Innovation Patterns in Some Successful C2 Technologies

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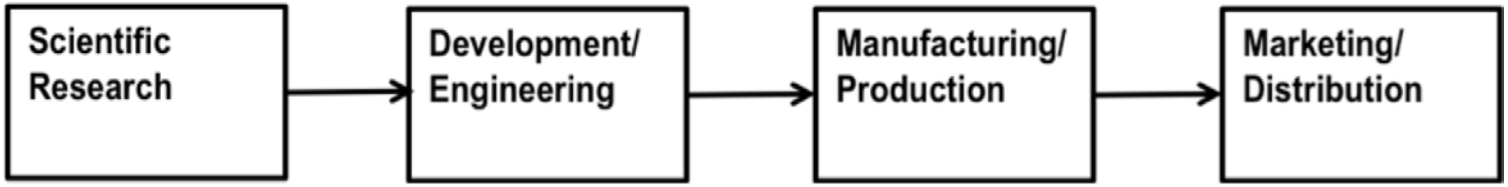
What We Will Discuss

- Models of Innovation
- DoD Success Stories in C2 Technologies that are describable by those models
- Innovation can be complex, with continual interactions between basic research, applied research, development, engineering, and marketing
- Scientific research and engineering knowledge can contribute to every stage in the innovation process.

“Linear Model” of Innovation



Linear Model

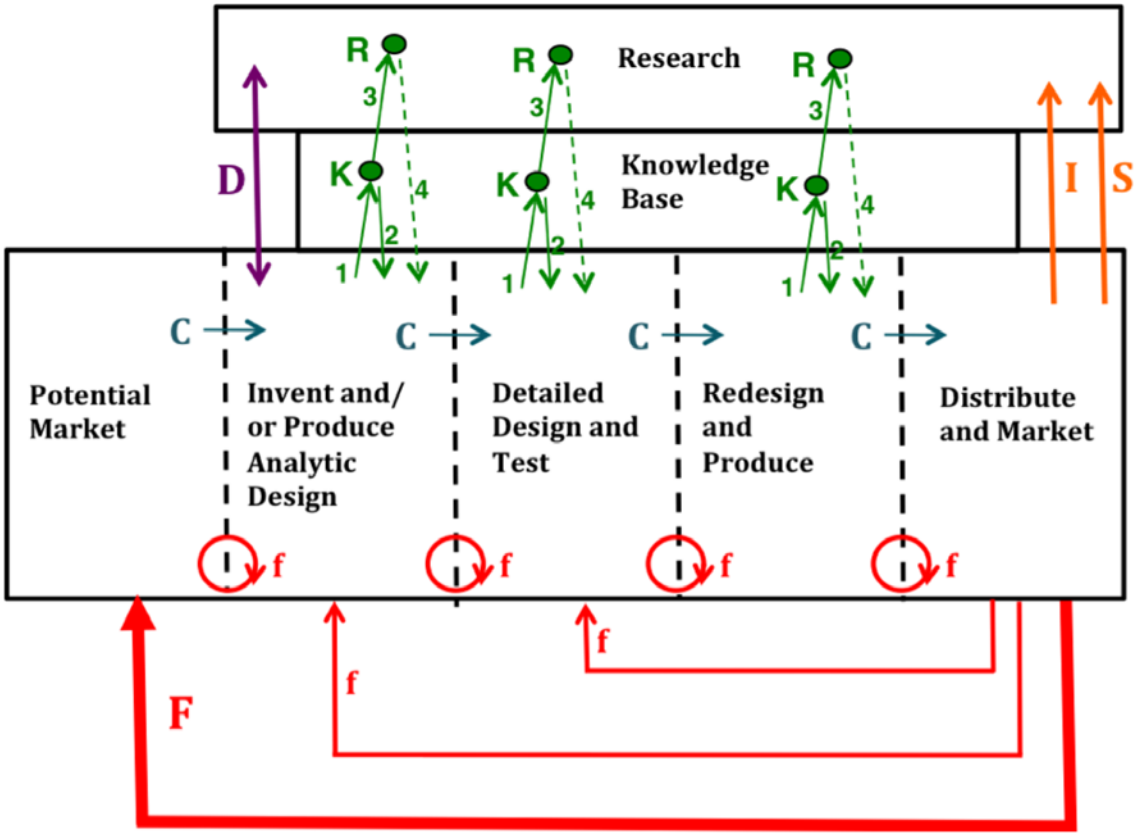
- Not “wrong,” but does not capture all complexities of innovation
- Part of the Post-War “Big Science” mentality
- Partly implicit in Vannevar Bush “Science—The Endless Frontier”
    - But phrase “linear model” not used explicitly there
- “Linear model” really constructed as term of art in 1980s, as a straw man to be opposed

