



**TECNOLÓGICO
DE MONTERREY**

Preparing Undergraduate Students for Industry's TSP Needs

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The Mexican TSP Initiative



National Public Policy to Enhance the Mexican IT industry (PROSOFT)

Goals for 2013

- To accomplish an IT services annual production level of 15 BUSD (**3.5 BUSD in SW development outsourcing**)
- To reach the OECD's average IT expenditure as an economy
- To position Mexico as the leading IT powerhouse in Latin America

Strategies

- Exports and investments
- **Human Capital capabilities**
- Digital economy legal framework
- IT domestic market
- Local IT industry
- **World class process capabilities**
- IT Cluster Initiatives

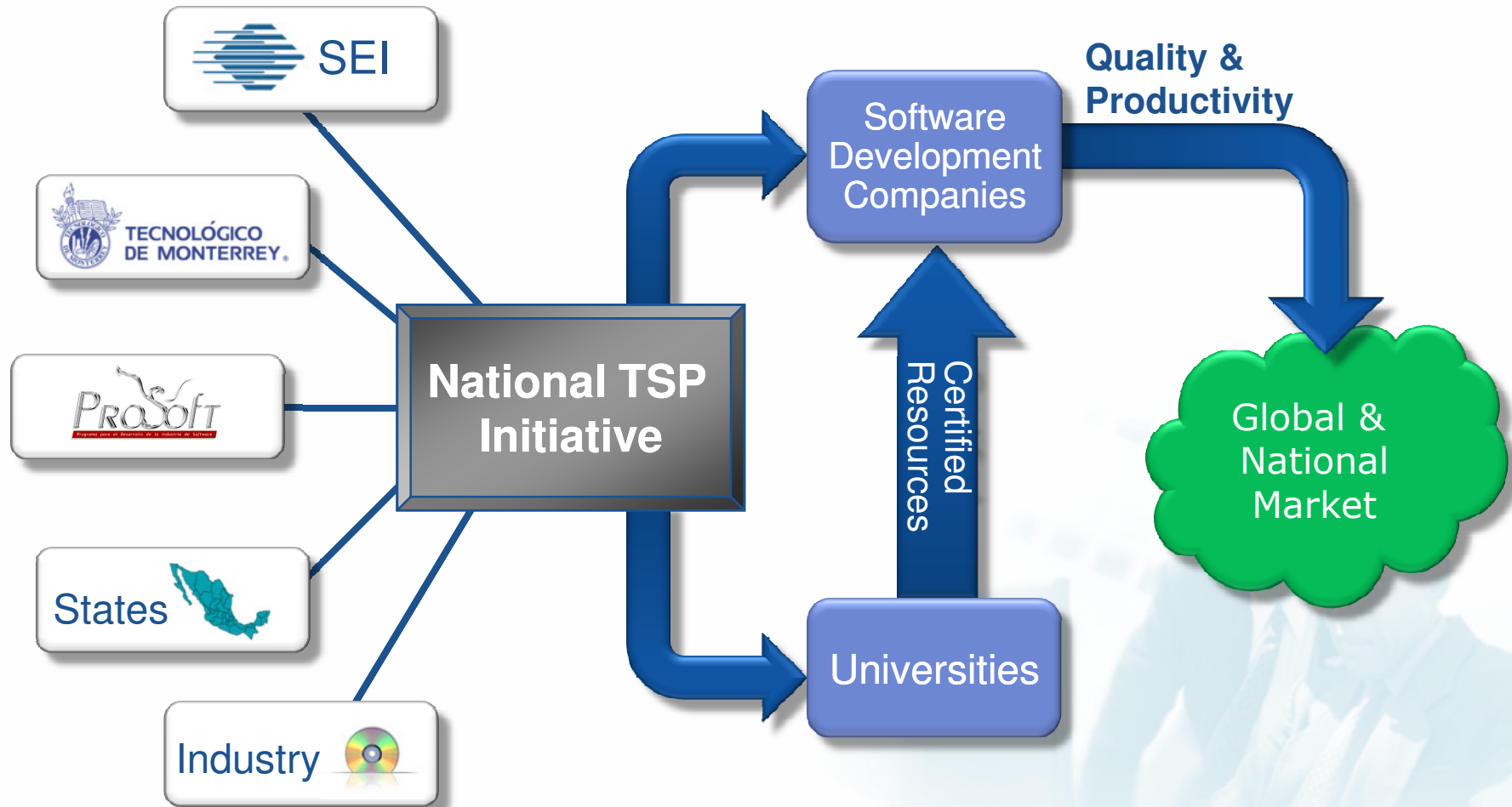


Mexican TSP Initiative

- **Objective**: international recognition of the Mexican software industry as a very high quality industry
 - High quality human resources
 - High quality software projects
- **Strategy**: establish TSP capabilities
 - Software development companies
 - Software Developers
 - PSP Instructors
 - TSP Coaches

