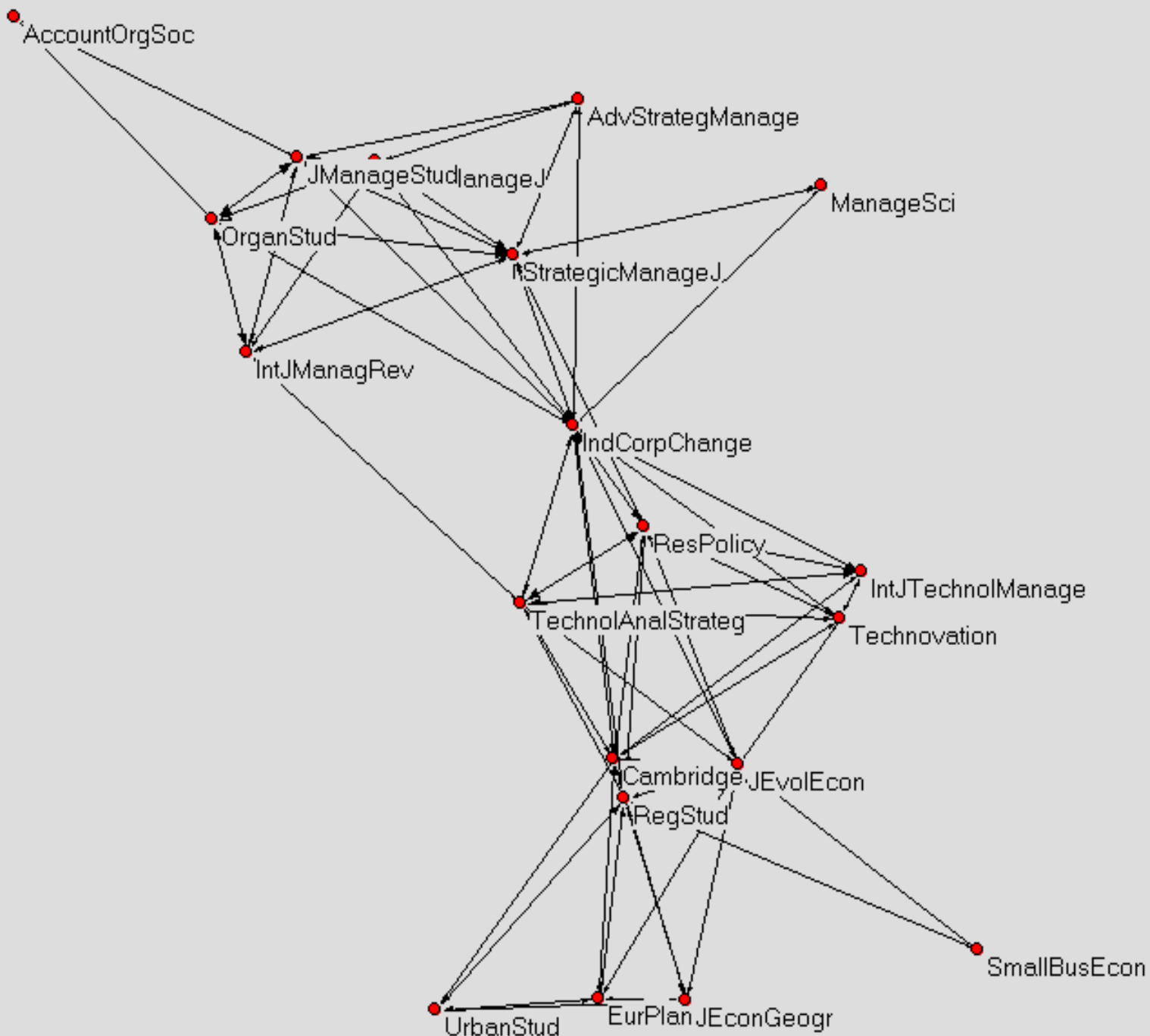


# Knowledge and Capabilities

**Paul Nightingale**  
**SPRU**

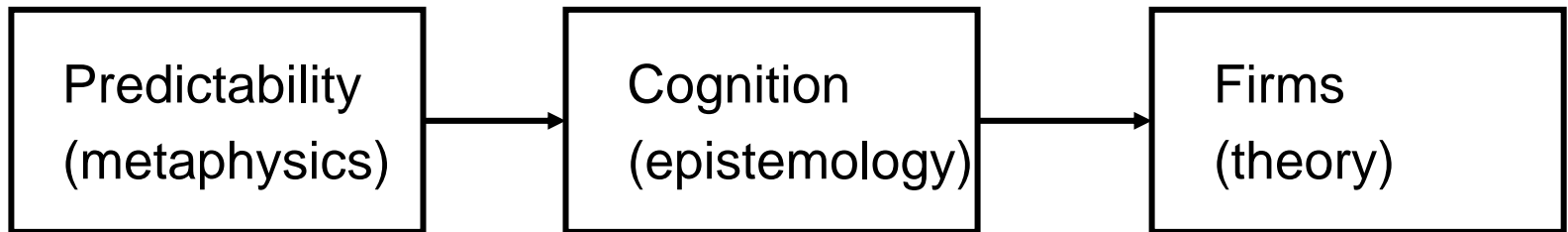
# Knowledge and Capabilities

- What are the central insights, controversies and challenges that have emerged since Nelson and Winter presented their approach a quarter of a century ago?
- First, discuss theory of the firm, knowledge & capabilities
  - Danger of Tautology: what kinds of capabilities, where and when?
- Then talk about data on 950 firms (update Taxonomy)
  - 423 point template; 200 interviews, ~3/firm, CTOs & VPT – 90 mins
- Take home message – simple theory works very well





# Meta-paradigms



## Mr. Optimiser:

predictable (world/cognition)	mirror of nature PR static event	allocation static event
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## Mr. Sceptic:

unpredictable	embodied PR process	dynamic capabilities
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# Who co-cites with who?

- Mr. Optimiser: - textbook neo-classical
  - World predictable - firms production function
- TCE; RBV accept metaphysics & epistemology
  - But why firms? – un-traded resources or costs of trade
- Evolutionary: metaphysics OK, not epistemology
  - Bounded rationality & dynamic capability
- Mr. Sceptic - question metaphysics
  - Empiricists & diveristy

# Mr Optimiser

- C-19<sup>th</sup> “science” - world predictable, knowledge is a “mirror of nature”
  - Both brain and world predictable – know stuff when they match. Prediction possible by running the causal tape forward.
- Practical reason is means-ends
  - Running the causal tape backwards from what you want to how to get it
  - Economics is practical reason where the end is maximised profit
- Firms are production functions –everything can be explained
  - Imperfect expression in real world
