24th International Conference on Enterprise Information Systems
26 April 2022

Crowdsourcing Software Development: Silver Bullet or Lead Balloon

Brian Fitzgerald
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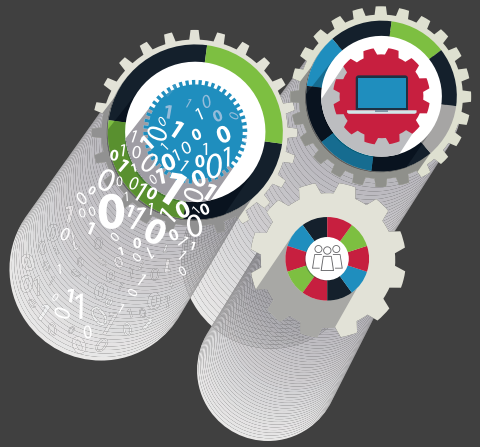

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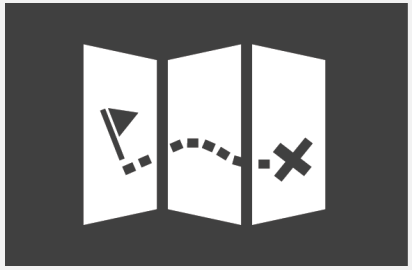
The basic promise of crowdsourcing software development is that ***high quality*** software can be produced ***quickly*** and at ***low cost*** by a ***large pool*** of self-selecting ***experts***

Overview

1

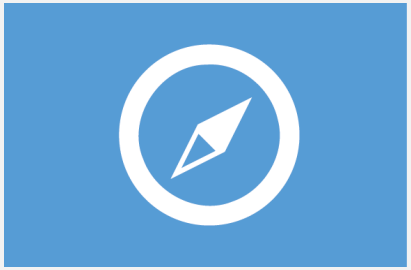
Introducing CSD

2



In-Depth Case Study of CSD (from customer perspective)

3



Theoretical Model of CSD tested with large-scale sample data

4

Conclusions

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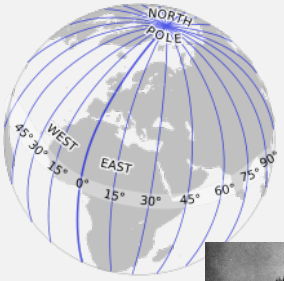
Introducing CSD

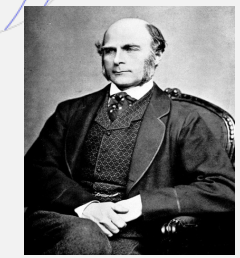
“No matter who you are, most of the smartest people work for someone else.

—Bill Joy

Crowdsourcing: Leveraging Wisdom of the Crowd

- Longitude Problem (1714)





- *Vox Populi* (Galton 1907)
- Amazon Mechanical Turk

amazon mechanical turk
Artificial Artificial Intelligence

- InnoCentive

INNOCENTIVE
WHERE THE WORLD INNOVATES

Positioning Crowdsourcing vs. Outsourcing vs. Opensourcing*

Dimension	Outsourcing	Opensourcing	Crowdsourcing
Locus of Control			
Nature of Workforce			
Crowd Motivation			
Company Motivation			

* Agerfalk P, Fitzgerald B, Stol K (2015) *Software Outsourcing in the Age of Open: Leveraging the Unknown Workforce.* Springer

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Expected Benefits from Crowdsourcing

Cost Reduction

- Lower labour costs in different regions
- Eliminates recruiting overhead

Faster Time-to-Market

- 'Follow-the-sun' 24/7
- Parallel decomposition of tasks

High Quality

- Self-selecting experts with broad and deep knowledge
- Linus' Law: *Given enough eyeballs, every bug is shallow*

Creativity and Open Innovation

- Go beyond internal fixed mindset

2 Case study*

* Stol KJ & Fitzgerald B (2014) Two's Company, Three's a Crowd: A Case Study of Crowdsourcing Software Development, *Proceedings of 36th International Conference on Software Engineering (ICSE Technical Track),* Hyderabad, May 2014

