Quadruple Helix and “Mode 3” Knowledge Creation: Moving from Tactical Fragmentation to Strategic Integration

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World Economy in a New Era
21st-Century Drivers of Change

• Network Ubiquity
  – More than a billion Internet users and three billion wireless subscribers, worldwide

• Open Standards
  – Widely-adopted technical and transaction specifications

• New Business Designs
  – Horizontally-integrated operations
TWO KEY POINTS ON GLOBALIZATION

1. Globalisation will continue and it will continue to create pressures to reallocate economic resources across sectors, firms and occupations.

Globalisation means unbundling. All sorts of economic relationships were bundled spatially to avoid or minimise transportation; this situation implied that the price of many goods, services and wages were set in local markets, not global markets. This bundling meant that workers’ pay was tied to the bundle’s average productivity. By pure logic, we know that the link to the average dragged down the wage of some workers while pulling up the wages of others. Unbundling breaks the link to the bundle’s average. Workers will increasingly get paid what they are worth on the world market. This will lead to gains and pains from trade.

2. The direction and nature of the change is impossible to predict with any accuracy.

Government statistical collection procedures were set up to track the post-war industrial boom when jobs were associated with particular firms and particular firms were associated with particular sectors. Now, jobs are associated with particular tasks and tasks are increasingly reallocated across firms across sectors (outsourcing) and across nations (offshoring). Economists do not have detailed knowledge of exactly what caused the bundling in the first place, so they will not be very good at predicting how the unbundling will occur, i.e. which tasks will be offshored and which will not. Moreover, as firms experiment with unbundling, they are learning that some jobs really cannot be done in India. It turns out that even firms do not fully understand the linkages among the tasks that had been bundled geographically for so long. However, it seems clear that it is probably not true that the biggest adjustments will be made by low skilled workers as it was in the past. Many unskilled workers are performing tasks that are entirely shielded from global competition due to their very nature; it is much easier to offshore a financial analyst’s job than it is to offshore a shop assistant’s job.
INNOVATION DEFINED

• Innovation resides at the intersection of invention and insight, leading to the creation of social and economic value

• US National Innovation Initiative
**National Innovation System**

**GloCal Knowledge Economy**

- **Human Capital**
- **Think Tanks/Antenna**
- **University**
- **Firms**
- **Innovation & TFP Growth**

Other Public Policies:
- Rules of the Game
- Infrastructure (ICT)
- Subsidies/Tax incentives
- Coordination Initiatives
Research is the Transformation of Money into Knowledge

Innovation is the Transformation of Knowledge into Money

Consequence:

• The job is not finished, when research is done.
• The job is done, when research has led to innovations with benefits for customers.

* Bamelis, Bayer
PUTTING THINGS PERSPECTIVE:

The CPI Model

Knowledge Creation
Knowledge Diffusion
Marketability

Government
- Influences
  By Policies, Exchange Rates, WTO Membership
- Defines Policy, Programs

Industry
- Sol
  Competitiveness
- GDP/Capita/Industry
  Productivity
- $ %GDP
  Innovation

- Industry
  SOL
  Competitiveness
  GDP/Capita/Industry
  Productivity
  $ %GDP
  Innovation

- Industry
  Buyers
  Influence
  Suppliers

Firm
- Value Chain

Knowledge Diffusion
Marketability

Influences
By Policies, Exchange Rates, WTO Membership

Influences
By Policies, Exchange Rates, WTO Membership

Influences
By Policies, Exchange Rates, WTO Membership

Programs
High Risk, Uncertainty
Basic & Applied Research
Defense R&D

Consortia
Universities
Applied Research Labs

Membership, $

Internal
R&D

Development Labs

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e. Carayannis and J. Sagi
Source: Adapted from Elias G. Carayannis, GWU Lectures and in print, 2005
Towards the “Smart” GloCal Knowledge (and Energy) Grid

Know-who  Know-why  Know-how  Know-what

Tacit  Explicit

Global

Regional

Local
EVOLUTION

INNOVATIVE \( \uparrow \) HIGH RISK

LAND GRANT UNIVERSITIES

GERMAN RESEARCH UNIVERSITIES

AMERICAN RESEARCH UNIVERSITIES

EUROPEAN MEDIEVAL UNIVERSITIES

GREEK ACADEMIES

CONSERVING \( \downarrow \) LOW RISK

LARGE SCALE
INTELLECTUAL FUSION

SCHOOL OF EARTH AND SPACE EXPLORATION
SCHOOL OF MATERIALS
SCHOOL OF COMPUTING AND INFORMATICS
SCHOOL OF SUSTAINABILITY
SCHOOL OF LIFE SCIENCES

