

# Lessons learned in 7 years of Teaching PSP<sup>SM</sup> to University Students



**TECNOLOGICO  
DE MONTERREY**

**TSP Symposium 2013**  
**Rafael Salazar**



# Tecnológico de Monterrey

- Mexican Private University
- 31 campus
- 99,203 students
  - 26,943 High School
  - 55,246 Undergraduate
  - 17,014 Graduate
- 8,831 professors
- Virtual University → +20,581 students





# Why train our university students in PSP?

- To accelerate TSP introduction in our Software Industry
  - Break the vicious cycle:
    - Company: can't use TSP because I don't have PSP-trained SWEs
    - Trainer: why train SWEs in PSP if there are no TSP-projects?
  - Organizations need PSP trained engineers
    - We don't want to put all the burden in the companies
    - Universities must prepare SWEs before they get into the industry
- To prepare better Software Engineers



# Preparing Software Engineers

- In Mexico most of our undergraduate programs are Computer Science + Software Engineering
  - For example, Tec de Monterrey's undergraduate program has 12 CS courses, and 9 SWE courses (plus other 6 optional SWE courses)
- But even with that SWE training some SW companies complain that students are not ready to work in SW development
  - Some of their complains have to do with the student's ability to develop:
    - Quality code (zero defects) and
    - On time (management skills)



# What we have done in Tecnológico de Monterrey

- Started teaching PSP in August 2006
- In undergraduate
  - Found a class where we could teach PSP
  - 1 year before graduation
  - With “enough” time to accomplish all PSP work
- In graduate
  - Created a new class



# TSP Symposium 2008

<b>n = 50</b>	<b>First Program</b>	<b>Last Program</b>	<b>% Diference</b>
Average LOC	136.32	195.08	+43.1%
Productivity (LOC per hour)	33.25	33.78	+1.6%
% of time spent in Compile & Test	31.3%	7.7%	-75.5%
Total defects injected per KLOC	94.63	37.83	-60.0%
Defects per KLOC removed in Unit Test	26.56	4.20	-84.2%
% of defects removed in Unit Test	28.1%	11.1%	-60.4%
% of defects removed before Compile	16.0%	77.2%	+383.7%
% of people with zero defects in Compile & Unit Test	2.0%	42.0%	+2000.0%



# PSP courses taught by Rafael Salazar

August 2006 → May 2013 (12 groups)

Type of course	Stu- dents	Pass	% Pass	Finish	% Finish	Certif. Exam	Certi- fied	% Certif
Undergraduate On-site	129	111	86%	101	78%	70	46	65.7%
Undergraduate Satellite	182	156	86%	145	80%	97	49	50.5%
Graduate	15	14	93%	15	100%	9	8	88.9%
<b>TOTAL</b>	<b>326</b>	<b>281</b>	<b>86%</b>	<b>261</b>	<b>80%</b>	<b>176</b>	<b>103</b>	<b>58.5%</b>





# Challenges

- Not enough time in a semester
  - For students
  - For professor
- Few time in the classroom
- Many students getting behind and/or not finishing
- Too many resubmissions
- Some material is taught when it is not yet needed
- They forget to send some files
- Every student organize files in their own way





# Course redesign

- Reduced number of assignments
  - Before:
    - 8 programs + 2 reports
    - Sequence based in PSP for Engineers
  - Now:
    - 6 programs + 1 report
    - Sequence based in PSP Fund. & Advanced
    - Removed program 4
- Reordered topics
  - Based in PSP for Engineers material



# Course redesign

- New process for assignments
  - Homework: read some chapters and hand a summary
  - Class: doubts, exercises, tutorials
  - Homework: PSP assignment
    - More clear and precise instructions (i.e. Prog. 2)
    - Multiple files
    - Added a checklist for PM

	P1	P2	P3	P4	P5	P6	Report
Process	PSP0	PSP1	PSP2	PSP2.1	PSP2.1	PSP2.1	Theirs
What's new	Time & defect log	Size & PROBE I	Quality & manual plan	Design	Design Review & PROBE II	-	Data Analysis & new process
Chapters	1 y 2	3, 4 y 5	8 y 9	10 y 11	6 y 12	-	7, 13 y 14



# Course redesign statistics

On-site courses	Students	Pass	% Pass	Finish	% Finish	Certif. Exam	Certified	% Certif
6 prog + 1 Rep	19	18	95%	18	95%	11	10	90.9%
8 prog + 2 Rep	88	71	81%	62	70%	38	23	60.5%
TOTAL	107	89	83%	80	75%	49	33	67.3%

Satellite courses	Students	Pass	% Pass	Finish	% Finish	Certif. Exam	Certified	% Certif
6 prog + 1 Rep	44	35	80%	36	82%	26	7	26.9%
8 prog + 2 Rep	138	121	88%	109	79%	71	42	59.2%
TOTAL	182	156	86%	145	80%	97	49	50.5%



