Extending March's Exploration and Exploitation: Managing Knowledge in Turbulent Environments

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Seminal Model by March (1991)

- Organizational learning modeled as a balance:
  - exploitation (p1) = reusing existing competences with certain return
  - exploration (p2) = considering new competences with uncertain return
  - exploitation likely to be positive in short-term, negative in long-term

- Beauty of a stylized computer model:
  - parsimonious in its design
  - allows specific manipulations of values
  - conclusive in its qualitative observations

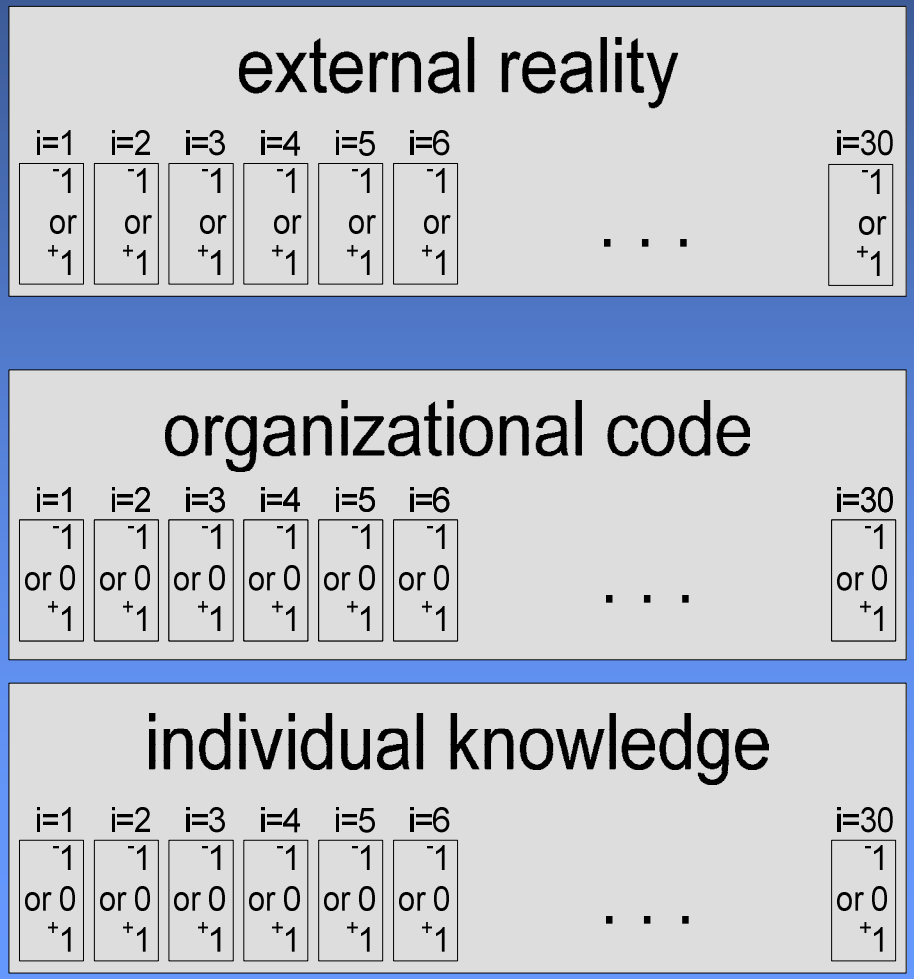
Seminal Model by March (1991)

- Individual reality:
  - m=30 dimensions, each independent of one another
  - can be either {-1}, {0}, {+1}, with {0} as neutral or no opinion
  - n=50 individuals in org, each initially with random values

- Organizational code:
  - m=30 dimensions, each independent of one another
  - can be either {-1}, {0}, {+1}
  - code represents collective knowledge of the org, initially all {0}