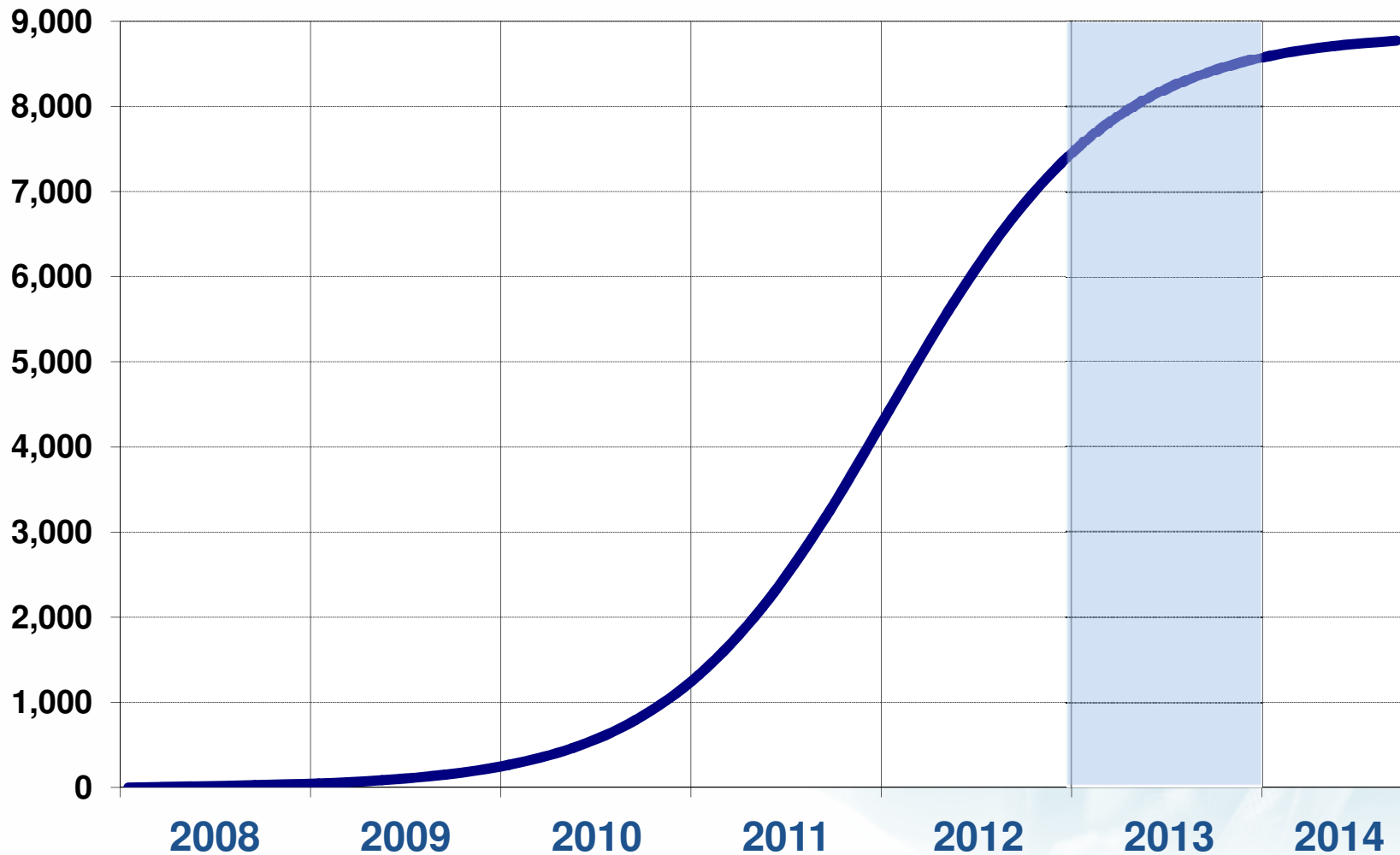


Conceptual Diagram





Number of Teams using TSP to accomplish Prosoft goals





Capacity needed to achieve our goals

	2008	2009	2010	2011	2012	2013
Teams using TSP	57	302	1,543	6,642	16,872	24,017
Organizations using TSP	18	50	152	379	593	648
PSP Software Engineers	241	1,334	6,631	22,163	37,690	42,987
PSP Instructors	5	17	67	164	148	50
TSP coaches	7	26	130	480	886	1,010



Results (Tec de Monterrey): Oct/06 → Aug/08

■ TSP introduction

- 10 companies (software development services)

■ People trained

- 101 managers
- 282 Software Engineers
 - 139 undergraduate students
 - 33 faculty
 - 110 industry

■ Certifications from people trained

- 59 certified PSP developers (13 undergraduate students)
- 23 authorized PSP Instructors (12 faculty)
- 4 authorized TSP coaches (3 faculty)
- 22 TSP coach candidates (6 faculty)



Preparing Disciplined Software Engineers



Why train our undergraduate 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?
 - If goal = \$3.5 BUSD of high quality software development
 - We need around 57,500 PSP-trained SWEs
 - 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**
 - We'll talk about this



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 did in Tecnológico de Monterrey

- **Found an undergraduate class where we could teach PSP**
 - ❑ Not an optional class
 - ❑ 1 year before graduation
 - ❑ With enough time to accomplish all PSP work
 - One semester = 15 weeks
 - One week = 8 hours (3 in-classroom + 5 out-of-classroom)
 - $15 \text{ weeks} * 8 \text{ hours} = 120 \text{ hours}$
 - PSP needs 120 hours of total work



What we did in Tecnológico de Monterrey

- **Started in August 2006 (4 semesters)**
 - ❑ 4 campuses
 - ❑ 139 students
 - ❑ 97 passed (70%)
 - ❑ 65 finished all programs (47%)
 - ❑ 25 presented the certification exam (18%)
 - The exam is optional because it is expensive for Mexican students
 - 13 passed the certification exam (52% efficiency)