Case: "Tech Platform Inc. (TPI)"

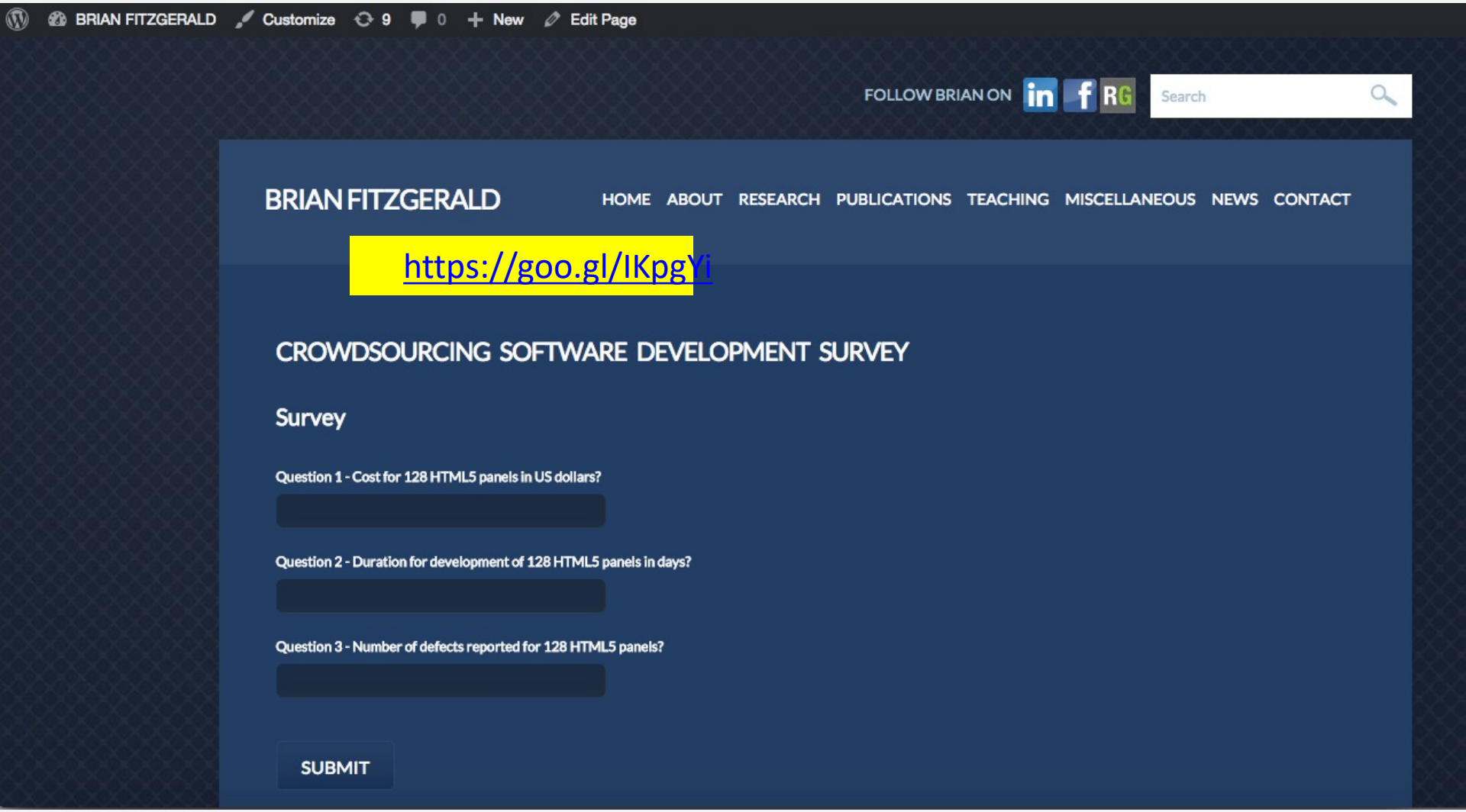
TPI: global player in cloud solutions

- 400 sales offices in 75 countries
- 50K employees

Crowdsourced project: "Titan"