P-20 EDUCATION

SYSTEM INNOVATION

IP COMMERCIALIZATION EXPERIMENTS

LICENSED TEMPLATES
MASTER SPONSORED RESEARCH AGREEMENTS
DEAL FLOW DENSITY
SOCIALLY RESPONSIBLE IP
FACULTY ENTREPRENEURSHIP INCENTIVES
In Conclusion...

21ST CENTURY INNOVATION ECOSYSTEM

• A 21st Century Innovation Ecosystem is a multi-level, multi-modal, multi-nodal and multi-agent system of systems.

• The constituent systems consist of innovation meta-networks (networks of innovation networks and knowledge clusters) and knowledge meta-clusters (clusters of innovation networks and knowledge clusters) as building blocks and organized in a self-referential or chaotic fractal (Gleick, 1987) knowledge and innovation architecture (Carayannis, 2001), which in turn constitute agglomerations of human, social, intellectual and financial capital stocks and flows as well as cultural and technological artifacts and modalities, continually co-evolving, co-specializing, and co-opeting.

• Sustainable Entrepreneurship and Robust Competitiveness can only exist in a Democratic Society and Polity balancing openness and participation with creativity and innovation...
Source: (CARAYANNIS, DIVERSITY IN THE KNOWLEDGE ECONOMY AND SOCIETY, MAY 2008)

Heterogeneity dynamics – (IPO)

Input H → Process H → Output H

Knowledge
Technology
Entrepreneurship
Land/Labour/Capital

Number of firms
Size of firms
Number of products
Firm Performances
Market concentration

Co-opetition, Co-specialisation, Co-evolution
Creativity & Innovation

• Creativity
  • The result of inspiration and cognition
  • The liberation of talent in a nurturing or provocative context
  • Mostly an intensely private and individualistic process
  • Operates at the *micro* (individual) level

• Innovation
  • Changes the yield of resources
    • A new product or method that boosts supply-side productivity or increases the value obtained from resources by the consumer
  • Not just invention, but economically viable adaptation, improvement, or creation
    • Research is transforming money into knowledge
    • Innovation is turning knowledge into money
  • Operates at the *meso* (team/group/organizational) level

*The uncreative mind can spot wrong answers, but it takes a very creative mind to spot wrong questions.*  
–Anthony Jay
Creativity + Innovation = Competitiveness

- Competitiveness
  - The edifice resting on the pillars of creativity, invention, and innovation
  - The capacity of a project team, organization/firm, industry, or nation to attain and sustain greater productivity than similar entities
  - The drive for survival and ascent
  - Operates at the *macro* (project/firm/industry/national/regional) level

- Creativity, Innovation, and Competitiveness
  - Can be modeled as a double helix
    - Akin to nature’s fundamental scaffold and evolutionary competence
      - One strand represents the flow and record of creativity
      - The other strand represents competitiveness
      - The value-adding chain of creativity, invention, innovation, productivity and competitiveness links both strands
  - This chain catalyzes strategic learning
    - To do things better, cheaper, faster
    - At the micro, meso and macro levels
The CIC Double Helix and Value-Added Chain
Balancing Competition and Competitiveness

![Diagram: Competitiveness vs. competition trade-offs](image.png)

*Figure 1. Competitiveness vs. competition trade-offs.*
Balancing Competition and Competitiveness

Strategies for managing disruptive innovation

- Strategy 1 - Push upmarket toward high-end customers
- Strategy 2 - Stay with customers
- Strategy 3 - Change the market's demand for functionality
Balancing Competition and Competitiveness
MODE 3 KNOWLEDGE INTEGRATION (VS. MODE 1 AND MODE 2

Knowledge integration of:
Mode 3

- Mode 1, Triple Helix
- Mode 2
- National innovation systems;
- multi-level systems of innovation;
- sectoral systems of innovation;
- "democratizing innovation";
- linear and non-linear models of innovation.