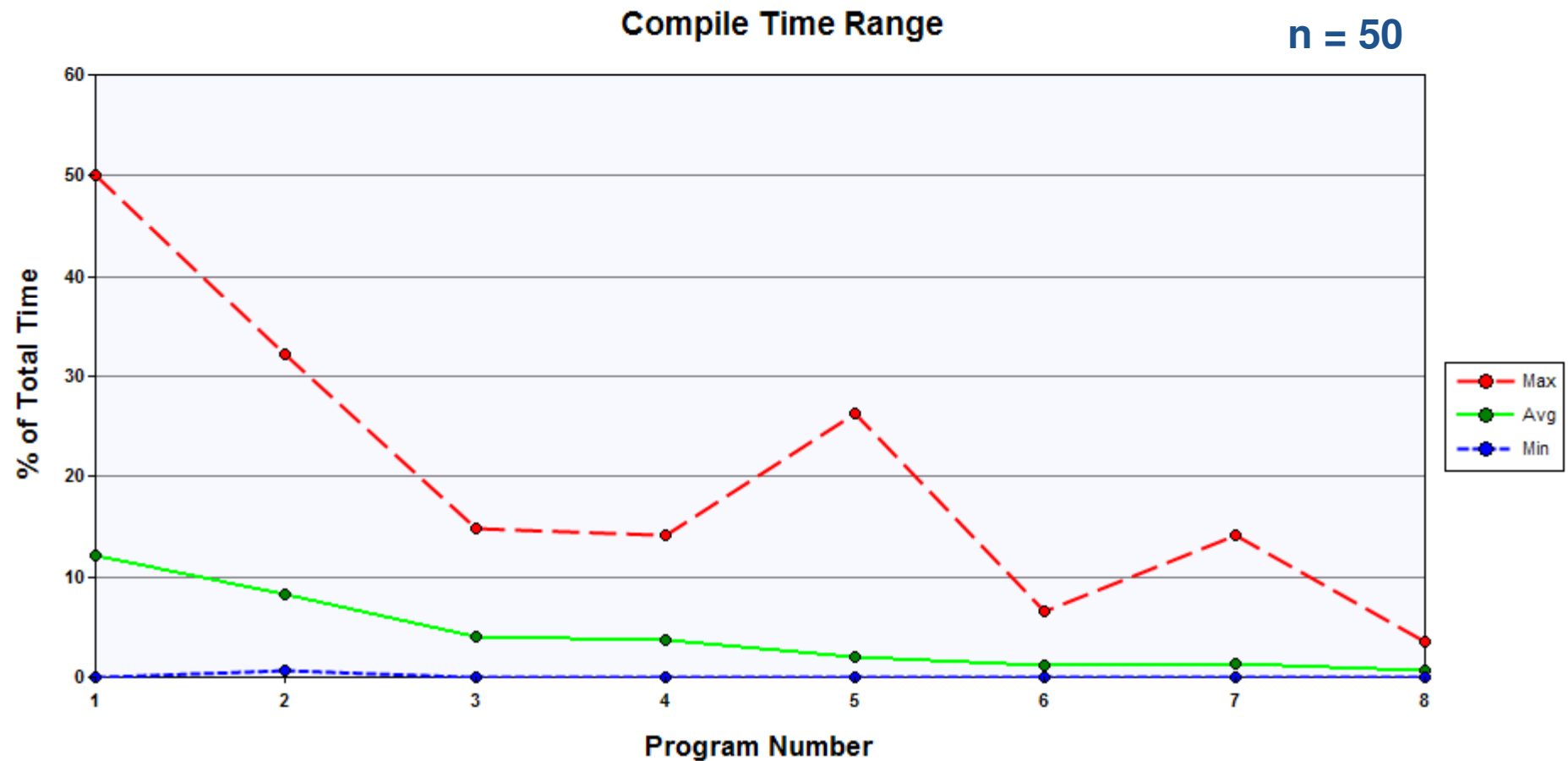


Did it work?