- **Task**: Porting a migration utility used by field engineers from a stand-alone tool to a web application (128 panels)

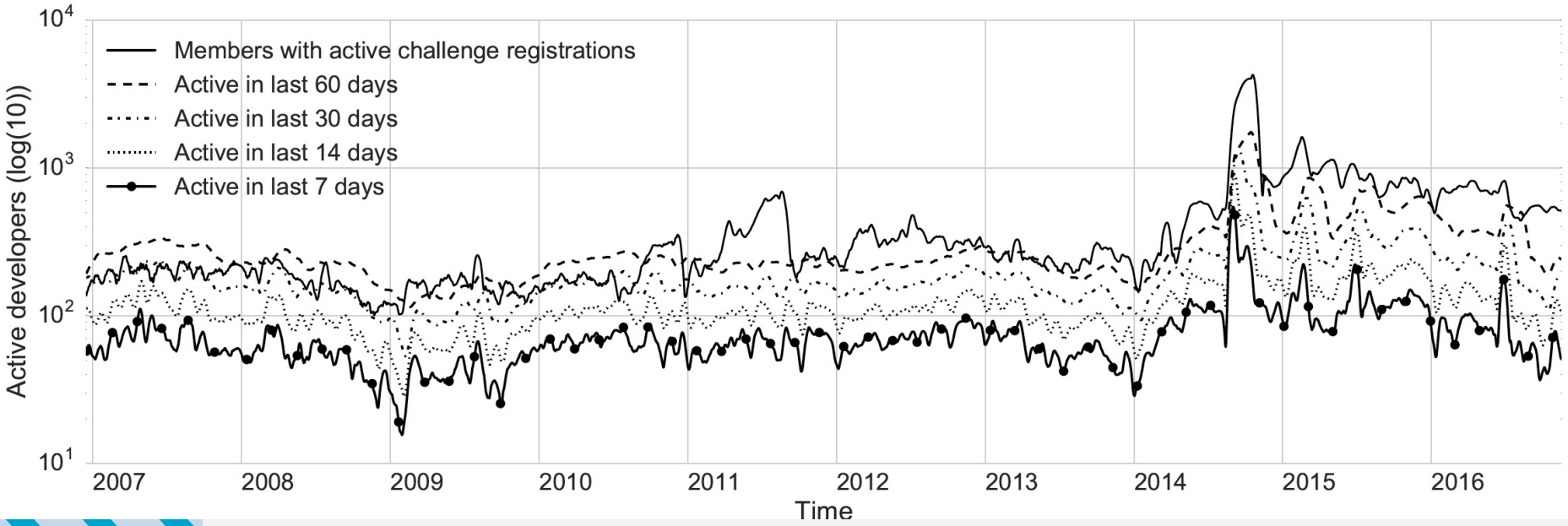
Testing the Wisdom of *this* Crowd



TopCoder.com

>1 million members *from < 50K in 2004*

but < 0.5% active developers