Knowledge integration of:
Innovation Networks and Knowledge Clusters.

Technology life cycles, "creative destruction", and/or the co-evolution of different knowledge modes.

Knowledge integration of:
Quadruple Helix

Knowledge integration of:
Innovation Ecosystem

"Democracy" of Knowledge:
Co-developmen and co-evolution of different paradigms of knowledge creation, diffusion and use.
QUADRUPLE HELIX CONCEPT

Direction of time

First Helix:
Academia / universities

Second Helix:
Industry / business

Third Helix:
State / government

Fourth Helix:
Media-based and culture-based public / media / creative industries / culture / values / life styles / “creative class”?.

Triple Helix: University-industry-government relations (helices).
Quadruple Helix: University-industry-government-“media and culture-based public” relations (helices).
FROM TACTICAL FRAGMENTATION TO STRATEGIC INTEGRATION:
The Pieces Must Fit Together – “Mode 3” Knowledge Production System for Innovation and Entrepreneurship

Quadruple Helix: Government-University-Industry-Civil Society/Creative Media
THE 21ST CENTURY FRACTAL INNOVATION ECOSYSTEM: A NEXUS OF INNOVATION NETWORKS AND KNOWLEDGE CLUSTERS

Source: CARAYANNIS ET AL, RE-DISCOVERING SCHUMPETER, MACMILLAN PRESS, MARCH 2007

Strategic Knowledge Serendipity

Strategic Knowledge Arbitrage
Strategic Knowledge Arbitrage

Strategic Knowledge Serendipity

Multi-modal

Co-evolution

Multi-modal

Co-specialization

Multi-modal

Co-competition

Multi-modal

Multi-lateral

Multi-level
IV: The end of a technological regime or business cycle

III: The beginning of a new S-curve

II: The end of an S-curve

I: The beginning of the S-curve

CREATIVE

DESTRUCTIVE

Performance per unit cost

Time

Macro

Meso

Micro

Source: (CARAYANNIS, DIVERSITY IN THE KNOWLEDGE ECONOMY AND SOCIETY, MAY 2008)
Diversity in the Knowledge Economy and Society

Heterogeneity, Innovation and Entrepreneurship

Series editors: Elias G. Carayannis and Aris Kaloudis

The GWU/NIFU STEP series on Science, Innovation, Technology and Entrepreneurship
The S-curve of Technology Capability/Performance over Time reflects a societal learning curve.
Forces that Shape the S-Curve

Four Types of Innovation

- Incremental and Generational Innovations cause the curve to gradually get steeper, until an inflection point is reached, after which returns diminish.
- Radical and Architectural Innovations derive from the invention of a disruptive new technology.
- The gap between adjacent S-curves represents the condition of Economic Dis-Equilibrium.
Forces that Shape the S-Curve

Four Vectors of Influence

– Technology Push
  • Works from outset to inflection
  • Producers devise and introduce new technology to the market, showcasing their “better mousetrap”

– Market Pull
  • Also works from outset to inflection
  • Consumers have unfulfilled wants and needs, begging for a better way of doing things

– Technology Pull
  • Works from inflection to obsolescence
  • Producers cannibalize old technology investments to sustain their returns and suppress disruptive innovations for as long as possible

– Market Push
  • Also works from inflection to obsolescence
  • Standards, alliances, and other constraints suppress incremental improvements
Comprehensive Factor Integration

The side-view of the vector model is fully congruent with the technology life-cycle model.
Integrated Innovation Model (Carayannis et al, 2004)

The Dynamics of Dis-Equilibrium

Expansion of Abernathy & Utterback’s Dynamics of Innovation

Copyright November 2003 Carayannis & Wetter
Entrepreneurial Critical Success And Failure Factors

Source: (CARAYANNIS, DIVERSITY IN THE KNOWLEDGE ECONOMY AND SOCIETY, MAY 2008)

Affordability

Charisma

Character

Culture

Communication

Coordination

Co-optation

Robust Competitiveness

Sustainable Entrepreneurship

Gestation Period and PATIENCE are KEY Factors…

Co-location and a Global / Local View are KEY Factors…
Innovation and Entrepreneurship Strategic Initiatives Framework