**Can students achieve what
industry SWE achieve?**

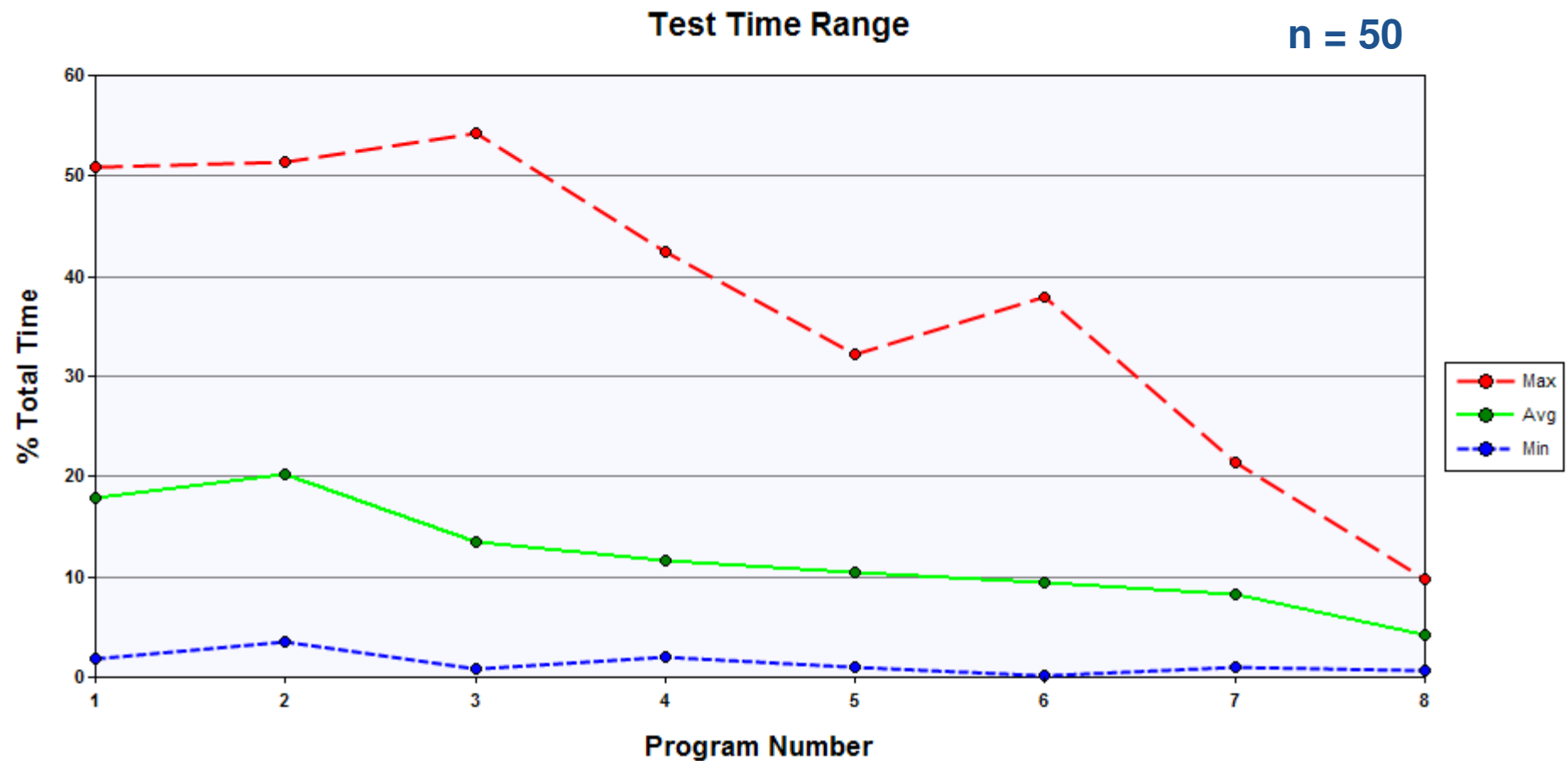