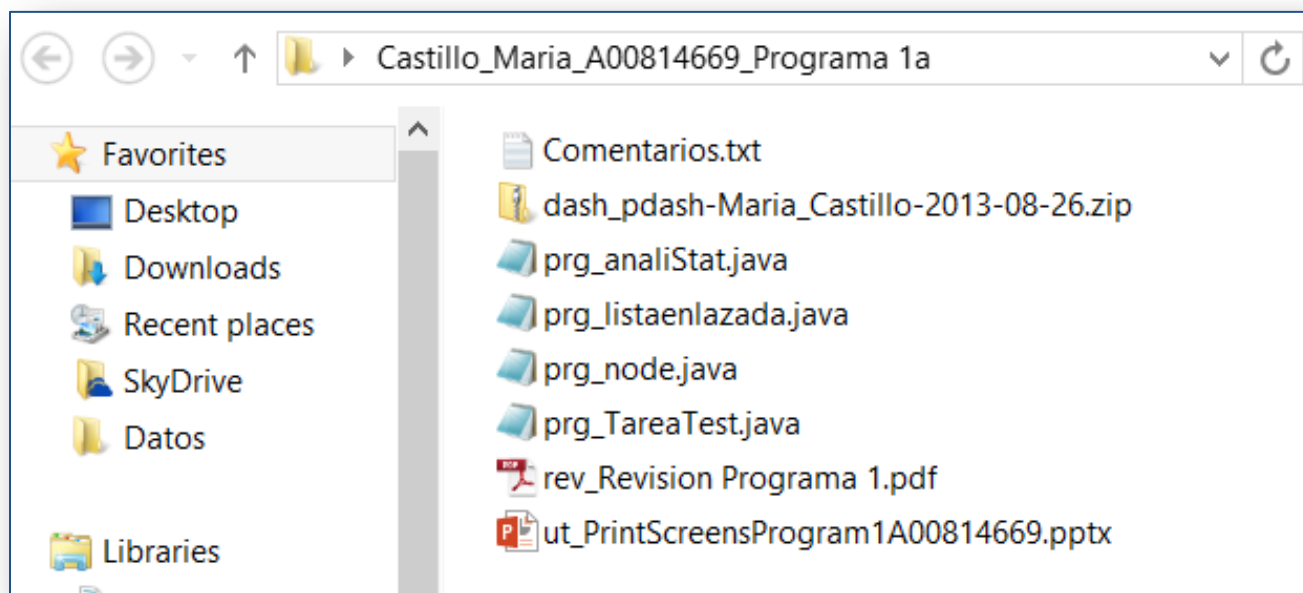
# Other Actions

- Limit the number of submissions to 2
- Establish due dates
  - They lose credit for being late
- Optional certification exam as final exam
  - Grading rules (110 / 90 / 70)
- For satellite courses
  - Teaching assistants (PSP Certified graduate students)



# Other Actions

- Tools to reduce grading time
  - Excel grading helper
  - ZIP generator





# Results

	8 programs			6 programs		
	First Program	Last Program	% Diference	First Program	Last Program	% Diference
Average LOC	140	281.3	100.93%	180.3	258.12	43.16%
Productivity (LOC per hour)	35.3	35.8	1.42%	32.4	28.6	-11.73%
% of time spent in Compile & Test	32.90%	4.70%	-85.71%	27.50%	3.60%	-86.91%
Total defects injected per KLOC	97.1	22.9	-76.42%	89.3	12.1	-86.45%
Defects per KLOC removed in Unit Test	29.1	2.4	-91.75%	23.6	1.9	-91.95%
% of defects removed in Unit Test	29.90%	10.00%	-66.56%	26.50%	16.00%	-39.62%
% of defects removed before Compile	7.80%	76.70%	883.33%	25.00%	84.00%	236.00%
% of people with zero defects in Compile & Unit Test	0.00%	50.00%	-	5.20%	62.50%	1101.92%



# TSP Symposium 2008

- Challenges

- ✗– Getting faculty to understand the importance of “process discipline”
- ✗– Getting the industry to demand Disciplined Software Engineers
- ✓– Too much time required from the instructors to properly teach PSP
- ✗– Getting funds to train all needed faculty

- Future work

- ✗– Teach PSP gradually through all years of undergraduate curriculum
- ✓– Develop tools to reduce the time needed by an instructor to teach PSP
- ✓– Develop better tools to use PSP/TSP
- ✗– Find a class to teach TSP to undergraduate students



# Thanks



**TECNOLOGICO  
DE MONTERREY**

**Rafael Salazar**  
**rafael.salazar@itesm.mx**