1. Educate the Young
   “learn from the best”

2. Reform Legislation
   “remove the obstacles”

3. Create the Environment
   “provide ample opportunities for interaction”

4. Engage the Culture
   “leverage all centers of gravity simultaneously – systemic approach”

5. Coach Startup Teams
   “ensure teams are on the right track”

6. Create Success
   “from ideas and market opportunities to successful exits & IPOs”

7. Communicate Success
   “reach critical mass”

Sustainable Entrepreneurship & Innovation Growth
**Pillar One:**

**Focused Investment Strategy**

- **Geographic Focus**
  - Netplex

- **Investment Size/Stage**
  - $2-4 Million
  - Early, Middle, Pre-IPO

- **Technology Sector**
  - E-Commerce
  - Internet/Intranet
  - Telecommunications
  - Enterprise Software

*Target market:
- Lacks venture capital
- Demonstrating strong growth
- Strong network in place

*Team’s strengths:
- Technology competencies
- Company building experience
- Hands-on preference
Pillar Two: Proprietary Deal-Flow

Professional Network
- Lawyers, Accountants
- Regional Technology Firms
- Other Venture Capitalists
- Angel Contacts

Regional Institutions
- Incubators
- Technology Centers
- Universities
- Speaking Engagements
- Tech Trade Associations

Limited Partners
- The Region’s Smart Money
- The “Barons of the Beltway”
- Side-by-Side Investments
- Local, Successful Entrepreneurs

FBR Relationship
- 12 Tech Research Analysts
- 18 Tech Investment Bankers
- Regional Presence

Portfolio Companies
- Experienced CEOs
- Partnership Network
- Entrepreneurial Network

Referrals
Pillar Three: Opportunity/Risk Assessment Process

Annual Review
>1,000 Proposals

Prospect
200 Proposals

Due Diligence
50 Proposals

Deal Strategy
20 Proposals

Annually Invest
in 6-9 Deals

ID Candidates
- Active search
- Business review
- Reference quality
- Domain focus
- Financing size
- Location
- Maturity

ID Opportunities
- Value creation process
- Market sizing
- Management capability
- Competitive landscape

Assess Risk
- Detailed technical assessment
- Customer refs
- Industry research
- Distribution strat
- Competitive anlys
- Management refs
- Exit opportunity

Partnership
- Evaluate value-add
- Fin modeling
- Valuation process
- Assess build-out needs
- Creative deal structures

Investment
- Final investment discussions
- Terms negotiation
- Business strategy development
- Capital draw down

Market -- People -- Financing -- Products & Services
Implications for S&T Policies and R&D Practices: Mapping Formal & Informal R&D Networks of Networks and Clusters

– Identify a new approach to measuring the lasting effects of government-supported industry-university collaboration on overall collaboration initiatives

– Determine critical “lessons learned” about the formation of university-industry research networks, and the influence of government programs and policies on those networks

– Evaluate government-supported collaborations as platforms for the convergence and clustering of university and private sector research efforts

– Track the generation and diffusion of scientific knowledge by mapping the formation, restructuring, and dissolution of research networks over time
**Implications for S&T Policies and R&D Practices:**
*Mapping Formal & Informal R&D Networks of Networks & Clusters*

- **R&D Consortia are not so much “directed” as “guided”**
  - Many aspects of success are dependent on exploiting fortuitous opportunity
    - Selection of industry partners
    - Research direction and focus
    - Institutional support

- **R&D Consortia differ in their learning experiences (from internal and external sources)**
  - More research needed to isolate and define learning processes
  - Learning processes change over time and vary across centers

- **Developing model of inputs, outputs and outcomes--emerging question of linkage/appropriateness IS KEY…**
  - Inputs: funding (restricted/unrestricted), existing knowledge, participant expertise, infrastructure, institutional support
  - Outputs: graduates, courses, publications, testbeds, applications, products and processes
  - Outcomes: changes in engineering education, changes in research approaches, regional economic development
Implications for S&T Policies and R&D Practices:

- **Market, Knowledge and Network Spill-over Effects**
- **Network Externalities Effects: Sarnoff, Metcalfe, Reed Laws**
  - Infra-structural, Multi-use, Path-breaking Technologies
- **Public Goods with Private Spill-overs and Private Goods with Public Spill-overs**
- **Spin-offs and Spin-ons – Dual Use & Reverse Dual Use Technologies**
- **Entrepreneurs: Obsessed maniacs & clairvoyant oracles**
- **Policy Making: Pushing wet noodles while herding wild cats**
- **Embedded, Distributed, “Ambient” Intelligence Tools and Methodologies**
Innovation activities could be increasingly globalised, in the sense that firms both perform more of their innovation activities in different countries. Relevant indicators are:

1. R&D spending of affiliates as a percent of total BERD (OECD, MSTI 64).

2. The percentage of total business R&D funded from abroad (New Cronos indicator ir024).

3. Co-patenting by individuals in different countries. Data are available from the OECD\textsuperscript{16},

4. Co-authorship share for international scientific articles. Data are available from the NSF\textsuperscript{17} for the United States, the EU-15, Japan and China.
FROM TRADE IN GOODS TO TRADE IN TASKS

Figure 6: The first and second unbundling schematically.

Home labour → Task 1 Task 2 → Good/Service

Factory as a “package of tasks”

“New paradigm” competition: Trade in tasks (competition between workers performing same task in different nations)

“Old paradigm” competition: Trade in goods (competition between factories/sectors in different nations)

Foreign labour → Task 1 Task 2 → Good/Service
Managing Real Options

Create Options
Structure decisions to increase flexibility

Recognize Options
Effective implementation

Realize Option Value
Effective implementation

Value Option
Financial models or decision analysis

Source: Day & Shoemaker, 2000
Knowledge Formality, Serendipity, and Arbitrage: Their Effects on Sustainable Entrepreneurial Action
Research Question

- Much of current literature on regional entrepreneurship treats the entrepreneur as a passive actor in a system of innovation activity
  - Keilbach and Sanders 2009; Klepper and Sleeper, 2005; Krugman, 1994
- But entrepreneurship has separately been linked to economic growth
  - Carayannis, 2009; Romer, 1990; Nelson and Winter, 1982
- Research at a firm- or individual level gives entrepreneurs more active roles in shaping the futures of their ventures
  - Carayannis, 2009; Aldrich and Ruef, 2006; MacPherson and Holt, 2007
  - A core assumption of this study is that entrepreneurs pursue differentiation by appropriating differentiated knowledge from external sources
    - Carayannis, 2007; Kelley and Nakosteen, 2005
- Research question of simulation study
  - How do patterns of knowledge acquisition and assimilation influence the rate and sustainability of new venture formation on a competitive landscape?
    - Conceived as competition for knowledge between incumbent firms and new ventures within innovation system
    - This landscape described conceptually as innovation networks connecting knowledge clusters (Carayannis, 2007)
Systems view of entrepreneurship

- Entrepreneurship has been linked to economic growth
  - Carayannis, 2009; Keilbach and Sanders, 2009; Nelson and Winter, 1982

- Entrepreneurship defined as system of systems
  - Institutional support mechanisms; alliance networks; R+D consortia; competitors; entrepreneurs
  - “Mode 3” (Carayannis and Alexander, 1999; Carayannis and Campbell, 2006) defines innovation as occurring within a network of innovation networks and linked knowledge clusters, which include a substantive level of entrepreneurship
  - Carayannis and Campbell’s (2009) Quadruple Helix provides an organizing framework for the systems view of entrepreneurship – multiple heterogenous stakeholders acting at different environmental layers (i.e., technical, task, institutional, societal) to generate sustainable entrepreneurial activity

- Entrepreneurship induces heterogeneity in market structure
  - A process of innovation driven by co-opetition, co-evolution, and co-specialization (Carayannis, Kaloudis, and Mariussen, 2008)
  - Diversity and market selection mechanisms create heterogeneous agents in an economic system of innovation.
Key concepts

- Entrepreneurial Knowledge Appropriation = Knowledge Acquisition + Knowledge Transformation
  - Both of these dimension emerges from absorptive capacity model of firm growth (Cohen and Levinthal, 1990; Todorova and Durisin, 2007)
  - Distinguish between strategic, tactical, and operational knowledge (which is housed and impacts different layers of the organization)
  - Combination of two processes: knowledge acquisition, knowledge transformation
  - Value creation through combination of new knowledge with existing knowledge stores
  - Core function of entrepreneurship
Key concepts