Compile time improved



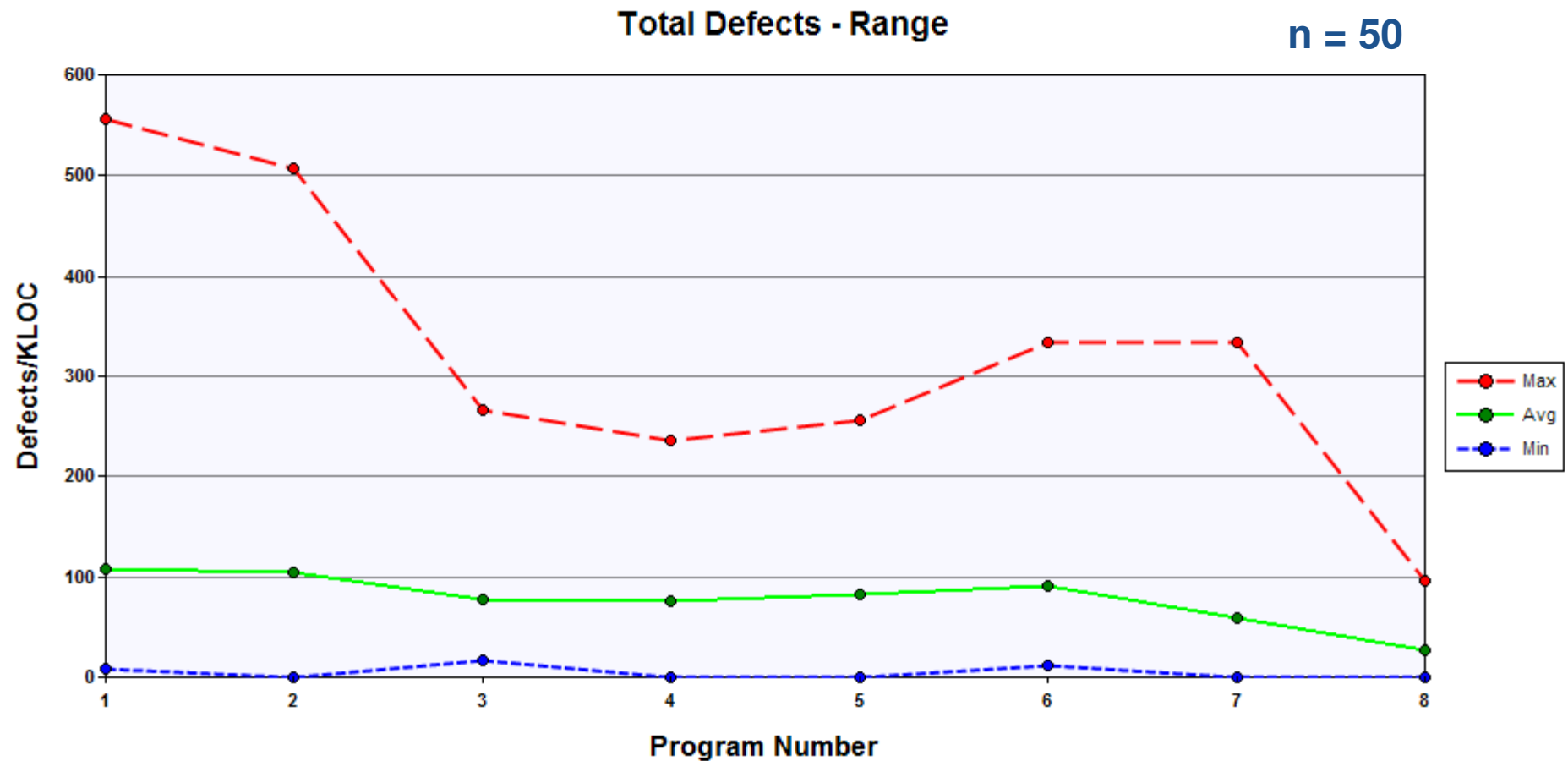


Test time improved





Total defects injected went down

