

Empirical Analysis of COTS Activity Effort Sequences

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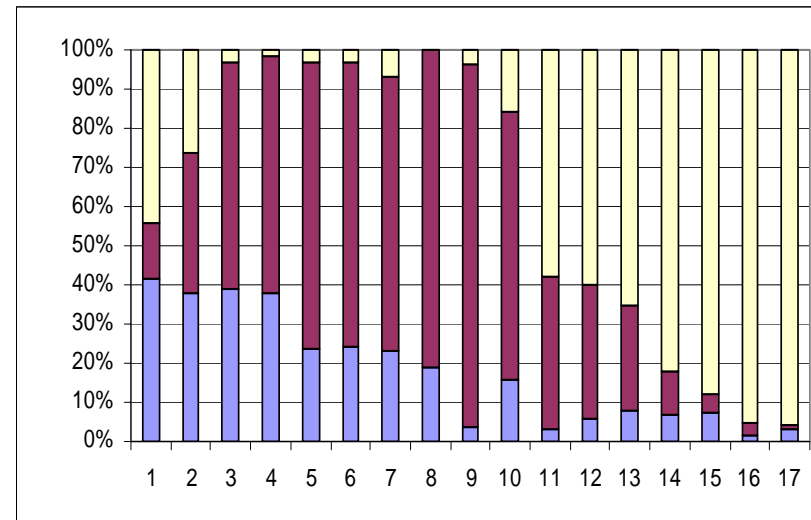
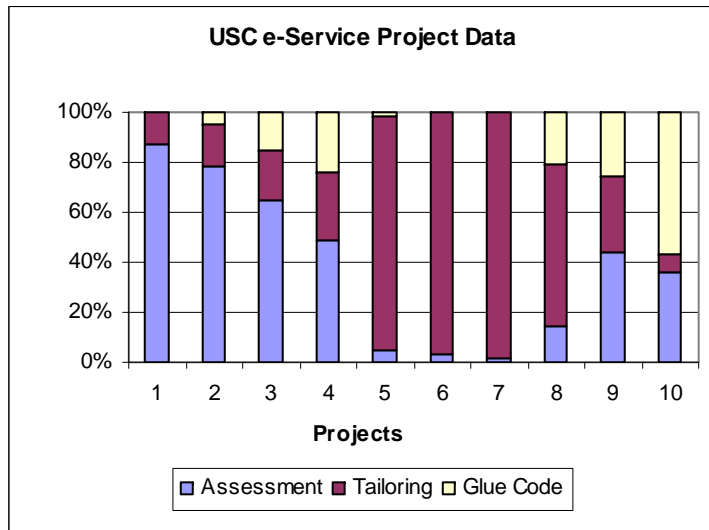
Outline

- ● Background
- COTS-Based Applications Process Decision Framework
- COTS Activity Sequence
- COTS Sequence Patterns
- COTS Sequence-Risk Patterns
- Conclusions

Background

- COTS related activities differ from those conducted for non-COTS systems
- 3 empirically categorized COTS activities:
 - Assessment (A)
 - Tailoring (T)
 - Glue code development (G)
 - A, T, G, C (custom development) activity sequence may serve as a “genetic code” for analyzing and characterizing its generally unique COTS development process

CBA Effort Distributions



- **USC e-Service project data**
 - 5 person teams
 - 24 weeks fixed schedule

- **COCOTS Calibration Data**
 - Small to large business mgmt., analysis, and control applications

Objectives

- An analysis and characterization of CBA activity sequences may serve to:
 - Identify and avoid high risk development patterns
 - Aid in COTS effort planning, monitoring, and control
 - Help explore COTS development options and rationalize COTS decision making
 - Provide evidence to further validate the composable CBA decision framework
 - Help illuminate the COTS risks and risk management within the A,T,G COTS development activities

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Issues in COTS development process

- Risky to specify upfront, detailed requirements
- Large variation in development approaches (e.g. turnkey, adaptation, integration)
- Current CBA process models stay at a much abstract level
- A single generic CBA process is unable to provide adequate development guidance
- CBA Process Decision Framework allows the dynamic process composition from major COTS activities

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COTS Activity Sequences

- COTS Activities [COCOTS Definition]:
 - COTS Assessment is the activity whereby COTS products are evaluated and selected as viable components for a user application
 - COTS Tailoring is the activity whereby COTS software products are configured for use in a specific context. This definition is similar to the SEI definition of “tailoring”
 - COTS Glue Code development and integration is the activity whereby code is designed, developed, and used to ensure that COTS products satisfactorily interoperate in support of the user application

Representations

- The representation of a COTS activity effort sequence is the particular time-ordered sequence of letters A, T, G, and/or C
- Reported by the developers
- Parentheses are used when two or more activities were conducted in parallel
- For example, (TG) would represent simultaneous tailoring and glue code.