Kline Model

- Technologies can move both forwards and backwards in the process
  - e.g., back to the lab if further development is needed.
- Downstream stages (e.g., marketing) can be consulted for input at earlier stages (such as design and test).
- Scientific research and engineering knowledge can contribute to every stage in the innovation process.
- Most firms create technology platforms, which are generic architectures that become the basis for a variety of technology-based products and services.
- The knowledge and skills needed for innovation are developed by communities of practitioners, not by individuals, and many of those communities exist outside of a particular firm (for example, in universities).
- Users of technology can be an important source of ideas for improvements or even new innovations with substantial market potential.

Adapted from: Encyclopedia of Business, http://www.referenceforbusiness.com/management/Str-Ti/Technology-Management.html

Kline Model



Feedback loops operate best when they operate fast, with minimal formalism and bureaucracy

Cautions in Applying to Military Systems

- Applies best in commercial/industrial contexts
- DoD is a monopsony, with a limited supplier base
  - What constitutes a “market?”
  - How are “market signals” generated & received?
  - Especially in complex, multibillion dollar procurements
- But in the case of individual IT capabilities with identifiable end users, analogy is more apt
  - End users are the market, not the acquisition establishment
    - Provided you have the right “top cover”

Generations of Innovation Models

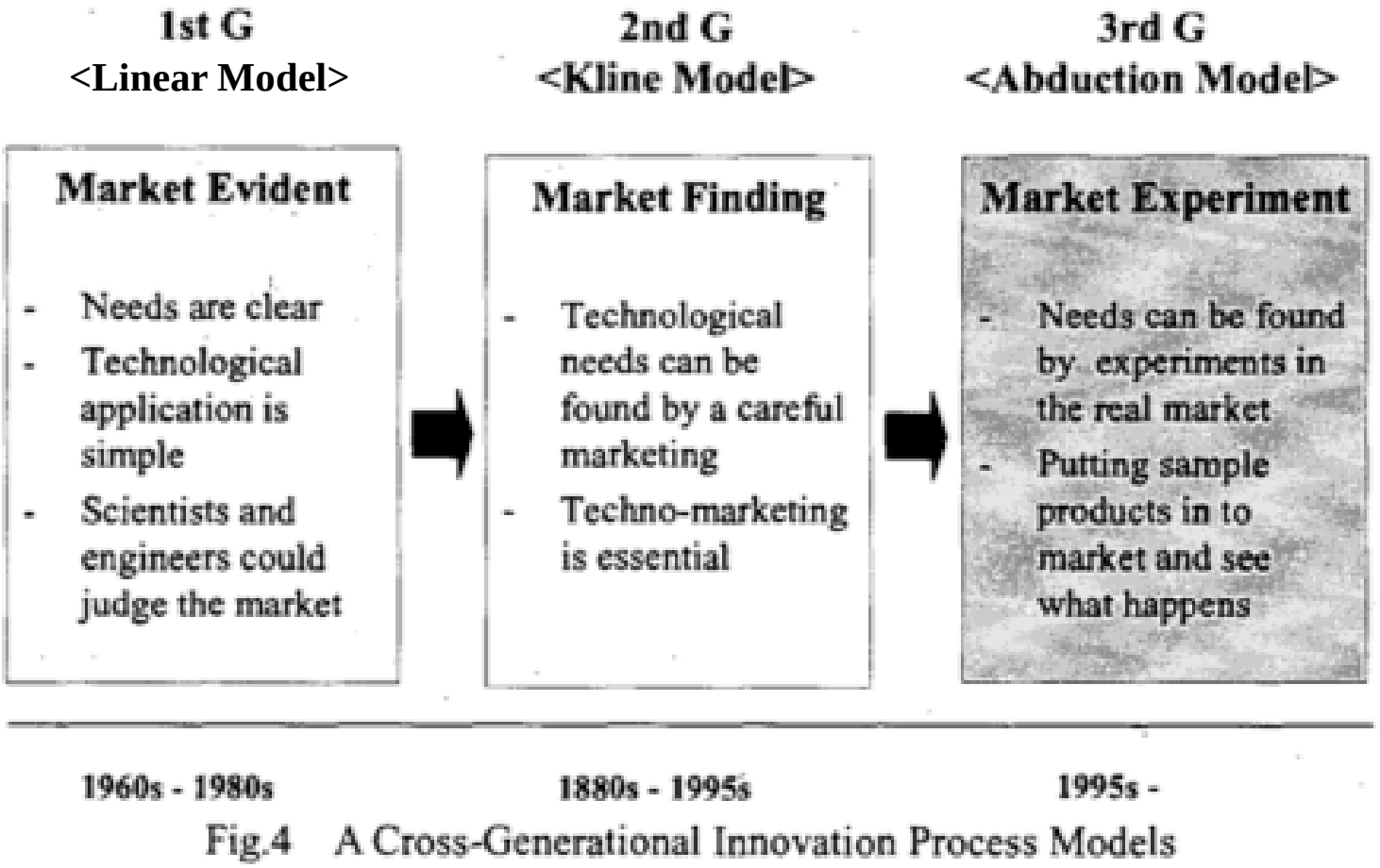


Fig.4 A Cross-Generational Innovation Process Models

Figure slightly corrected from Kameoka, A., D. Ito, and K. Kobayashi (2001). "A Cross-Generation Framework for Deriving Next-Generation Innovation Model." *Change Management and the New Industrial Revolution*, *IEMC '01 Proceedings*, Albany, NY.

Tactical Ground Reporting (TIGR) System

- DARPA-developed tactical situational awareness system
- Largely COTS-based
  - e.g. Google-Maps-like interface
- Allows operators to share facts, issues, suppositions, lessons learned via geo-referenced multimedia
- “Pass down log on steroids”
- Mapping capability links geography with
  - Still images
  - Audio
  - Video
  - Text
- Junior officers and NCOs can
  - Study before patrol
  - Augment after patrol

Photo from Maeda (2010)