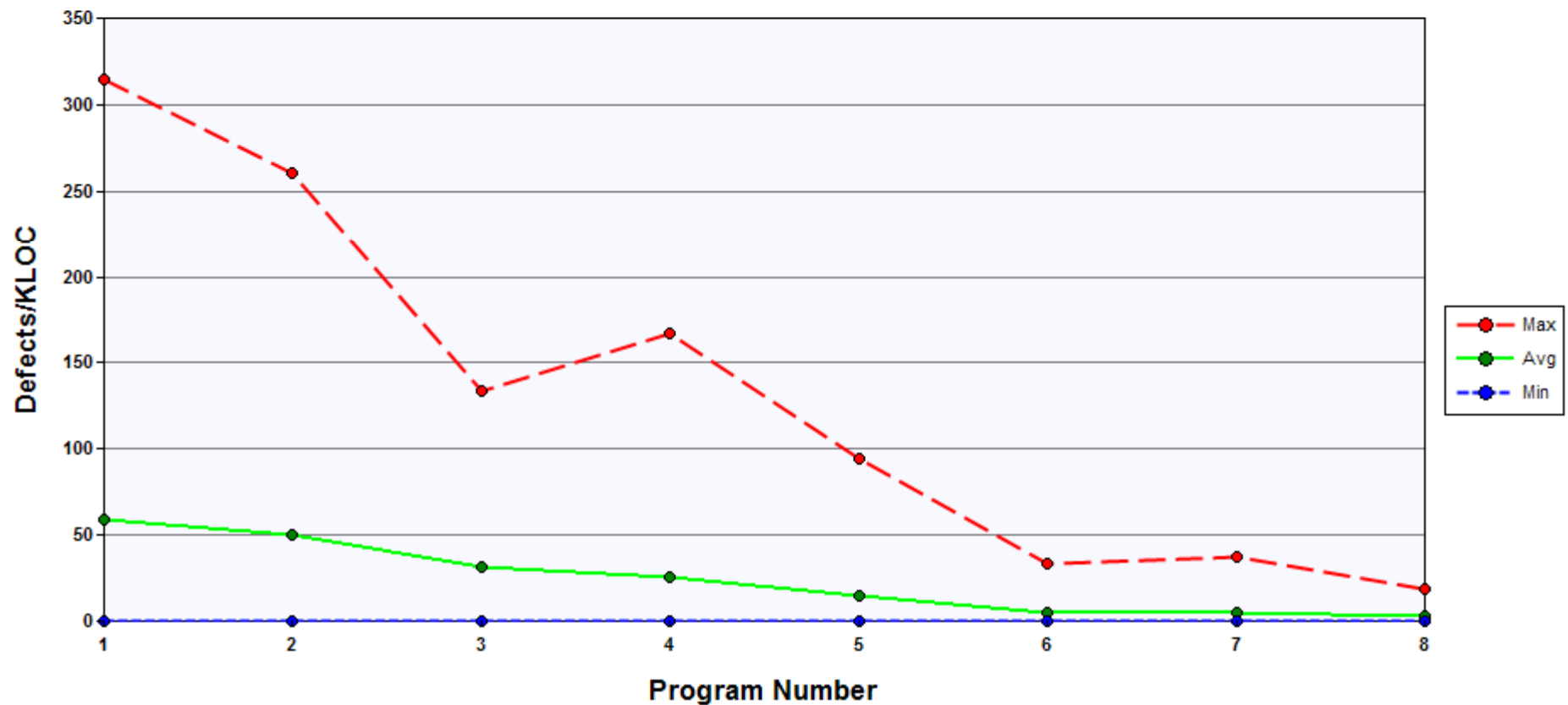




Defects found in compile decreased

Defects Found in