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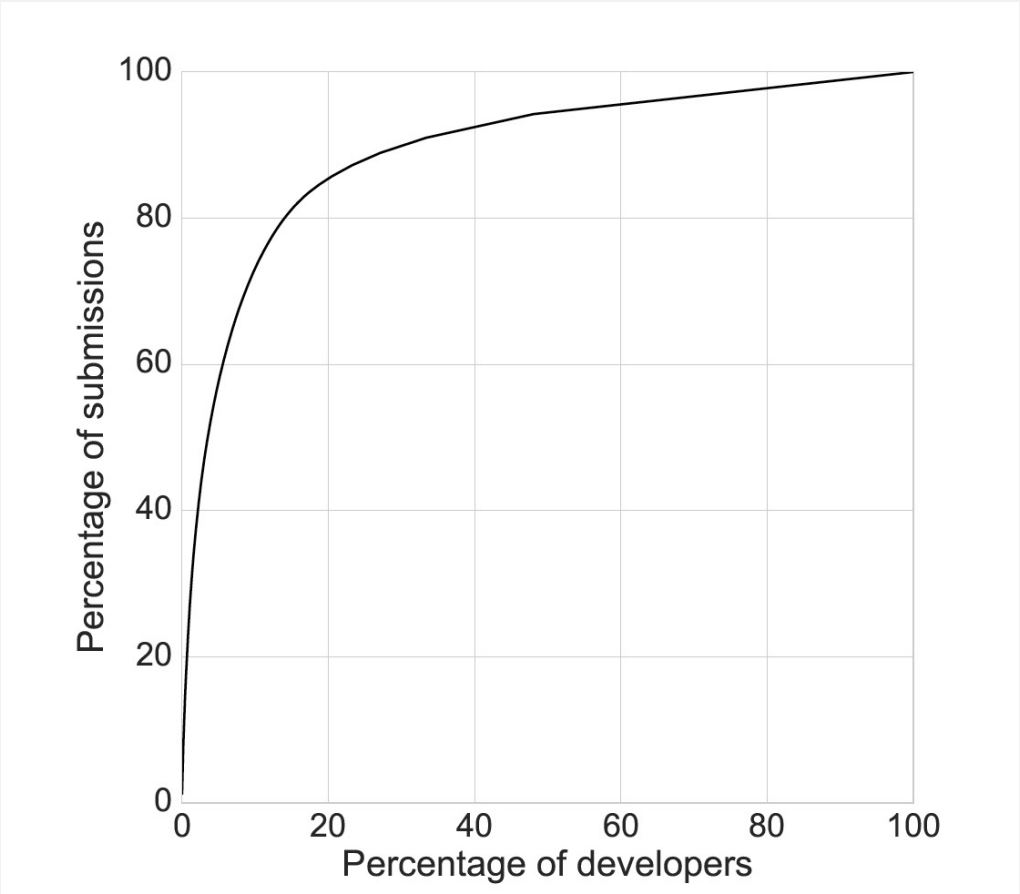


TopCoder.com

TopCoder Roles

Platform Specialist, Co-Pilot,
Crowd Contestants

TopCoder mantra

TopCoder does heavy lifting/process management

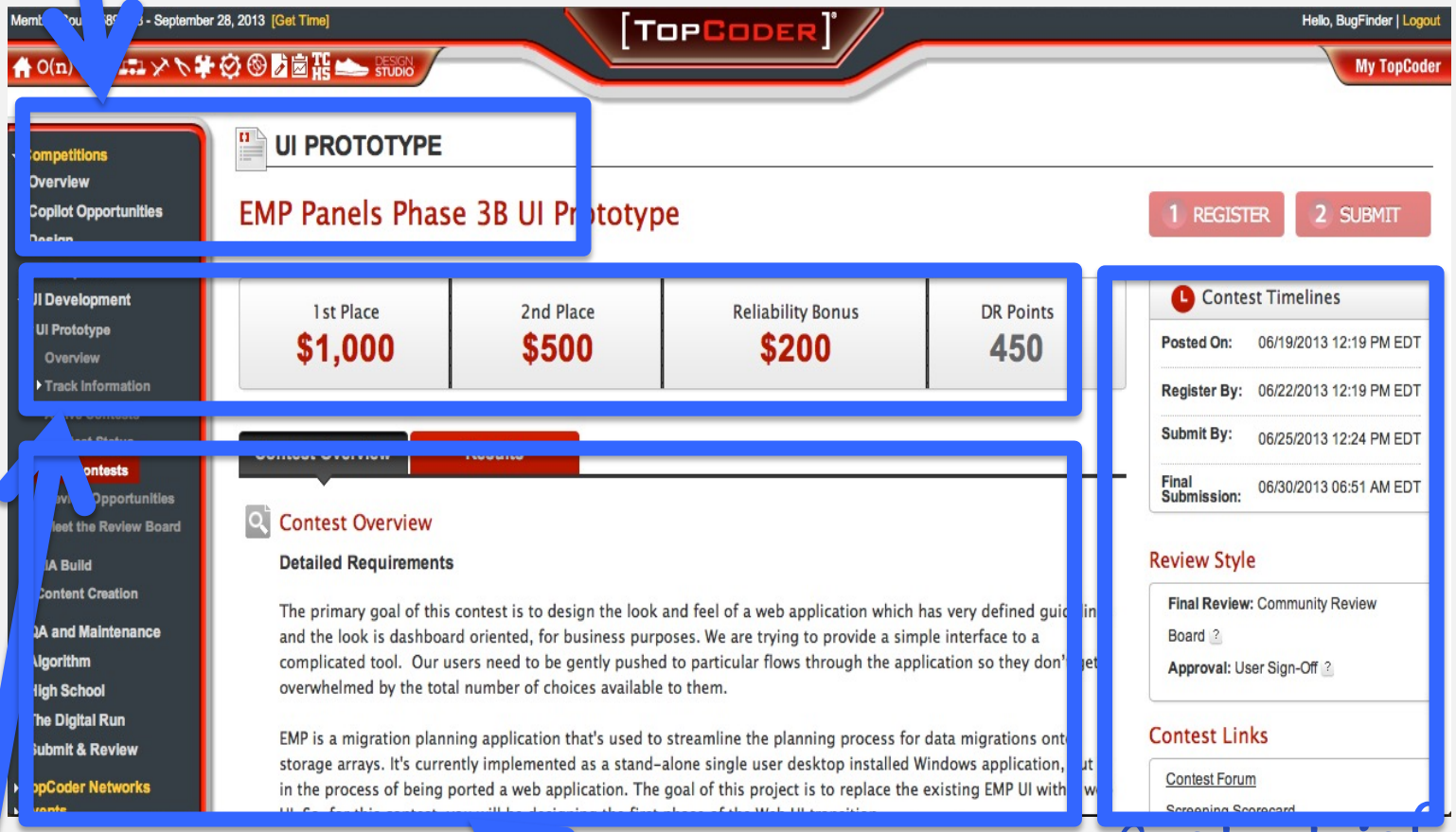
Customer is *"conductor of world-wide talent pool"*