- **Knowledge acquisition**
  - Accessing new knowledge from external sources: “ability to identify and acquire externally generated knowledge that is critical to its operations” (Zahra and George, 2002: 189)
  - Informal knowledge acquisition occurs through embeddedness of entrepreneurs within a socio-economic milieu
  - Formal knowledge acquisition occurs through the network structures erected by organizations

- **Knowledge transformation**
  - Internal processing of acquired knowledge through combination with existing knowledge
  - Entrepreneurs have limited extant knowledge resources, so transformation represents critical mechanism of growth

- **Networks: mechanisms for knowledge appropriation**
  - Accessing new knowledge from external sources: “ability to identify and acquire externally generated knowledge that is critical to its operations” (Zahra and George, 2002: 189)
    - Informal knowledge acquisition occurs through embeddedness of entrepreneurs within a socio-economic milieu (informal, non-durable networks)
    - Formal knowledge acquisition occurs through the network structures erected by organizations
  - Network characteristics determine the nature and rate of knowledge flows within innovation systems (Provance, 2007): density – number of connections between firms/new ventures, quality of network – types of connections
Knowledge transformation

- Strategic Knowledge Serendipity - “the capacity to uniquely identify, recognize, access, and integrate knowledge assets”; have been described as “happy accidents” of innovation

- Strategic Knowledge Arbitrage - “the capacity to create, identify, re-allocate, and recombine knowledge assets”
  - Carayannis, 2007, 2008; Carayannis and Formica, 2007

- The effects are transformation are influenced by an entrepreneur’s network – size, density, and quality of knowledge flowing through it

**Proposition 1:** The frequency and quality of new venture formation is higher when knowledge serendipity serves as the knowledge transforming mechanism than when knowledge arbitrage does.

**Proposition 2:** The frequency and quality of new venture formation is higher when knowledge arbitrage serves as the knowledge transforming mechanism than when knowledge serendipity does

**Proposition 3:** Knowledge arbitrage will exert a stronger positive influence on the frequency and quality of new venture formation than knowledge serendipity as the topology of the knowledge system surrounding the entrepreneur grows.
Formality of knowledge acquisition

- Formal knowledge acquisition facilitates explicit knowledge transfer
  - Santarelli and Vivarelli, 2004; Rosenkopf and Almeida, 2003

- Informal knowledge acquisition facilitates cluster-specific tacit knowledge spillover
  - Saxenian, 1994; Almeida and Kogut, 1999

- Formality introduces constraints on the transfer of knowledge, limiting heterogeneity, frequency
  - Provance in Knowledge Matters…, Carayannis and Formica (eds.), 2007

Proposition 4: Knowledge arbitrage will have a stronger positive influence on the frequency and quality of new venture formation than serendipity in regions where formal knowledge acquisition is more prevalent.
Simulation model

- The computational model examines two dimensions underlying the nature of entrepreneurial action within innovation systems:
  - How the innovation system’s structure influences entrepreneurial effectiveness
  - How the arbitrage of knowledge and serendipity as primary forms of entrepreneurial action influence system structure.

- Agent-based systems simulation approach on a dynamic landscape
  - Two-dimensional landscape on which a fixed number of innovation “neighborhoods” reside; 20x20 sized torus-shaped orthogonal set of lattice points, for a total of 400 lattice points
    - Modelling the dynamics of entrepreneurship in an innovation system requires a simulation design that can create interactions between actors with heterogeneous behaviors; the design must also allow for evolution of behaviors and states over time
    - Size of modelled landscape is computationally manageable, yet statistically robust. Torus shape ensures internal validity of model – no lattice point in landscape is biased positively or negatively in influencing agent behaviors: agents can move with equal likelihood in all directions.
  - Simplified simulation environment from a true economic system by creating two parallel, overlapping planes of two-dimension grids of coordinates or lattice points. One plane is the market needs landscape; the other plane is the resource competition landscape
Simulation model