- “mistake to confuse the firm of economic theory with its **real world** namesake. The chief mission of neo-classical economics is to understand how the price system coordinates the use of resources not the inner workings of **real** firms” Demsetz (1983:377)

# Transaction Costs & RBV

- Accept all Mr. Optimiser's views – empirical existence of firms (*problem*)
  - Same view of science, method, cognition etc
- 1) Transaction costs = 'costs of using the price mechanism'
  - Coase absent transaction costs, firms don't exist
  - Williamson science of contracts... governance structures "Nexus of Contracts"
  - Cheung (1983) usefulness 'firm'?, Alchian & Demsetz (1972) authority/price distinction?
- 2) RBV have same problem but different take
  - Rather than a transaction cost, its resources that aren't traded/exchanged
  - Performance differences explained in terms of differences in inputs
  - Lippman and Rumelt (1982) tech diff to copy
  - Barney 1991 Peteraf 1993, Barney 1986 info asymmetry

# Evolutionary Tradition

- Accept predictability, question epistemology
- *In theory* it is possible to predict the world, but *in practice* full ‘rationality’ is not possible – rationality is bounded
- Instead, rely on Simon’s imperfect satisfying heuristics in cognition, routines in firms.....
  - Dynamic (learning)
  - Bounded rationality, path dependence, uncertainty,,
  - Heterogeneity: capabilities
  - Tacit (hard to trade)

# Empiricist Tradition

- Question 'scientific credentials' (SPRU)
  - Firms and people are **not** essentially the same
- Freeman/Rosenberg/Pavitt - unpredictability
  - Create predictable behaviour (Chandler & Pavitt)
  - Technological capabilities needed in house that are localised, untraded and specific to firms and technology
  - Hence substantial empirical diversity and is why new patterns of innovative behaviour constantly emerging
- Question: given reality of diversity, does 'a' theory of 'the' firm make sense?
  - More deeply: how consistent is a 'knowledge' based view?