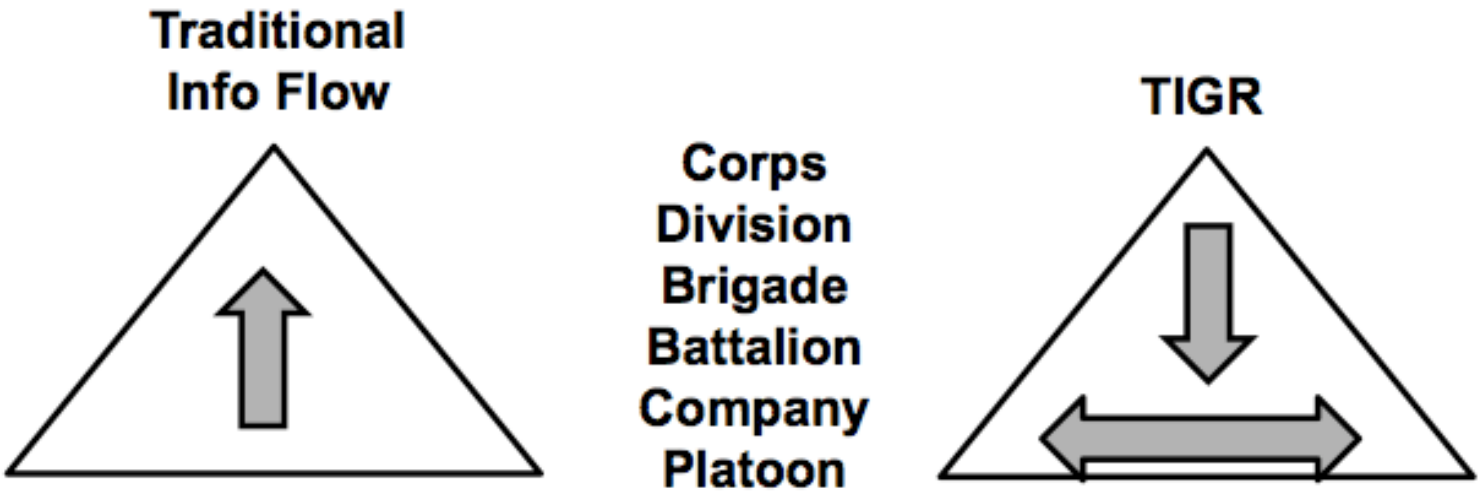
Tactical Ground Reporting (TIGR) System

- Post patrol web-logging information on
  - Individuals
  - Facilities
  - Equipment
  - Dangers encountered

- Obtain/see/hear
  - Locations of key buildings
  - Location data on past attacks
  - Photos of suspected insurgents
  - Interviews with civilians
  - Videos of past maneuvers
  - Etc.

Photos: http://www.usi-inc.net/24.html

Tactical Ground Reporting (TIGR) System



Graphic from Maeda (2010)

"It is a bit revolutionary from a military perspective when you think about it, using peer- based information to drive the next move.... Normally we are used to our higher headquarters telling the patrol leader what he needs to think." —Quote from staff officer in First Brigade Combat Team on using TIGR

CAVNET → TIGR

- CAVNET
  - Useful predecessor to TIGR used in US 1st Cavalry in Iraq
  - Made famous by well-publicized incident
    - Patrol leader in Baghdad learned of insurgents wiring posters of Moqtada al Sadr to set off explosives when US soldiers took them down
    - Another officer elsewhere learned of this on CAVNET and alerted others, saving lives

Photo: http://www.globalsecurity.org/military/world/iraq/images/muqtada_sadr3.jpg

- CAVNET lacked
  - Robust database for multimedia & reports
  - Good user interface

- Soldiers from 1st Cavalry teamed with DARPA to work on what became TIGR
  - DARPA PM interacted directly with soldiers returning from Iraq
  - Team of programmers worked directly with soldiers
  - As versions were developed,1st Cav tested them directly

TIGR Did Not Go Through All Normal Procurement Channels

- TIGR was not a program of record
  - Did not have Army acquisition support for fielding
  - Not initially sanctioned for use over tactical wireless nets
- Arose quickly from compelling operational needs
- Initial compromise agreement: Use only within 1st Cav
  - At-risk adoption
  - 1st Cav developed SOPs
  - Encouraged use down to squad level
  - DARPA teamed with Rapid Equipping Force (REF) for maintenance of tool in Iraq
- Popularity with troops led to greater support within Army at large
  - Had to overcome technical & procedural roadblocks
    - SOPs for sharing classified information
    - Interoperability with mainstream C2 systems @ battalion +

Photo: http://blog.mtviggy.com/wp-content/uploads/2009/11/batman-color2.jpg

TIGR Innovation

- Showed many features associated with a complex and tightly coupled innovation process (Kline Model).
- Originated not from an initial discovery but from a set of pressing needs.
- Iterative development process, with considerable feedback loops between stages.
  - Esp. between the end user (the “market”) and the first conceptual stage driving the development.
  - In-theater experimentation
- PM on contractor side described TIGR as “something completely unique, a living, breathing system.”
- Much of the work on TIGR can be characterized as experimental development and engineering…
- …But innovation process also exhibited paths into the global scientific knowledge base, and initiated some new research in a number of areas.
  - e.g. creation of a distributed architecture with policy-based data dissemination to keep the bandwidth load on the tactical network low and hence minimize the impact of network outages.