"Software development cost reduction of 62%"

(TopCoder, Tech Crunch 2013)

TopCoder Contest Interface

Contest Name



Prizes/Cost

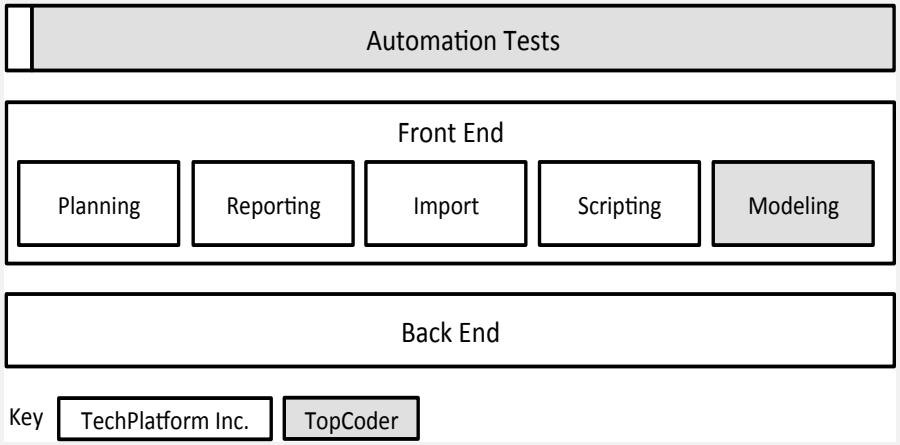
Detailed description

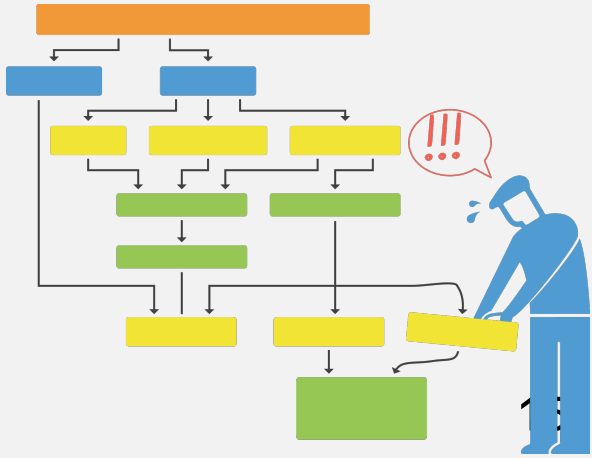
Contest info

Coordination: Task Decomposition

What software parts to crowdsource?