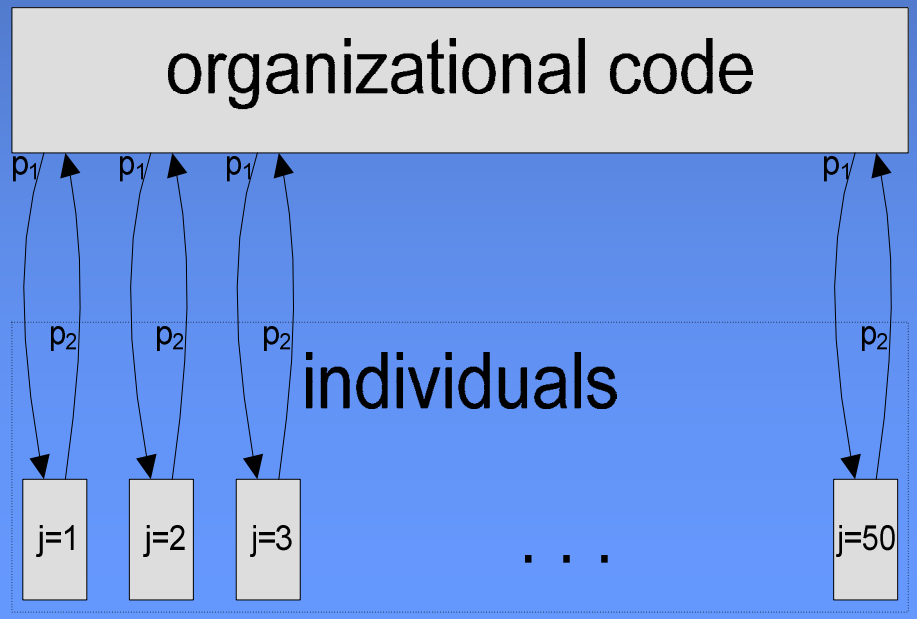
Nuances of the Original Model

- Org code and individual knowledge can learn:



Nuances of the Original Model

- Organizational learning:
  - neither org code nor individuals directly see true external reality
  - org code can only change belief to match best (expert) individual
  - yet org may adopt an incorrect dimension from an expert in err



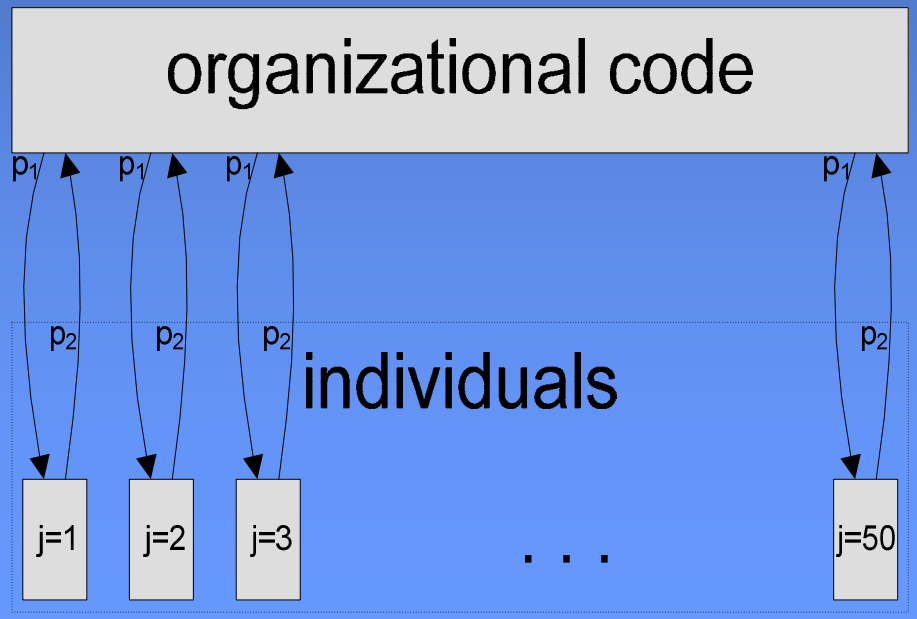
Additional Extensions by March

- Turnover:
  - for each iteration, probability (p3) individual will be replaced
  - new individual has a random collection of knowledge/beliefs

- Environmental turbulence:
  - for each iteration, probability (p4) a dimension of reality will "flip"
  - each flip can be from either {-1} → {+1} or from {+1} → {-1}

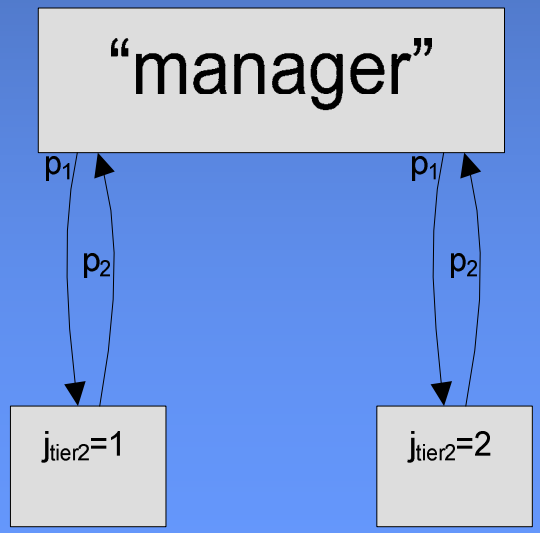
This Study: Extending the Model

- March's model only considered a flat organization:
  - no reporting structure between individuals
  - no use of technology to try and manage knowledge