Combined Information Data Network Exchange (CIDNE)

- Developed by Army III Corps
- CENTCOM-managed database for counter-IED
- Originally designed as a system to manage brigade+ Sons of Iraq contacts
  - Used by Civil Affairs
    - Track People, Facilities, Institutions
  - Ended up bringing together many Army communities by providing standardized reporting framework for operations & intelligence
  - Allows useful correlation & packaging of data for troops and commanders
  - This ability led to usefulness in Counter-IED work
  - Using WebTAS (Web-Enabled Temporal Analysis System) to mine CIDNE database, users can create accurate & up-to-date IED hazard overlays in near real time
- Developed by small team of software engineers working directly with troops
  - Multiple Kline-like iterations
- Largely COTS-based

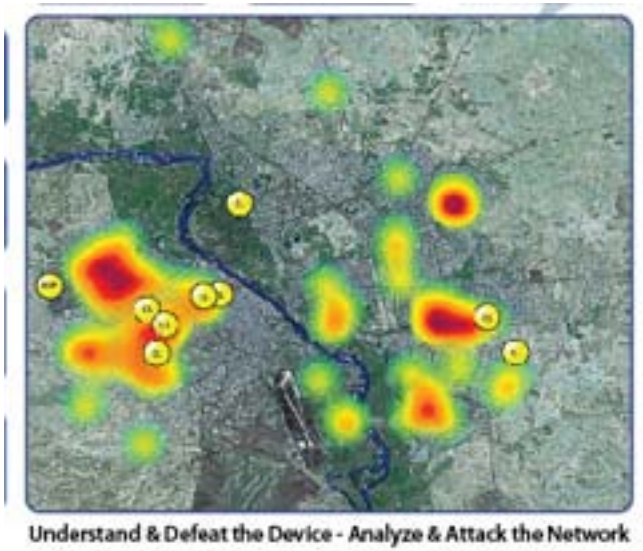


Photo: http://www.issinc.com/solutions/cidne.html

Wartime Fielding

- SOPs have arisen to support wartime fielding of ITs like TIGR & CIDNE
  - Emergent requirements documented as Urgent Operational Need (UON)
  - Sometimes UON can suggest a specific IT solution
  - Army G-3 validates
  - UON → Resourcing typically 60+ days
  - Process kicks in to determine if PoR will adopt UON or if UON → new PoR
  - For IT, G-3 and G-6 are involved

- IT used on networks must be certified for interoperability

- But sometimes commanders can use technology "at-risk"
  - Both TIGR and CIDNE expanded rapidly because many commanders approved "at-risk" operation
  - Got in & did useful work without formal programmatic support
  - But still bogged down with formal process demands for certification, validation, etc.

- Gen. Chiarelli on TIGR: A technology that "forever changed our Army" […] "in spite of everything the Army could do to stop it."

Edge Innovation

- Rapid development with intimate involvement of users
- Dedicated maintenance and upgrade teams in constant contact with end users
  - Forward-deployed group supporting fielded capabilities and collecting feedback
  - CONUS group providing updates & patches as needed
- User-friendly web-based front ends + databases focused on individuals, organizations, and facilities
- Horizontal and vertical information flow in deployment of system

Command Post of the Future (CPOF)