0 Founder commitment

1 New venture knowledge acquisition

2 New venture market entry

3 Incumbent firm knowledge acquisition

4 Firm innovation market acceptance

5 Market need resolution

Failure to commit to new venture

Failure to enter

MARKET RESOLUTION

VENTURE FORMATION
Simulation methodology

Research design

- Six configurations, representing landscapes of different complexity/reality
- Configurations selected for statistical and theoretical purposes.
  - (a) – (d) provide internal and construct validity to the design of the simulation
  - (d) – (f) provide external validity (reasonable “realness” that allows us to test certain factors for analogs in the real settings, e.g. failure rate of new ventures)
  - (d) – (f) also allow us to evaluate real comparisons of regional or national variations in entrepreneurial activity. For example, Blend A (e) is designed to provide a simplified model of east coast versus west coast philosophies regarding knowledge exchange among entrepreneurial founders

• Analysis
  - OLS regression to examine independent variables across configurations
  - Post-hoc ANOVA analysis of within-configuration variation
NEW VENTURE FORMATION SIMULATION

STAGE 1: Static Poisson Model

0 Founder commitment
0. Failure to commit to new venture

1 New venture knowledge acquisition
1. Failure to enter

2 New venture market entry

3 Incumbent firm knowledge acquisition

4 Firm innovation market acceptance

5 Market need resolution

MARKET RESOLUTION

VENTURE FORMATION
NEW VENTURE FORMATION SIMULATION
STAGE 1: Static Poisson Model

LANDSCAPE CONCEPTION
NEW VENTURE FORMATION SIMULATION

STAGE 1: Static Poisson Model

The New Venture Knowledge Acquisition cycle runs once per period for each New Venture. This cycle include several permutations of tentative acquisitions for each New Venture in each lattice point that are tested for improvement to the New Venture’s position relative to Market Need.

The resulting knowledge string is tested to determine whether the selection improves the New Venture’s position relative to market need. A simulated annealing algorithm is used to create the possibility of adverse selection occurring. With this algorithm the possibility of worse performance decreases or cools with age.
NEW VENTURE FORMATION SIMULATION
STAGE 2: Dynamic Poisson Model

Failure to enter Founder commitment to new venture

Failure to commit to new venture

New venture knowledge acquisition

New venture market entry

Incumbent firm knowledge acquisition

Market need resolution

Firm innovation market acceptance

Market need resolution

Failure to survive
NEW VENTURE FORMATION SIMULATION

STAGE 2: Dynamic Poisson Model

ELEMENTS TO BE ADDED FOR STAGE 2 SIMULATION –

A The Founder generation routine will become a variable rather than a parameter. The initial value of the variable will be set during configuration, and may be varied across lattice points. The variable will be measured as the number of new nascent ventures (founder PVKE) to consider forming in a given lattice point each period. The value of the variable will be influenced by an algorithm described qualitatively in B, C, D, and E.

B Positive (negative) changes in number and diversity of market needs present in a lattice point will increase (decrease) the rate of nascent ventures (A) in that lattice point.

C Positive (negative) changes in the rate of firm innovation market acceptance in a lattice point will decrease (increase) the rate of nascent ventures (A) in that lattice point.

D Positive (negative) changes in the number of firms present in a lattice point will initially increase (decrease) the rate of nascent ventures (A) to some level set in configuration and then decrease (increase) the rate of nascent ventures beyond that level.

E Positive (negative) changes in the number of new venture failures in a lattice point will initially decrease (increase) the rate of nascent ventures (A) to some level set in configuration and then increase (decrease) the rate of nascent ventures beyond that level.

F On some [low] probability, a market need will change its requirement string based on the entry of a nascent venture in order to increase the speed of market success for the new venture (to reflect disruptive change).

G A parameter for triggering incumbent firm failure will be established in the simulation. This parameter should be considerably larger than the one for new ventures. The firm will be deactivated in the simulation on failure (but meta-data on firm retained).

H The selection process for acquiring loose knowledge will be modified to (i) produce incidental spillover of the loose knowledge from adjacent regions (lattice points), and (ii) consumption of loose knowledge within a lattice point. For (i), the radius defining the range of acquisition of loose knowledge will be redesigned as an algorithm using a Poisson distribution that allows for loose knowledge from an adjacent lattice point to be acquired on a low and decreasing probability. For (ii), on some probability (set during configuration), loose knowledge that is acquired by a new venture or incumbent firm will be considered consumed by that entity and will disappear from the landscape. On some probability lower than the consumption probability, new loose knowledge clusters will be generated in lattice points.
Conclusion and Implications

- Study isolates four mechanisms of knowledge appropriation
  - knowledge acquisition formality
  - knowledge serendipity
  - knowledge arbitrage
  - network typology

- Study confirms the presence of heterogeneity in means by which new ventures form, and examines conditions under which different factors are more influential
  - Informal knowledge acquisition promotes role of serendipity
  - Serendipity more influential, except in presence of stronger formal acquisition processes (e.g., networks) – FORMALITY OVERSHADOWS “HAPPY ACCIDENTS”
  - Entrepreneurial networks matter, but only after critical mass is reached
Words of Wisdom to remember...