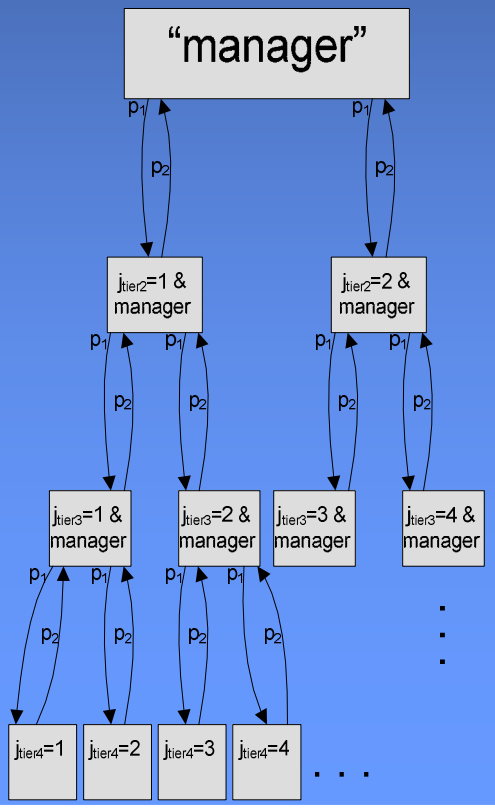
This Study: Extending the Model

- Consider a reporting structure:
  - org code becomes a manager to a set of (b) reporting individuals
  - each direct report still has a probability (p1) of learning from their manager
  - each manager has a probability (p2) of learning from expert report



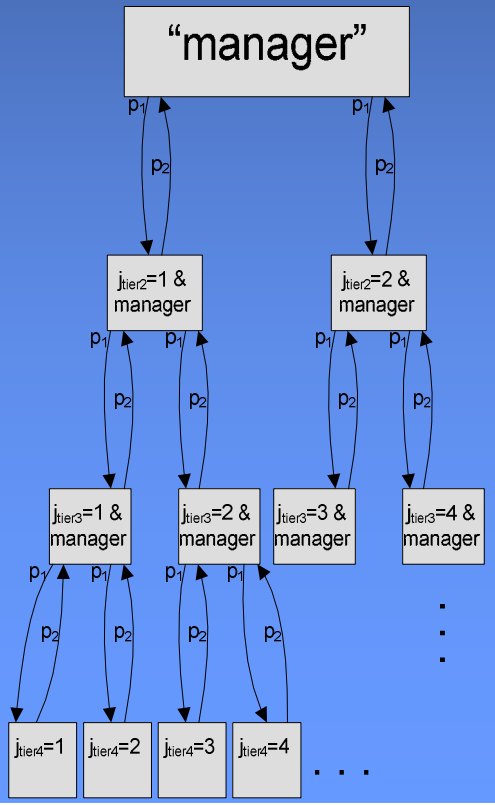
This Study: Extending the Model

- Consider a reporting structure:
  - a report can in turn become a manager to other reporting individuals
  - each direct report still has a probability (p1) = exploitation
  - each manager has a probability (p2) = exploration from direct reports



Effects of Multiple Tiers

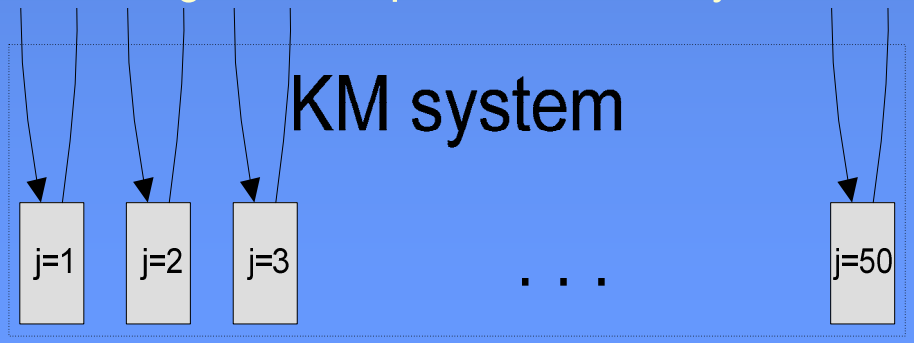
- Allows for multi-tier organizational hierarchies:
  - what effect does increasing the depth of a hierarchy (d) have?
  - what effects do turnover (p3) and turbulence (p4) have now?