# Part 2 – does a knowledge based theory of ‘the’ firm make sense?

# Explaining Diversity

- Issue isn't just knowledge – need to explain more... particularly diversity
  - since Pavitt ('84), Pavitt ('90) – info intensive; Archibugi ('01) – Multi-Tech
  - CoPS embedded software (Hobday '98)
  - System Integrators (Davies et al '01), Solutions Providers (Brady & Davies, '04), Networked service firms (Nightingale et al '03)
- Services - Manchester services are important and different.
  - BUT: Soete and Miozzo '90; Evangelista '00; Tether et al '01
  - Nightingale & Poll ('00) – “Rocket Science”; Siepel ('07); Hedge Funds
- Empirical Complexity and Theoretical Questions: - so what?
  - Static: not stamp collecting; misses a lot, weak, services?
  - Put these taxonomies in temporal order and simple pattern emerges

# Theory 1: Division of Labour

- Unpacking Russian Doll
  - Smith's expanding markets led to an increase in the division of labour, but for Babbage co-ordination also requires integration
- As Smith's markets expand, technical change shifts from *all* users, to *many* makers, to *some* philosophers
  - Expect to see changing pattern as technical change moves from users, to suppliers and then on to specialised R&D intensive organisations
- Babbage implies this production machinery can be integrated to generate production **systems**
  - These would in turn be subject to the same pattern
  - Scale intensive production, then CoPS suppliers & System Integrators

# Theory 2: Characteristics

- Old: organisational & technological capabilities are firm & technology specific, difficult to transfer & accumulate – hence diversity
  - Here we are explaining diversity with the division of labour first
  - More useful for type of trajectory than differences?
- New: The issue is the creation of predictability:
  - Infrastructure creates the conditions where scientific theories are true – allows science to be universal
  - Design knowledge on the other hand is much more local

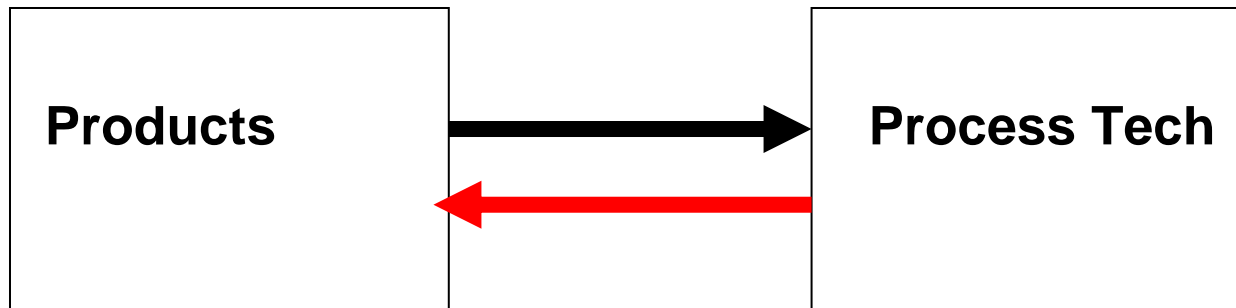
# Division of Labour

- 19<sup>th</sup> century:

**Products**  
**Process Tech**

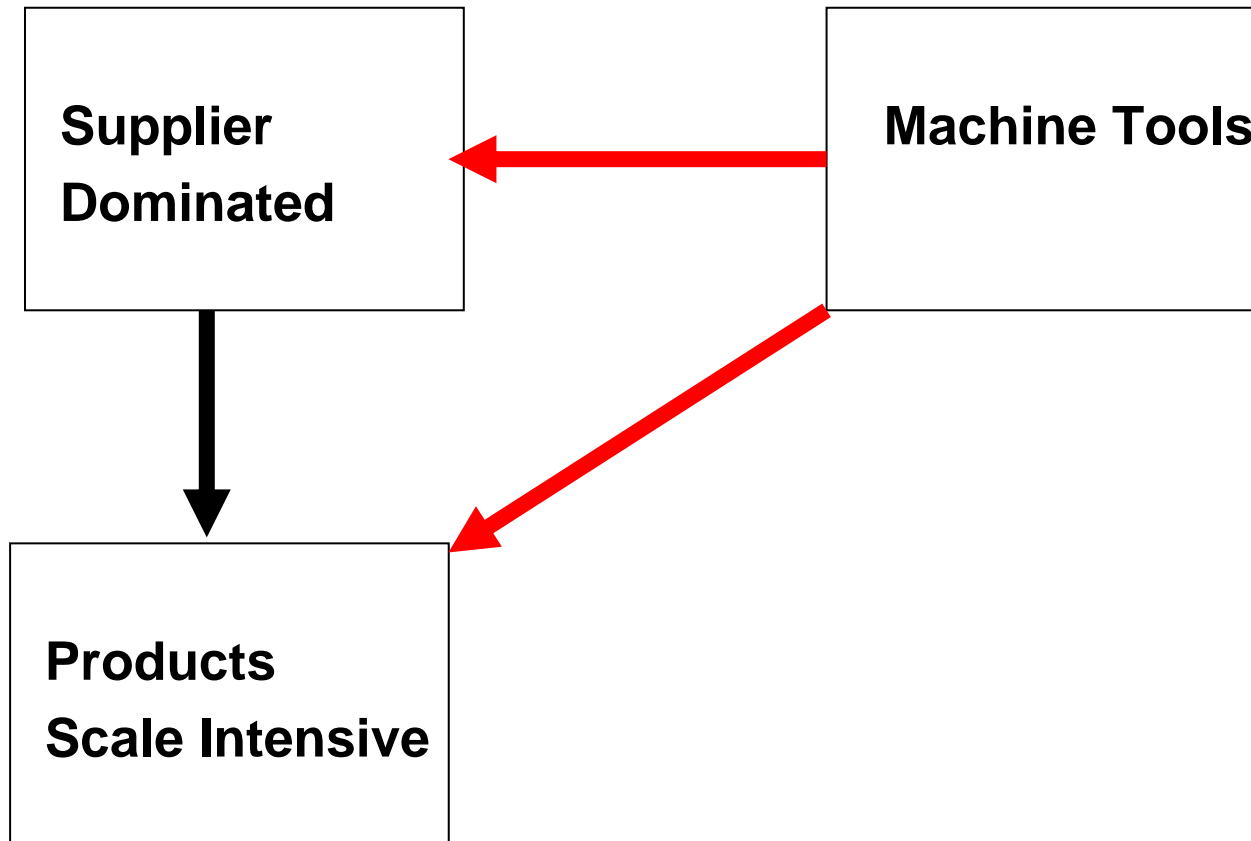
# Rosenberg/Scranton

- 19<sup>th</sup> century:
  - Black Division of Labour; **Red Tech Flow**



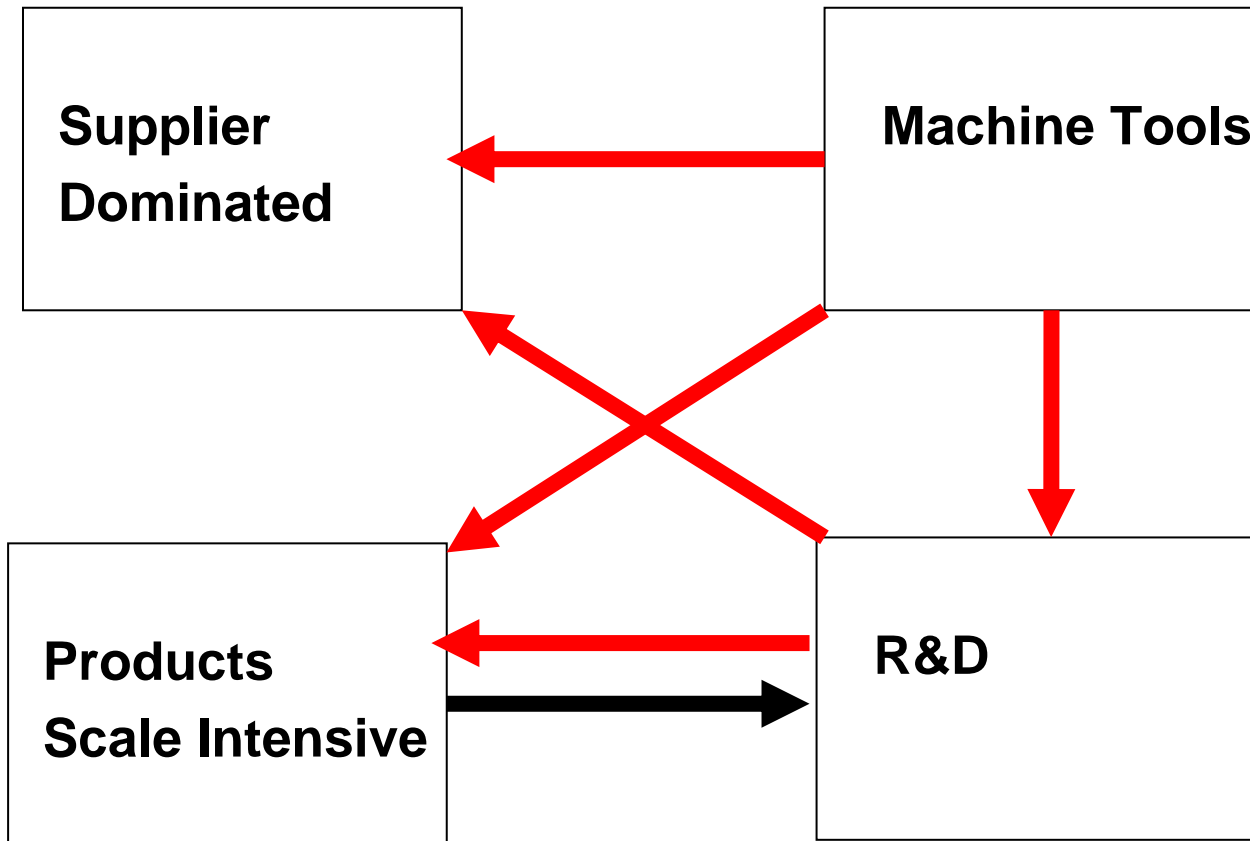
# Chandler

- 20<sup>th</sup> century:



# Mowery

- 20<sup>th</sup> century:

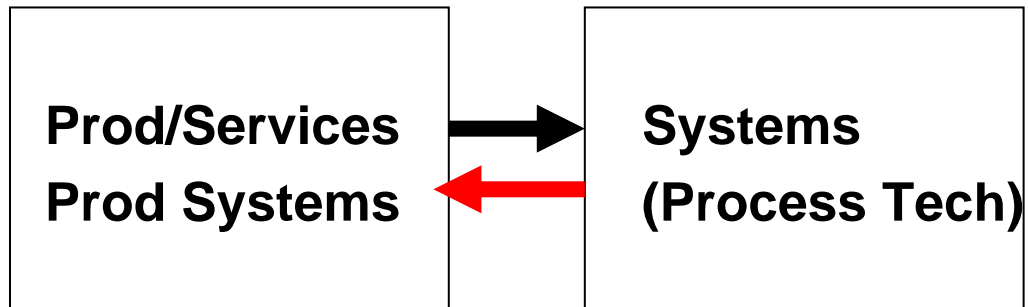


# Pavitt's Core Typology

Nature Firm	Standard Process	Innovative Process	Product Innovation Characteristics	
Innovative Products	SS	Sci	Performance Product	
			Design and users Design Offices	Internal R&D and public science R&D labs
Standard Products	SD	Sc	NA	
	Process Innovation Characteristics	NA Limited Suppliers Limited	Price Process Production Eng & Suppliers Production Eng	Customer Preference Main Direction of Innovation Source Product or Process Technology Location in-house capabilities
	Appropriation Strategy and Size Firm	Reputation (SS) and Limited (SD) Small	IPR, scale and secrecy (Sci) Scale, barriers to entry (Sc) Large	

# Hobday

- 1970s onwards-:



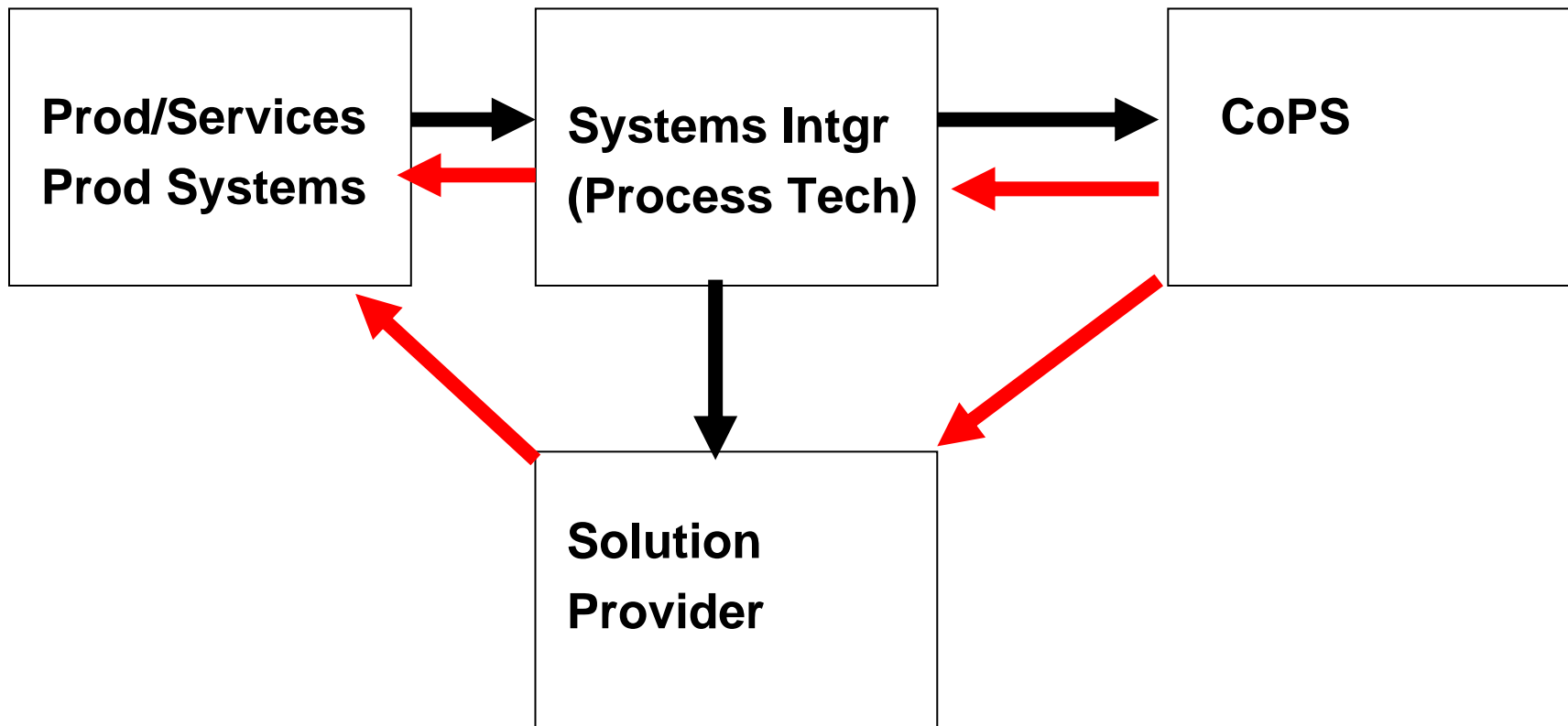
# Hobday

- 1970s onwards-:



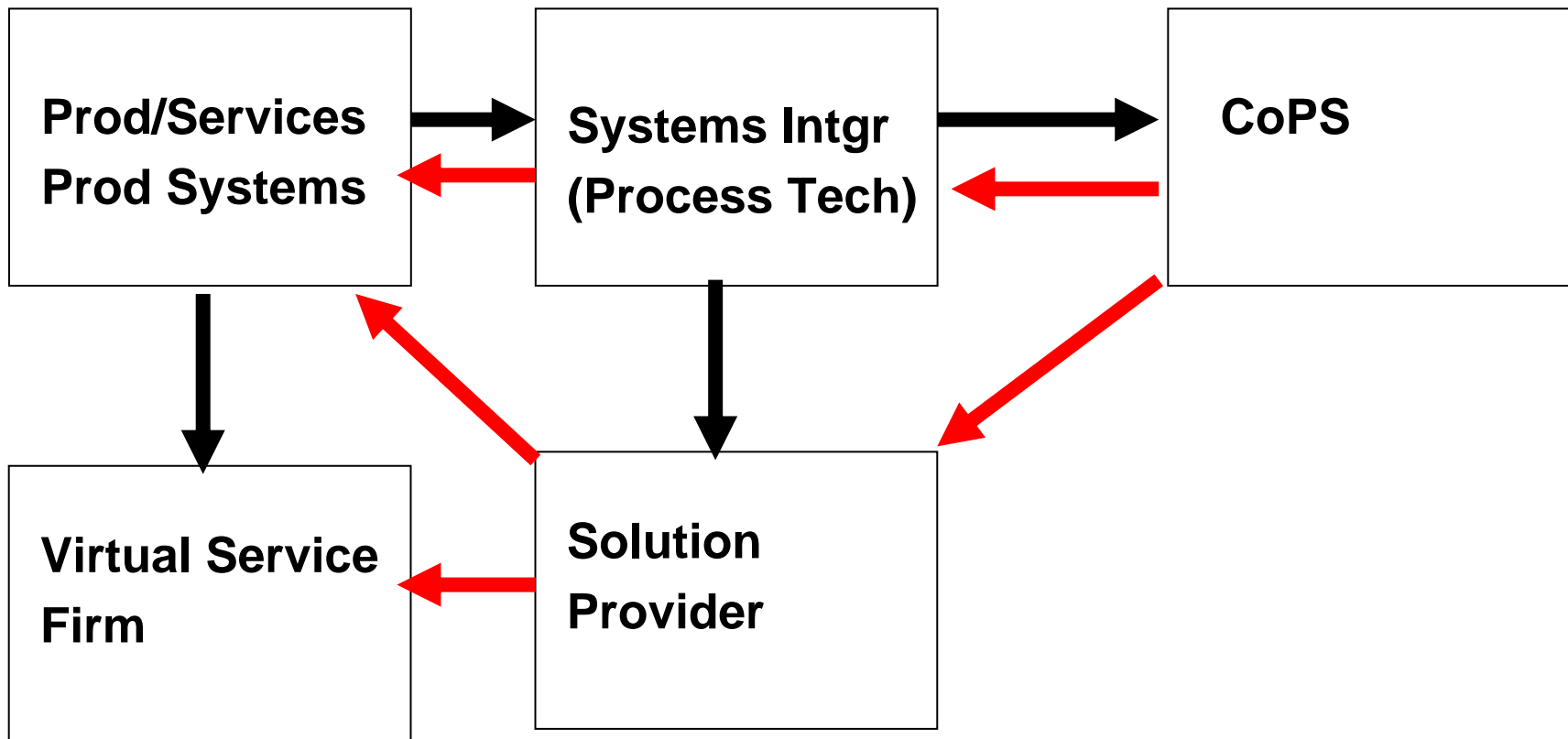
# Davies

- 21<sup>st</sup> century:



# Nightingale

- 21<sup>st</sup> century:



# Dynamic Typology

- Same process of increasing divisions of labour that applied to machinery also applies to systems:
  - In-house, to Systems Integrators, to Integrated Solutions
  - risk-man, to rocket sci, to hedge funds
- Many features similar to Machine Tools:
  - users, bespoke, batch
- Different: complex, size, cost, volume:
  - later, hierarchy, outsourced, project

# Theory 3: Services different?

- Material-immaterial distinction confuses a distinction between products & services with a distinction between technological artefacts (material) and technological function (imposed)
  - Mistakenly assigns each exclusively to manuf or services (note product/manufacturing jump). In reality artefacts & functions cannot be separated and are found in manufacturing and services.
- Fallacy of composition – many manufacturing steps not production, many service steps involve production and use of technology.
  - Distinction reflects closeness to production and after-the-fact legal ownership: for example, leasing.
- Issue is financial/economic: reflecting relative costs & performance of having a function generated by an artefact one legally owns.

# Services & SYSTEMS

1. As consumer goods (produced *by* systems) reduce in cost, consumers produce personal services at home (Gershuny)
2. As production systems increase in complexity, professional services become more important
3. As fixed costs increase, tech capabilities move upstream, local operational knowledge increases as source of innovation, utilisation rates improved by provision of services and solutions become more important

Nature Firm Trajectory	Standard Process	Innovative Process Flow	Innovative Process Project		Performance/Product
Systems	<b>X</b>	<b>PO</b>	<b>SI, CoPS,</b>		Design (SW); design & testing, PM
Information	<b>PS</b>	<b>MTF-I</b>	<b>IS, N-Sys</b>		Learning; professional
Science	<b>PS-S&amp;T</b>	<b>MTD-Sci</b>	<b>X</b>		R&D; R&D public science
Design	<b>PS-D, SS, CoPS</b>	<b>MTF-D</b>	<b>KIBS</b>		Design; users; design offices
Standard	<b>SD, V-S</b>	<b>Sc, N</b>	<b>Non-tech infra</b>		NA
Customer Pref Main Direction Source Location	NA Limited Suppliers Limited	Price Process Suppliers Product Eng	Perf/Overruns Project PM Offices		
Appropriation Strategy Size	Non-tech Move Sc-In Small	IPR, Scale Cost reductn Large	Reputation Reuse-upgrade Medium-Large		