USC e-Service CBA Sequences

Table 1 CBA Activity Sequence Examples				
No.	Activity Sequences			
	Incp.	Elab.	Cons.	Tran.
1	A	AC	ATG	C
2	A	AT	A	A
3	A	(TG)A	G	G
4	A	A(TG)	A(TG)	G
5	AT	AT	T	T
6	A	T	TG	G
7	AT	T	T	T
8	AT	(AA) TG	(TGC)	G
9	A	AT	TG	G

Sequence Data Collection and Validation

- Three major data sources:
 - Weekly effort report (quantitative)
 - Weekly progress report (qualitative)
 - Weekly risk report (qualitative)
- Having both quantitative and qualitative reports helps determine the correctness and consistency of the team reports

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Defining sequence patterns

- **Anticipated patterns**
- **Unanticipated patterns**
- **Unlikely patterns**

Anticipated patterns (1)

- An anticipated CBA sequence pattern is a sequence of COTS activities that:
 - Is expected or perceived as common within a typical project
 - Has a viable rationale to exist within a typical project
 - Is a valid “walk” within the CBA decision framework
 - Does not violate critical constraints of a typical project

Anticipated patterns (2)

- *Pattern 1: Assessment first.*
 - *A is commonly done to evaluate the extent that the candidate COTS capabilities can satisfy requirements*
 - *Observed in case-study projects: 100%*
 - *Affirmed within CBA decision framework*
- *Pattern 2: Assessment to tailoring ($A \Rightarrow T$)*
 - *While assessment is on going or once assessment is done, it becomes more clear what needs to be done and what can be customized or parameterized*
 - *Observed in case-study projects: 100%*
- *Pattern 3: Tailoring to glue code ($T \Rightarrow G$)*
 - *When integrating COTS packages, often tailoring can help prepare unrelated COTS packages to “fit” together with glue-code*
 - *Observed in case-study projects: 33%*

Anticipated patterns (3)

- *Pattern 4: Assessment to tailoring and glue code ($A \Rightarrow (TG)$ or $A \Rightarrow T \Rightarrow G$)*
 - This is particularly true with multiple COTS candidates where a thorough assessment with tailoring and/or glue code development to do experiment testing on COTS candidates to avoid faulty candidate being selected
 - *Observed in case-study projects: 67%*
- *Pattern 5: After Inception, A, T, TG as a repeatable pair ($A \Rightarrow A$ or $T \Rightarrow T$ or $(TG) \Rightarrow (TG)$)*
 - Due to frequent requirement changes, COTS volatility, re-assessing, or re-tailoring a COTS package is common in addition to possibly a certain amount of rework on glue code to accommodate the changes.
 - *Observed in case-study projects: 67%*

Unanticipated patterns

- *UPattern 1: Assessment to Custom Development ($A \Rightarrow C$)*
 - It is disappointing to find that no COTS candidates will feasibly satisfy pre-defined system OC&P's
 - This pattern is unexpected as people do not generally look for COTS solutions unless there is some initial indication that it is feasible to pursue (i.e. flexible OC&P's, known COTS candidates, etc.)
 - *Observed in case-study projects: 11%*
- *UPattern 2: Tailoring to assessment ($T \Rightarrow A$ or $(TG) \Rightarrow A$)*
 - Most likely, such a sequence segment results from requirement changes, COTS changes, or insufficient early assessment
 - *Observed in case-study projects: 56%*

Unlikely patterns

- *Tailoring or glue code first in Inception*
- *Custom development first in Inception*
- *Assessment, Tailoring, and Glue code in parallel ((ATG))*
- *Glue code to Tailoring ($G \Rightarrow T$)*

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Risk arising from COTS activity sequences (1)

Segment of Activity sequence	Indicated Risk Items	Risk Mitigations	# Of occurrences in case-studies
A(T) Or A(TG)	Selecting faulty COTS candidate; Insufficient early assessment will cause problem while integrating Faulty COTS vendor claims	Performing very detailed assessment: <ul style="list-style-type: none"> ➤ Hands on experiment; ➤ Prototyping by tailoring ➤ Prototyping by developing some glue code Investigating more information other than obtained from the vendors or marketplace.	9
TA	Requirement changes make initial COTS unsatisfactory; COTS version upgrade during development demands re-evaluation; Tailored package didn't perform as expected. Insufficient early assessment	Introduce a new assessment activity to evaluate the change impacts. Introduce a new assessment activity with newly obtained information and/or newly learned knowledge.	3
GA	Requirement changes make initial COTS no longer satisfying; COTS version upgrade during development demands re-evaluation;	Introduce a new assessment activity to evaluate the change impacts. Introduce a new assessment activity with newly obtained information and/or newly learned knowledge.	2