Effects of Knowledge Management

- How to model norms of use of a KM system:
  - collect average knowledge of the top (rEX)% expert individuals
  - make this knowledge available to all managers in org
  - each manager has a probability (pKM) of using org KM system for learning vs. learning from an expert direct report (p2)

- Consider impact of KM on March's model:
  - what effect does increased frequency of use for a KM system have?
  - what effect does including more experts in a KM system have?



Expectations

- Expect to find:
  - fragmentation of knowledge in a multi-tier hierarchical organization
  - multiple tiers lead to inefficient knowledge exchange
  - multiple tiers lead to inefficient knowledge flow delay

- With KM:
  - use of a KM system will counter environmental turbulence
  - best norms of use for a KM system will not be heavy (where pKM $\geq$ 0.5)
  - best norms of use for KM will include “top” 1% experts only (vs. rEX $\geq$ 10%)

Hypotheses

- H1:
  - additional tiers in a hierarchy will decrease the accuracy of average individual knowledge levels when an organization opts for a strategy of high exploitation and low exploration in a multi-tier hierarchical organization

- H2a and H2b:
  - increasing personnel turnover (within the values of 0.000 to 0.040) will increase the accuracy of average individual knowledge levels
  - increasing environmental turbulence (within the values of 0.000 to 0.040) will decrease the accuracy of average individual knowledge levels

Hypotheses

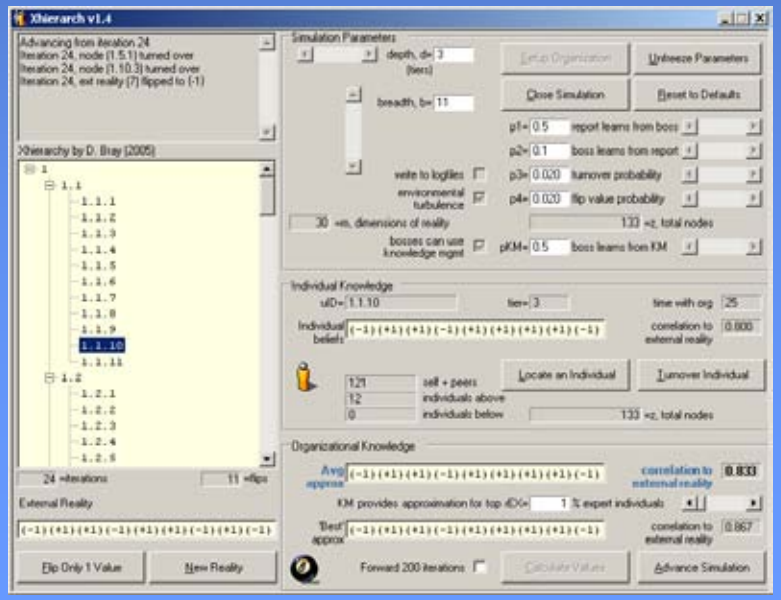
- H3:
  - increasing the probability of norms of use and influence of a knowledge management system (pKM) will increase the accuracy of average individual knowledge levels, insomuch that the knowledge management system does not become another source of exploitation

- H4:
  - widening the number ratio of expert individuals (rEX) whose consensual knowledge is included in the knowledge management will introduce additional randomness into the system and decrease the accuracy of average individual knowledge levels

