by 2020

Visioning and Idea solicitation	Idea selection	Development, testing, prototyping	Scale-up / Commerci alization
•Vision from senior DOE employees, shaped by workshops with academia, industry, and other experts •Gathered opinions on timeline and structure to achieve ambitious goal •Technology-neutral approach: 15 different solicitations for different solar technologies, soft cost reductions, and power electronics			

Cross-Cutting Innovation Issues	• Staffing and Leadership: Hired 18 PhDs quickly to get project moving • Metrics: • Incentives: cut off funding quickly if not performing

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HHS: VAi2
Innovation Goal: Add structure to VA innovation process and improve service quality

Visioning and Idea solicitation	Idea selection	Development, testing, prototyping	Scale-up / Commercialization

• Four-pronged approach
  • Employee competitions
  • Industry Competitions
  • Special Projects
  • Prizes and challenges
 	
• Competition announced on internal and external websites
 	
• 600 proposals from industry and 15000 ideas received from employees
	• Tiered review process:
	• Industry competition: panel of internal + external experts vote on proposals; second round of scoring on more detailed proposal.
	• Other competitions follow similar process.
	• Final selection panel = 5 members of top leadership (SECVA, DEPSECVA, COSVA, CTO and CIO)
	• Act as VCs for selected ideas; decision need not be unanimous
	• $102M portfolio funding 135 innovations, small prizes funding many ideas
		• BAA as procurement vehicle
		
		• 2 yr window to prove idea
			•

Cross-Cutting Innovation Issues	• Staffing and Leadership: The fund should be housed in the Secretary's office and involve senior leadership • Metrics: Innovation fund must improve (a) cost, (b) quality, (c) access, and (d) customer satisfaction in delivery of veteran benefits • Risk: Portfolio is balanced across all 6 major lines of business, though VHA forms the bulk.

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HHS: CDC i-fund
Innovation Goal: Test and Develop proof-of-concepts for CDC public health priorities

Visioning and Idea solicitation	Idea selection	Development, testing, prototyping	Scale-up / Commercialization
•Competition announced on internal website and CDC-wide email •Brief Proposal to lower barrier to entry	• Tiered review process: • First tier: 70 subject matter experts score proposals on novelty, significance, chance of success, potential impact, and feasibility • Second tier: top 15 posted online for crowdsource of all CDC staff to comment and vote (use of textmining tools) • Third Tier: Senior Management review results of first two tiers, estimate impact, and choose	• Quarterly review on PI-provided milestones • Final presentations on Innovation Day at end of year	• Programs determine worth for mainstream funds • TTO gets involved in cases of products to license/ patent

Cross-Cutting Innovation Issues	• Staffing and Leadership: Senior support very important in times of declining budgets. Innovative programs must be sold to past constituencies in terms of funds and new processes like crowdsourcing. • Metrics: 300 comments on 18 proposals from nearly 10% of total CDC staff. Want to measure how many i-fund projects get main division funding • Incentives: Do not allow anonymous comments on crowdsourcing web site to discourage harsh criticism

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HHS: CMMI Pioneer Award Initiative

Innovation Goal: Test the effectiveness of several innovative payment models

Visioning and Idea solicitation	Idea selection	Development, testing, prototyping	Scale-up / Commercialization
• Solicitations sought from Accountable Care Organizations (ACOs) which are groups of providers with experience working together to coordinate care for patients • ACOs present ideas for identifying, testing, and spreading new models of care and payment.	• Interval review process • 32 ACOs selected for Pioneer Awards out of 80 applicants	• Selected ACOs given 18 months to implement their idea on a small scale • ACOs required to collect data on effectiveness of payment models including raw claims data and quality measures • Claims data used to gauge patient experience during trial period	• Rapid scale-up of successful programs anticipated (under 6 months) • Provisions of the Affordable Care Act give CMS the legislative authority to effect change of regulations across the board • Clearance and budget process internal to CMS and HHS

Cross-Cutting Innovation Issues	• Staffing and Leadership: • Metrics: • Incentives:

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Consultant discussions

Eric Ries, Lean Startup
Concepts of Lean Startup

- **Hypothesis-driven experimentation**
    - Identify a minimum viable product (or process), which is that version of a new product which allows a team to collect the maximum amount of validated learning about customers with the least effort.
    - Test as quickly as possible
    - This should take weeks and months, not years

- **<u>Build-measure-learn</u> feedback loops** – take an action, make something, measure, people respond, learn from data, use to impact next idea
    - Minimize the time it takes to create loop
    - Fail fast and learn : critical to use metrics

- **Piloting and scale-up in incremental step-ups**
    - Build on the microscale level - Test on a small population
    - Scale up incrementally and measure at every increment
    - ***At each step, either go big or kill it***. A continuous path to scale allows it to be a learning exercise and reduces frustration.

- **Innovation accounting**
    - Traditional accounting systems (ROI, profitability) are not effective in measuring outcomes.
    - However, some measure of impact on a per entity basis has to be developed and used to move to the next step

Examples: Nordstrom Innovation Lab, Darpa, Healthcare innovation

IDEO
Innovation concepts

- **Different models of innovation**:
  - **From the top -** the CIO runs how innovation integrates with everything (mandate built into processes, top-down tools to implement, lean– process based, not inspiration based);
  - **Skunk works** – innovation in the sidelines;
  - **Innovation consultancy** such as the Mayo Clinic; and
  - **Ground-up innovation -** Ideas bubble up from employees outside the decision-making process

- **Implementation is key**
  - More ideas don't mean better ideas
  - Great ideas don't matter; Getting ideas into play is more important

- **"Entrepreneurs in residence"** - promote the concept of taking risks, agile development and learning from mistake, at FDA, builds connections between small business executives who would serve as ambassadors between the FDA and the small business community.

- **Use of tiger teams** made up of experts to help agencies with specific technology needs and to help change the culture to one of taking risks similar to a start-up

- **Use of skunk works** – a "stealth" organization given a high degree of autonomy and unhampered by bureaucracy, tasked with working on projects that are disruptive to organization

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Henry Chesbrough
Open Innovation

- **Open innovation** - revitalizing a company's future by tearing down the walls between its R&D organization and outside companies and innovators

- Instead of trying to build a service or a product, **build a platform** - a platform, on the one hand, attracts others to build alongside and on top of what you're doing, but on the other hand allows you to provide a much wider set of experiences.

- **Idea selection**:
  - Bring in external experts to judge
  - Fast turnaround in sifting through ideas received through open solicitations will keep participants motivated

- **Customer perspective**: Many good ideas fail not because they didn't do what they were supposed to, but because the customer didn't do what they were expected to.

- **Metrics** – Different metrics for different risk portfolios

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14. ABSTRACT

The Assistant to the President, Chief Technology Officer, and Associate Director of Technology at the White House Office of Science and Technology Policy (OSTP) asked the IDA Science and Technology Policy Institute (STPI) to examine innovation pipelines in a range of public and private organizations and to identify practices that may be relevant to a broader set of government innovation programs. Building on a review of the literature and discussions with innovation leaders in the government and private sectors, STPI identified practices worth considering and emulating for each of the stages of an innovation pipeline. Findings focused on mechanisms to source early stage ideas, how to stage-gate ideas (portfolio management tools) and fund them, how to scale-up the best ideas, with the goal of replicating what works. While these practices are not directly transferable as-they-are, they provide useful food-for-thought as government agencies transform their processes and systems to adjust to the challenges of the twenty-first century.

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