- Least domain knowledge required
- Self-contained
- Scarce internal resources





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Coordination: Communication

Multiple interaction layers

TopCoder (TC)

- Account Manager
- Platform Specialist
- Co-Pilot
- Contestants

TPI

- TC Program Manager
- Titan Program Manager
- TC Architect
- Titan Product Architect
- Tactical Scrum Team
- Normal Scrum Teams

TopCoder waterfall process → TPI agile process

Challenge to integrate TC deliverables into Sprints

Coordination: Communication

Phase		Panels
1	Dashboards	40
2	Flagship product I	18
3	Flagship product II	33
4	Network devices	14
5	Legacy and third-party	23
		128

> "It feels like we've produced a million specification documents, but obviously we haven't. The way we do specifications for TopCoder is entirely different to how we do them internally. -TPI Architect

Coordination: Lack of Response/Potential IP Loss

Contest failure due to lack of submissions

53 contests but just **84** submissions

Type	Registrants	Submissions	%Sub/Reg
Copilot	13	6	46%
Studio	34	7	21%
Architecture	90	12	13%
Assembly	476	36	8%
Test Suite	8	1	13%
UI Prototype	99	22	22%
Total	**720**	**84**	**12%**

Two's company, 1.6 is a crowd...

IP Loss: Unknown workforce - **720** registrants saw specifications

Quality Assurance

- TC Waterfall approach **pushes error identification later** in life-cycle

- ***"Fleeting relationship"***
  - Lack of developer continuity across contests – recurrence of **same bugs**
  - No domain knowledge built up by developers

Planning & Scheduling

TopCoder warranty periods unsuitable

5 days to accept/reject deliverable

But cannot accept/reject part of deliverable

Tendency to accept to not deter contestants

Additional **30-day** warranty period

But fast changing code base – not useful to integrate new fixes after 30 days

Counting the Cost!

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Total Cost
1st $1,000

1st Prize

- Suggested by Co-Pilot

- Varied from $600 to $2,400

$1,000

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Total Cost

1st $1,000

2nd $500

$1,500

2nd Prize

50% of first prize:

$500

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Total Cost
1st $1,000
2nd $500
R.Bo. $200

$1,700

Reliability Bonus

Up to 20% of first prize:

$200

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Total Cost

1st $1,000

2nd $500

R.Bo. $200

DR $450

$2,150

Digital Run

45% of first prize

1 Point = $1.00

$450

Total Cost

1st $1,000

2nd $500

R.Bo. $200

DR $450

Spec.R $50

$2,200

Spec. Review

$50

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Total Cost

1st $1,000

2nd $500

R.Bo. $200

DR $450

Spec.R $50

Rev.B. $800

$3,000

Review Board

$800

Total Cost

1st $1,000

2nd $500

R.Bo. $200

DR $450

Spec.R $50

Rel.B. $800

CP $600

$3,600

Co-Pilot Fees:

$600

Total Cost

1st $1,000

2nd $500

R.bo. $200

DR $450

Spec.R $50

Rel.B. $800

CP $600

Subtotal $3,600

TC multiplier x 2

Price of 1 contest: $7,200

TC Commission

= total of above

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Total Cost
1st $1,000
2nd $500
R.bo. $200
DR $450
Spec.R $50
Rev.B. $800
CP $600

Subtotal **$3,600**
TC multiplier **x 2**

Price of 1 contest: $7,200

Platform "Cockpit" Fees for TPI:

$30,000 per month*

*** Varies per customer – as low as $3,000 per 'cockpit seat'**

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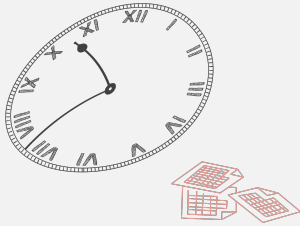
Cost, Time & Quality for 128 Panels

Cost: $650,000

Plus extra internal overhead in preparing specs and coordination effort

Time: 215 calendar days

(695 contest days)



Quality: 506 bug issues

Wisdom of Previous Crowds

Prior 'Academic' Crowd	
Cost (US$)	$211,000
Time	145 days
Quality (# bugs)	96

Prior 'Practitioner' Crowd	
Cost (US$)	$378,000
Time	174 days
Quality (# bugs)	158

Theoretical Model for CSD*

* Stol, K, Caglayan, B and Fitzgerald, B (2018) Competition-Based Crowdsourcing Software Development: A Multi-Method Study from a Customer Perspective, *IEEE Transactions on Software Engineering*, DOI: 10.1109/TSE.2017.2774297 *OPEN ACCESS!*

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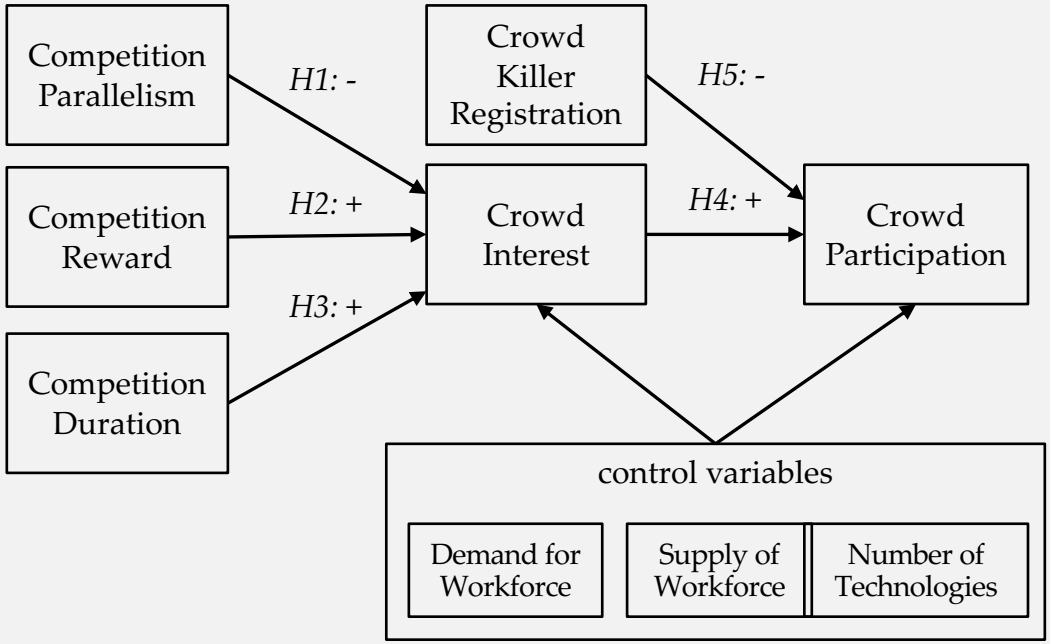
Data Source for Model Construction

- Case study
- Crowdsourcing literature
- Topcoder platform API

Model Variables

Construct variables	**Description**
Competition Parallelism	The number of competitions that are run simultaneously within the same project.
Competition Reward	First Prize money offered for a competition.
Competition Duration	Number of days between the registration deadline and the submission deadline (included).
Crowd Killer Registrations	Developers whose average win count is $3 \times \sigma$ greater than the average.
Crowd Interest	Number of registrations for a competition.
Crowd Participation	Number of submissions. Only registered members are able to submit
Control variables	**Description**
Demand for Workforce	At a given time, the number of competitions that are running at the time of a competition being advertised.
Supply of Workforce	The number of platform members at the time of a competition's advertisement.
Number of Technologies	The number of technologies that are specified for a competition.