	non utilisé	Prod. de masse, monopole	Production de masse	R&D brevets	Conseil et ingénierie	Intégrateurs	Prod. de masse personnalisé	Bataille d'architecture	Total
Joute_Épurée	0.19	-0.53	-0.54	0.21	-0.04	0.40	-0.08	0.56	0.00
Contexte-01-dynamisme [dynamism]	-0.02	-0.28	-0.22	0.21	-0.18	0.30	0.02	0.07	-0.01
Contexte-02-science & connaissance [science and knowledge]	-0.29	-0.42	-0.15	0.15	-0.21	0.25	-0.06	0.43	0.00
Contexte-03-interopérabilité [interoperability]	0.46	0.07	-0.23	-0.31	-0.15	0.27	-0.07	0.20	-0.01
Contexte-04-turbulence [turbulence]	-0.21	-0.66	-0.12	-0.02	-0.19	0.34	-0.03	0.40	0.00
Contexte-05-interdépendance [inter-dependence]	-0.04	-1.00	0.37	-0.49	-0.28	0.34	0.15	-0.04	0.01
Contexte-06-rivalité [rivalry]	0.29	0.09	-0.10	0.31	-0.20	0.16	0.32	-0.63	0.00
Contexte-07-regulatory approval	-0.03	0.29	0.42	-0.45	-0.53	0.08	0.22	-0.35	0.00
Contexte-08-coût [cost]	0.15	0.04	0.14	-0.41	0.09	-0.04	-0.16	0.11	0.00
Contexte-09-progression continue mais lente [continuing but slow]	-0.17	-0.05	-0.07	0.00	-0.15	0.13	0.23	0.01	0.01
Contexte-10-stimulation de l'entrée [stimulation of entry]	-0.03	-0.45	0.13	0.22	-0.05	0.10	-0.15	-0.09	0.00
Contexte-11-expertise des clients [client expertise]	0.23	-0.98	-0.21	-0.34	-0.04	0.48	0.13	0.40	0.01
Création Valeur-1-Intensité de l'innovation [intensity of innovation]	-0.01	-0.46	-0.21	-0.15	-0.28	0.36	-0.03	0.40	-0.02
Création Valeur-2-Orchestration des standards [orchestrating standards]	-0.20	-0.24	0.45	-0.31	-0.36	0.33	0.36	-0.48	0.00
Création Valeur-3-Optimisation des coûts [cost optimisation]	0.09	-0.27	-0.35	0.79	-0.19	0.45	0.10	-0.30	0.02
Création Valeur-4-Productisation de la science [productisation of science]	0.25	-0.48	-0.09	0.19	0.29	0.21	-0.53	0.17	0.01
Création Valeur-5-Co-innovation	0.16	-0.80	-0.30	0.14	-0.14	0.32	0.08	0.43	0.01
Strategy-1-Radical initiative	0.41	-0.22	-0.14	0.03	0.18	0.16	-0.42	0.14	-0.01
Strategy-2-Organizational Flexibility	-0.18	0.14	-0.08	0.13	-0.38	0.36	0.22	-0.15	0.01
Strategy-3-Natural Resources Ownership	-0.11	-0.88	-0.24	0.70	-0.33	0.40	-0.06	0.19	0.00
Strategy-4-IP and technological superiority	0.20	-0.44	-0.01	-0.42	0.31	0.24	0.13	-0.09	0.01
Strategy-5-Brand and reputation	0.47	0.76	-0.15	-0.14	-0.43	0.37	0.27	-0.62	-0.01
Strategy-6-Influence on public regulation	0.14	-0.38	0.39	-0.52	-0.39	0.24	0.15	-0.17	0.02
Strategy-7-Scale	-0.52	-0.30	0.07	-0.13	-0.16	0.44	-0.13	0.14	-0.01
Strategy-8-World scope	-0.07	-0.02	-0.08	0.00	0.07	0.12	-0.11	0.02	-0.02
Strategy-9-Continuity	0.04	-0.97	-0.10	-0.56	-0.06	0.38	0.36	0.24	-0.02
Strategy-competitive moves-1-Branding	-0.21	-0.74	-0.37	0.49	-0.29	0.63	-0.14	0.35	0.01
Strategy-competitive moves-2-Technological leadership	0.38	0.65	-0.21	0.15	-0.40	0.49	0.14	-0.51	0.00
Strategy-competitive moves-3-Regulatory game	-0.12	-0.32	0.52	-0.63	-0.06	0.30	0.17	-0.36	0.00
Strategy-competitive moves-4-Scale & acquisition	-0.16	-0.59	-0.33	0.38	-0.33	0.58	-0.07	0.23	-0.01
Strategy-collaborative moves-1-alliances & licences for market devt	0.26	-0.52	-0.14	-0.37	-0.31	0.51	-0.22	0.55	0.00
Strategy-collaborative moves-2-creating the eco-system	0.24	0.28	-0.04	-0.27	-0.21	0.56	0.24	-0.57	-0.01
Strategy-collaborative moves-3-standardization & regulation	0.07	-0.58	-0.18	0.10	-0.11	0.14	-0.14	0.38	0.00
Resultats_Inovativeness	0.16	0.15	-0.12	-0.12	0.12	0.04	0.01	-0.09	-0.01
Resultats_Rentabilité	0.17	-0.20	-0.05	-0.05	-0.01	0.26	-0.07	-0.13	-0.01
Resultats_New_Business									

# Conclusion

- Not sure a knowledge based view of the firm is consistent with the overall direction of change in the theory of the firm.
- Simple first principles theory: machines, systems & services
  - Explains considerable variation & makes predictions
  - Can critically engage with ‘fads’ and provides a nice ‘null hypothesis’
- Integrates manufacturing and services
- Inform policy – ‘Knowledge Economy/R&D’ silly
- Inform strategy – null hypothesis as simple tool
- Empirical evidence generally supportive, but adds considerable nuance (i.e., regulation in Science intensive)