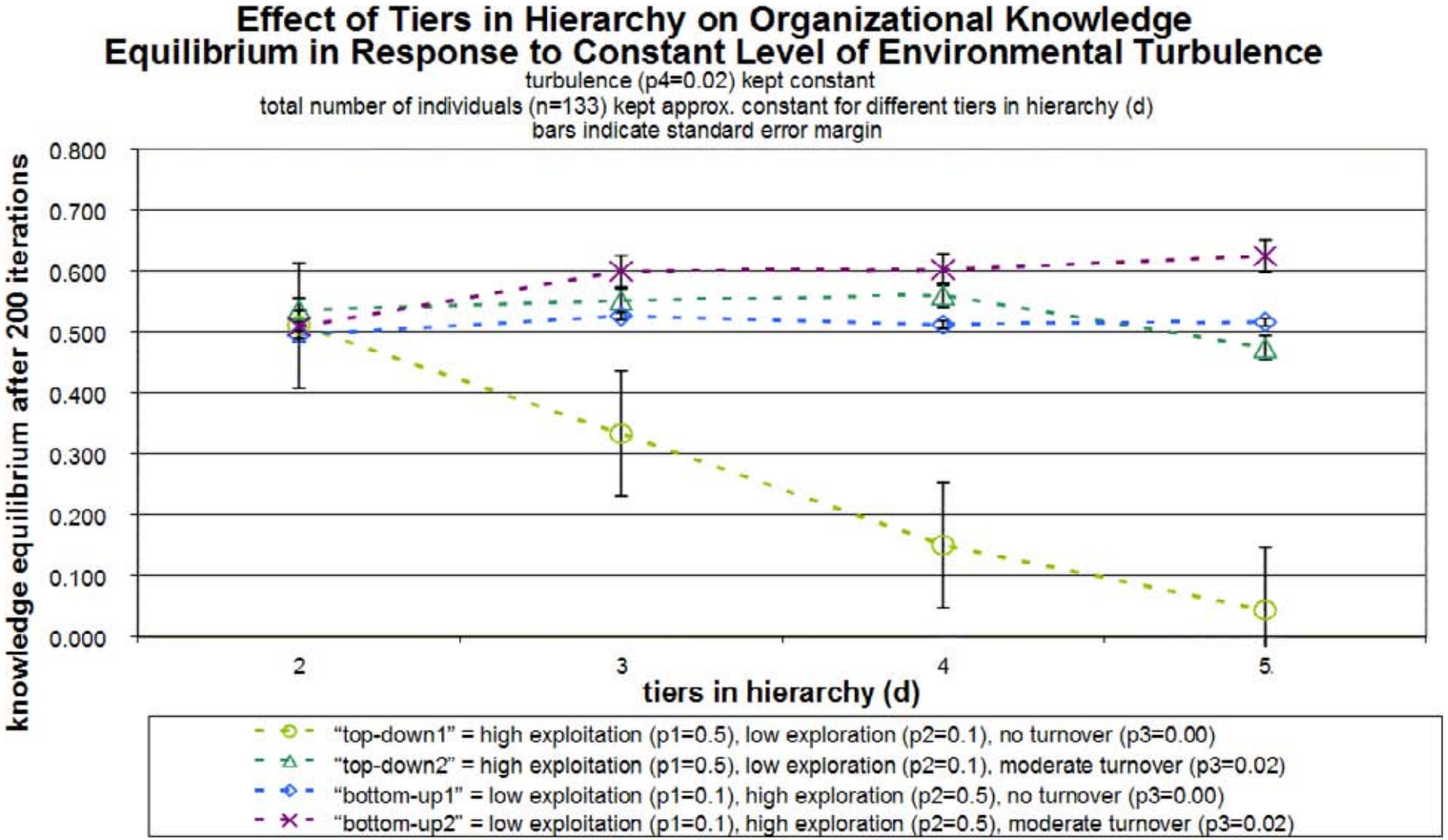
Method

- Build simulation per stated extensions:
  - validate simulation matches March's original results
  - then test extensions for a flat and multi-tier hierarchy
  - report observed relationships