Theoretical Model

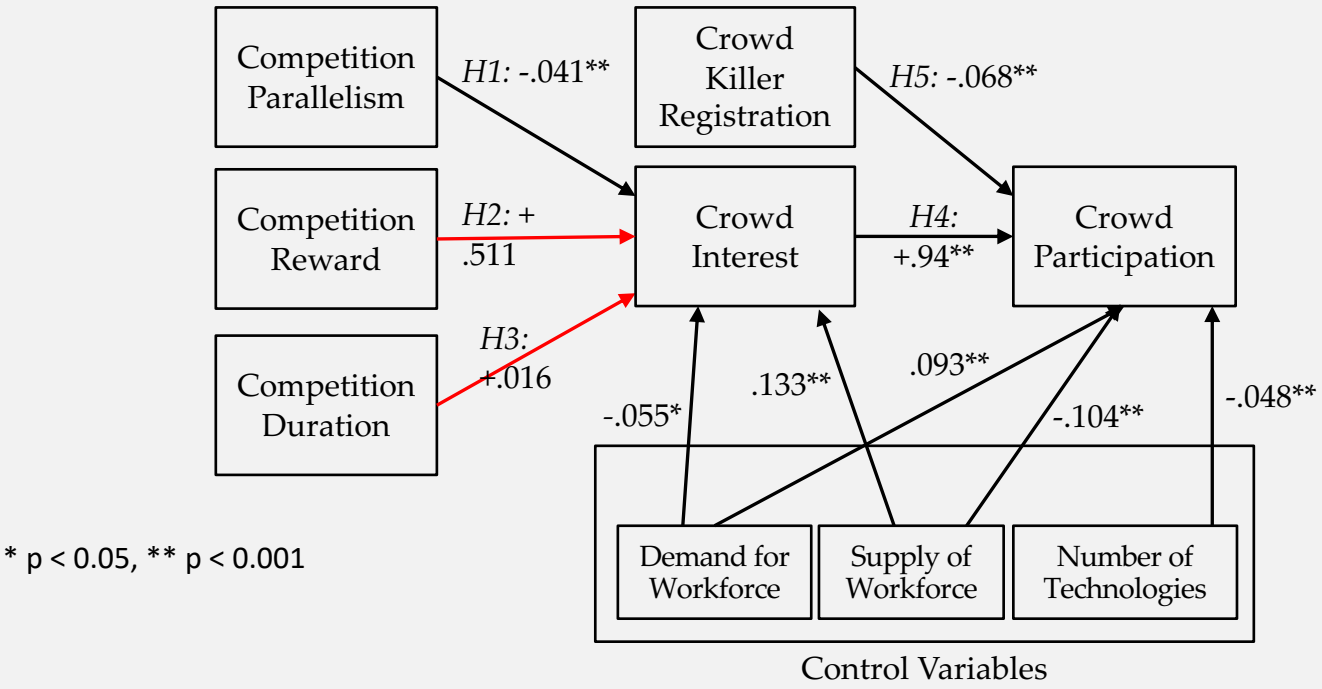


H1	Running competitions in parallel is negatively associated with crowd interest
H2	Competition reward is positively associated with increased crowd interest
H3	Competition duration is positively associated with crowd interest
H4	Interest from the crowd is positively associated with participation
H5	'Crowd killer' registration is negatively associated with participation

Data Source for Model Testing

- 13,602 (completed) competitions on the Topcoder platform (2007-2016)
- 20,747 Topcoder crowd members involved

Evaluating Model Fit (SEM)



Model Fit Indexes

X^2 Yuan-Bentler corrected	7.688 (p = .104)
RMSEA	0.067
Comparative Fit Index (CFI)	0.993

Conclusions

Conclusions

- Costly++
- Quality issues
  - Waterfall competitions – late detection of errors
  - No accretion of domain knowledge - fleeting relationship
- Crowd may be very small
  - Running too many contests in parallel reduces crowd size
  - Increasing price or duration makes no difference
  - Beware of Crowdkillers
- Crowdsourcing platforms lack *transparency* and *recombination* (*Secret Sauce* in Open Source)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Thank You


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