Risk arising from COTS activity sequences (2)

Segment of Activity sequence	Indicated Risk Items	Risk Mitigations	# Of occurrences in case-studies
GA	<p>Insufficient early assessment</p> <p>Integrated system did not perform as expected.</p> <p>Inexperienced COTS integrator</p> <p>Lack of interoperability standards to facilitate the integration</p> <p>COTS package incompatibilities may result in feature loss and significant project delays</p> <p>Requirements mismatch</p>	<p>Introduce a new assessment activity to evaluate the change impacts.</p> <p>Introduce a new assessment activity with newly obtained information and/or newly learned knowledge.</p> <p>Introduce a new assessment activity to find best integration option</p>	2
(GC)	<p>Critical requirements mismatch</p> <p>No suitable COTS satisfied</p>	<p>Determine the interconnection topology options and minimize the complexity of interactions;</p> <p>Implement the appropriate interfaces simultaneously with application code development.</p>	1
AC, or TC, or GC		Carry out a pure custom development from scratch.	1

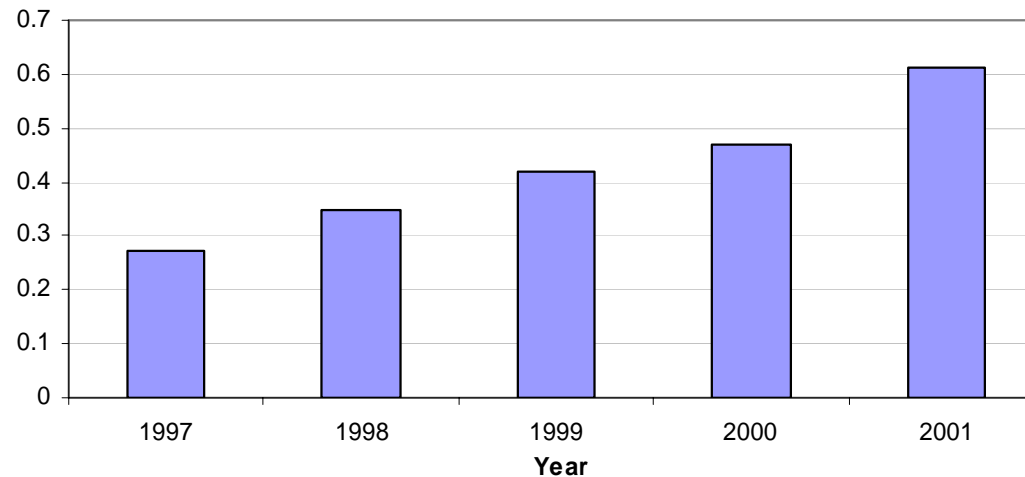
Conclusions

- COTS activity differs from traditional development activity
- COTS activity sequences provide an effective means analyzing complex and often subtle COTS process elements
- Valuable to developers inexperienced in COTS based system development
- CBA sequence patterns provide an empirical means of identifying and possibly avoiding COTS risks
- CBA sequence can aid in strategic planning to meet cost, schedule, and quality goals.

Backup Slides

Increase in CBA projects

- CBA Growth Trend
 - **USC e-services project data** shows: from **28%** in 1997 to **60%** in 2001



- Major Implications for education, staffing, processes, research

Key Definition and Context

- COTS Based Applications
 - as a system for which
 - at least **10%** of the development effort is devoted to COTS considerations
 - at least **30%** of the end-user functionality is provided by COTS products
- Different from custom development on COTS platforms

Phase Characteristics of COTS activity sequences

Project No	Inception	Elaboration	Construction	Transition
1.	Initial Assessment (A)	Further assessment (A) proved non-COTS solution (C) better. However, at the end of Elaboration phase, the Client introduced a new COTS candidate	Another round of assessment (A) on the new COTS package; Tailoring (T); Glue code development (G)	Glue code development found out COTS did not completely satisfy the requirements; redirect to non-COTS solution (C)
2.	Initial Assessment (A)	Detailed assessment (A); prototyping by customizing the likely winning COTS package (T). However, the client was interested in further assessment involving more COTSs rather than starting building an operational system. Project was redirected to assessment intensive.	Learning and studying new COTS candidates; setting up testing environment – COTS installation and configuration (A)	COTS evaluation testing; final COTS package recommendation. (A)
3.	COTS selection (A)	Tailoring (T), glue code development (G) found out COTS not working as expected; reevaluate project feasibility (A)	Integrating selected COTS (G).	Transitioning the operational system.

COTS Based Systems (CBS) Opportunity Tree