"The innovator has for enemies all who have done well under the old, and lukewarm defenders in those who may do well under the new law."

Nicolò Machiavelli
THE CHINA QUESTION:
Li Yuese nanti

- Few people, other than scholars, will be familiar with the story of the Cambridge don whose study of China’s scientific history helped to change the West’s appraisal of a civilisation once thought hopelessly backward.
- *By the time Joseph Needham died in 1995, he had published 17 volumes of his “Science and Civilisation in China” series, including several that he wrote entirely on his own.*
- The Chinese began printing 600 years before Johannes Gutenberg introduced the technique in Germany. They built the first chain drive 700 years before the Europeans. And they made use of a magnetic compass at least a century before the first reference to it appeared elsewhere.
- *So why, in the middle of the 15th century, did this advanced civilisation suddenly cease its spectacular progress?*
- So powerful has Needham’s contribution been to the historiography of Chinese science that this conundrum is still known as “The Needham Question”. Even the Chinese themselves use it: the phrase in Mandarin is Li Yuese nanti.
- In 1936 three Chinese assistants came to work in his biochemistry laboratory. One, Lu Gwei-djen, who came from Nanjing, began teaching him Chinese, which ignited Needham’s interest in the country’s technological and scientific past. He retrained as a Sinologist and took a job in Chongqing as Britain’s scientific emissary.
Chinafrique...

• FP: How does China’s investment in Africa differ from the powers who came before it?

• SM: There are five major differences:
  – One, China has no colonial past.
  – Two, it has a pan-African approach, unlike Europeans who only worked in their former territories.
  – Three, China sets no political conditions on its cooperation (such as democracy and transparency). The only requirement is that the African country must sever its ties with Taiwan.
  – Fourth, China finances infrastructure, such as dams, roads, and railroads, and it constructs them with its own labor.
  – Fifth, China is the last centralized system and can easily offer “package” deals that include, to use Guinea as an example, a bauxite mine, a dam, a power station, a refinery, and a railway—all financed by the Exim Bank of China. Its North American competitors always refused to embark on refining, because they said there was not enough electricity in the country, even though 122 sites have been identified as ideal for constructing dams.
THE CHINA QUESTION Re-visited…:

Li Yuese nanti

• Needham never fully worked out why China’s inventiveness dried up.

• Other academics have made their own suggestions: the stultifying pursuit of bureaucratic rank in the Middle Kingdom and the absence of a mercantile class to foster competition and self-improvement; the sheer size of China compared with the smaller states of Europe whose fierce rivalries fostered technological competition; its totalitarianism.

• With its unreformed one-party system, its rote-learning in schools and state control of big businesses, “new China” is hardly a haven for innovative thinking. Yet the Chinese continue to fret about the Needham question.

• A Communist Party chief of a middle school in central China recently said that it deserved deep thought and that the answer lay in an education system that fails to emphasize improving “character”.

• A former government minister also referred to Needham’s lament that China had produced no idea or invention of global impact for more than 500 years. Its contribution henceforth, the official said, should be “harmony”.
Points to Remember...

• The brightest frontiers of knowledge reside at the intersection of technology, insight and traditional disciplines

• A collaborative, sustained commitment by industry, government and academia is essential

• Innovation is a culture, not a department
  • Nick D’Onofrio,
    – IBM Sr. Exec. VP
    – Invited Lecture, GWU SoB, October 2007
Ending Thoughts...

• 'Until philosophers are kings, or the kings and princes of this world have the spirit and power of philosophy,... cities will never have rest from their evils - no, nor the human race as I believe...' [Plato, The Republic, Vol. 5, p. 492]

• 'The lowest form of thinking is the bare recognition of the object. The highest, the comprehensive intuition of the man who sees all things as part of a system.' [Plato]
She – she !!! 😊