- Real-time collaboration system with powerful military mapping

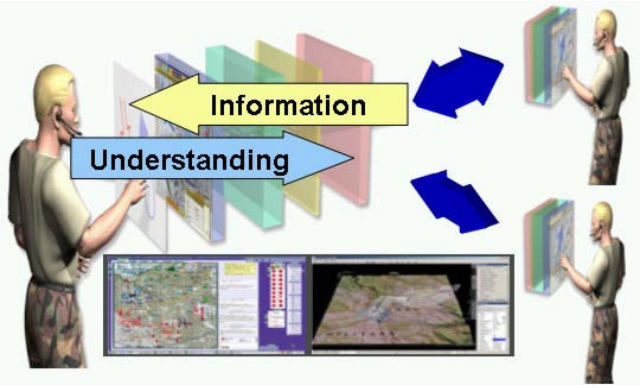
- "Virtual sand box" allowing flag officers, unit COs, in dispersed geographic locations to collaboratively
  - Visualize battlefield (terrain data, GPS)
  - Confer via voice or chat
  - Depict situations
  - Offer ideas/annotations
  - Plan course of action (COA)
  - Refine tasking
  - Self-synchronize plans

- Visual elements are "drag & drop"
  - e.g., Moving an event icon changes its lat./lon. In shared repository,
  - Moves it on all shared maps & views

Photo: http://www.flickr.com/photos/peoc3t/3552465286/sizes/m/in/photostream/

CPOF Development & Deployment

- Originally a DARPA program, late 1990s
  - Designed with aid of 2 retired marine colonels
- Now federated with Army's Maneuver Control System (MCS) through GCCS-A
  - Can also take data from TIGR and CIDNE
- First used by 1st Cavalry in Baghdad in handful of locations in 2004
- 3rd Infantry Division was first to receive CPOF with enhancements from in-theater experience
  - Disciplined & integrated development process
  - Field service representatives
  - User feedback & iteration
- Since 2006, PoR directed from PM Battle Command
- Currently in use throughout Iraq & Afghanistan
- Now the primary battalion+ battle command platform in SW Asia theater
  - 1000 systems used by Army, Marine HQ, and Air Force liaison elements
- Major development driver: User need to add new data object representations into the collaboration space



Graphic: www.acq.osd.mil/ott/tti/images/cpof.jpg

CPOF "Tool and Appliance" Capabilities Empower Edge Innovation

- Users at any level can assemble workspaces
  - Organize their workflows
  - Without disrupting views of other users
- Quick, disposable "mini-applications" to meet pressing needs
  - In ways no designer might have anticipated
  - Potential source of new, broader capabilities
- CPOF repositories are a rich source of empirical data on nature and content of C2 business processes
  - Can be used to refine system and processes

Issues

- Still difficult to strike a balance between
  - Protecting networks,
  - Enabling IT platforms to share information
  - Rapidly supplying units in combat with capabilities they need
- Interoperability
  - Rapid & quasi independent development can lead to interoperability problems
  - Continuing problem for CPOF and mainline C2 systems
  - Low semantic interoperability between TIGR, CIDNE, & CPOF
- Security
  - TIGR horizontal information sharing vs. Army rules for protecting classified information
  - CIDNE “Export-to-Excel” possibly used to capture data later given to Wikileaks
- Development in a War Zone
  - In-theater experimentation crucial
  - But soldiers have a lot more on their mind than providing user feedback
  - Difficult environment for engineers and scientists

Rapid Development & Transition of Cutting-Edge IT

- Identify pressing needs
  - Minimize formalism
  - Direct contact with users in theater and/or exercises
- Fill needs quickly
  - Maximize COTS use when appropriate
  - Take advantage of what users are already doing
  - Does not have to be perfect
- Deploy "at risk" if necessary
  - Fast-track certification
- Deploy as stand-alone if necessary
  - Integrate later
  - Don't let a need for immediate integration with existing systems stifle development & innovation
  - Insurgents & terrorists adopt technology "catch as catch can"
- Use R&D scientists & engineers for what they're best at
  - Tapping into applicable R&D storehouse of knowledge that developers may not be fully aware of
  - Suggesting & prosecuting new R&D threads for the longer term
- Dedicated development teams for continual refinement
  - Constant user feedback
  - Take advantage of user-generated innovation

"Our conventional modernization programs seek a 99% solution in years. Stability and counterinsurgency operations – the wars we are in - require 75% solutions in months. The challenge is whether…these two different paradigms can be made to coexist."

Secretary of Defense Robert Gates, speech at NDU, 29 Sept 2008