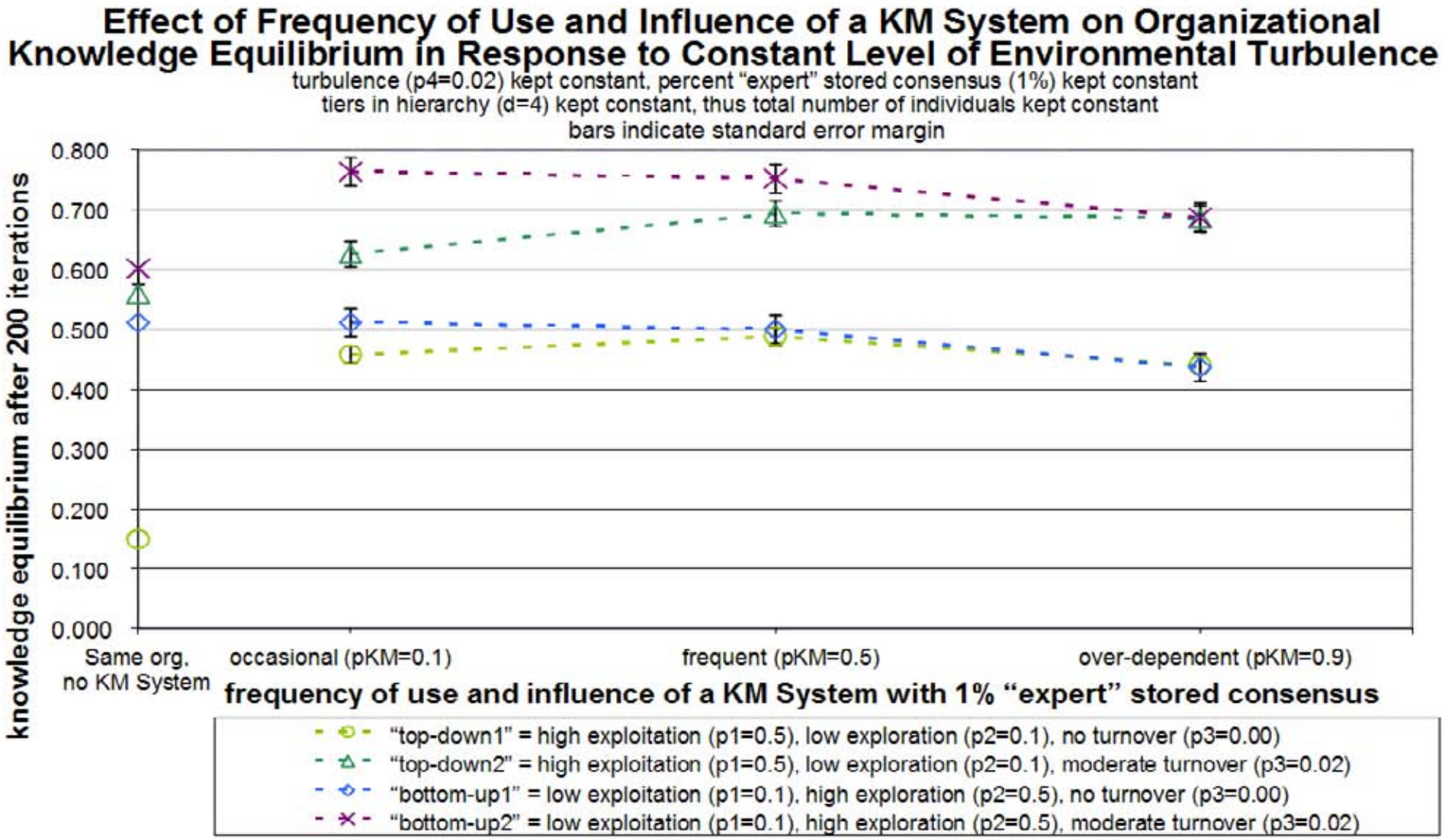
- Simulation coded in Microsoft .NET 2003:
  - creates model exactly as specified
  - outputs results for analysis



Results – Part 1



Results – Part 2



Results – Part 3

- Considered 6,000 possible organizations:
  - all were random samples drawn from population of all org strategies
  - on average, increasing exploitation has negative consequences for multi-tiered organizations, but not for flat organizations

Coefficients[a,b]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.658	.006		117.572	.000		
	probP1	.170	.014	.300	12.330	.000	.176	5.688
	probP2	.124	.006	.215	21.039	.000	1.000	1.000
	probP3	2.118	.118	.182	17.875	.000	1.000	1.000
	probP4	-5.646	.118	-.488	-47.876	.000	.999	1.001
	interactP1Depth	-.055	.003	-.446	-17.104	.000	.153	6.549
	countBreadth	-.001	.000	-.297	-21.028	.000	.520	1.922

a. Dependent Variable: corrOrgCMatch

b. Weighted Least Squares Regression - Weighted by countDepth

Conclusions

- Most noteworthy findings:
  - high exploitation and low exploration for a multi-tier hierarchical organization reduces the accuracy of average individual knowledge
  - this reduction in accuracy increases as the number of tiers in a hierarchical organization increase
  - heavy norms of use for a KM system can become another source of exploitation
  - across the board, low exploitation and high exploration represents the optimal strategy for countering environmental turbulence

probP1	.170	.014	.300	12.330	.000	.176	5.688
probP2	.124	.006	.215	21.039	.000	1.000	1.000
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Questions?

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- http://xhierarch.wiki.sourceforge.net/
  Code for simulation (open-source)

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