Compile - Range

n = 50

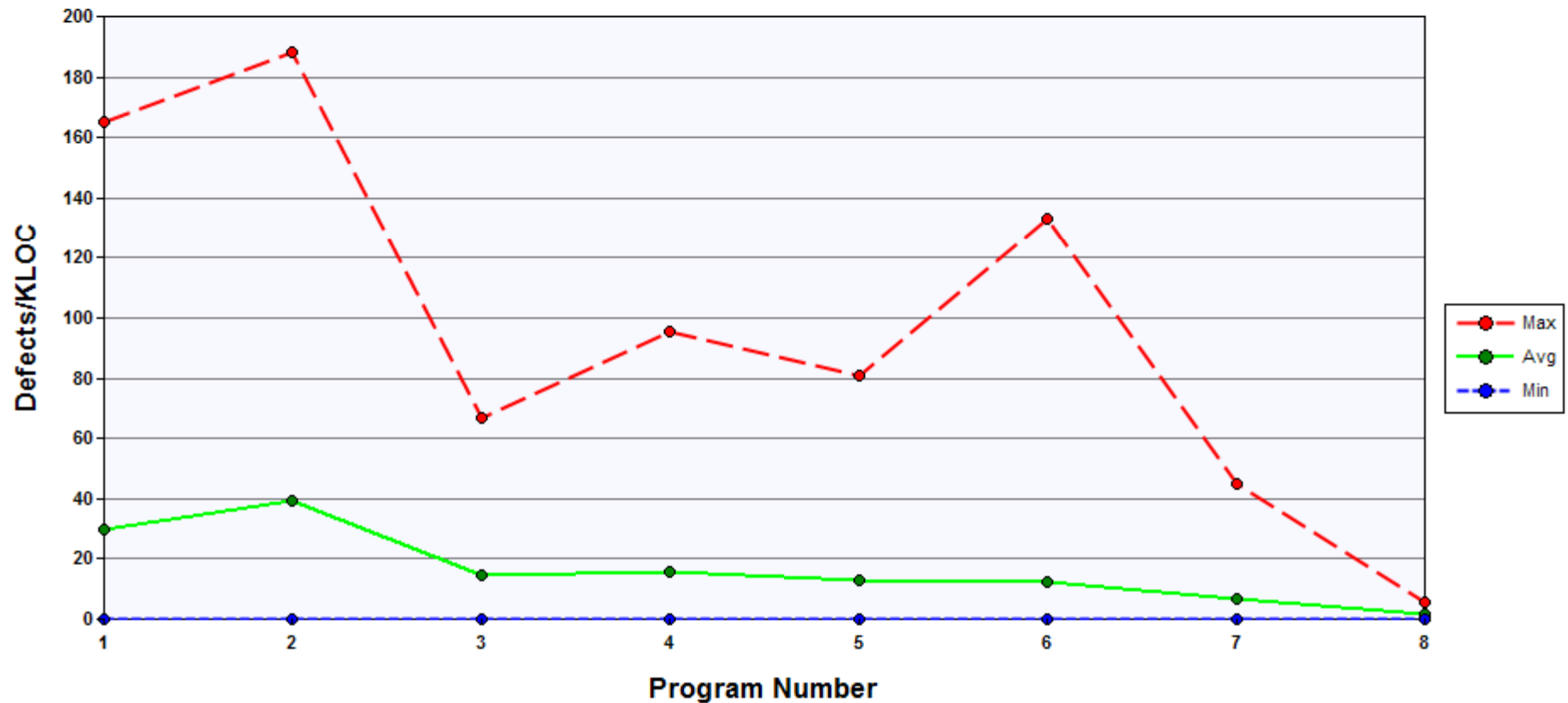




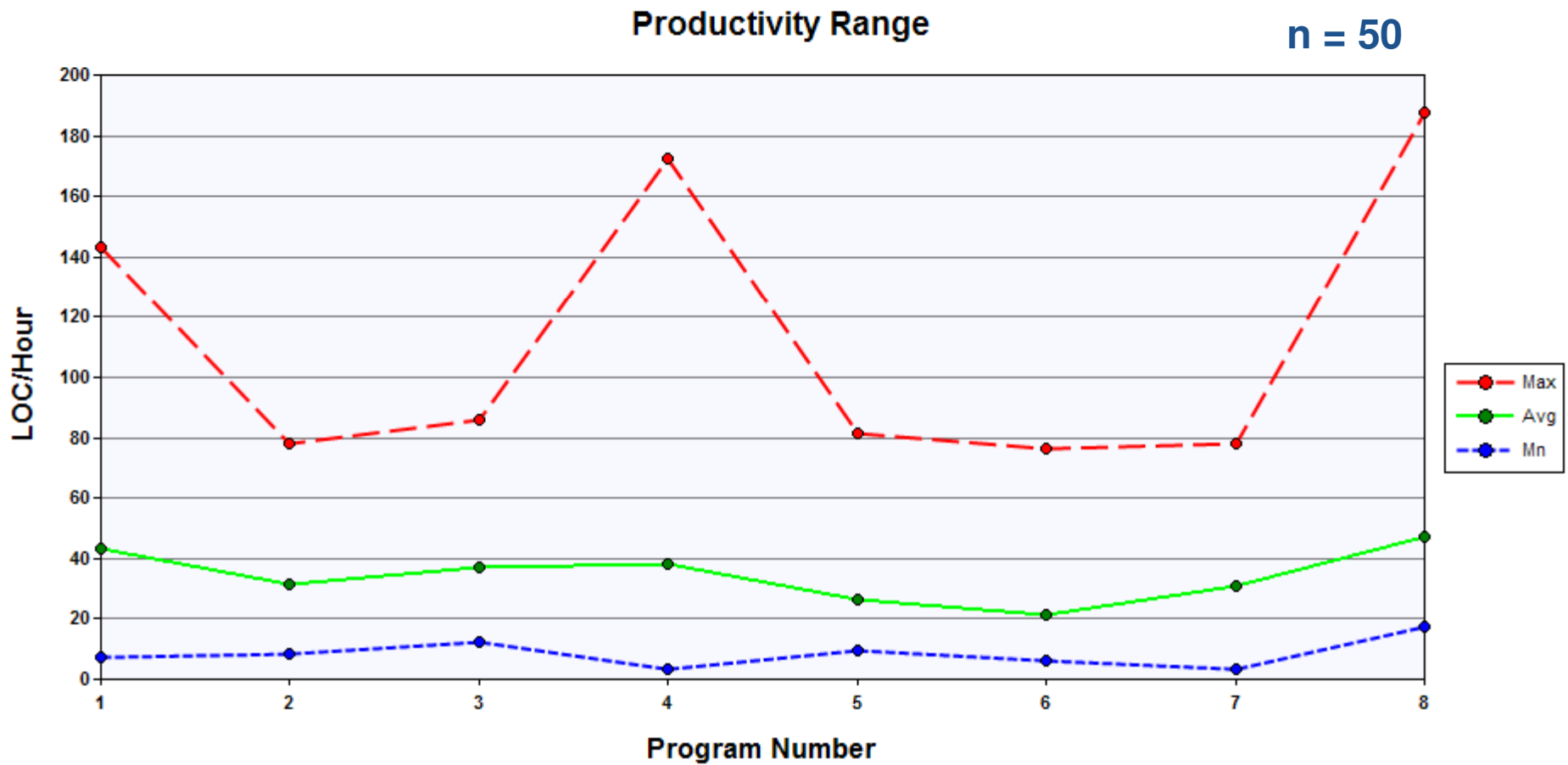
Also defects found in test

Defects Found in Test - Range

n = 50



Without affecting productivity

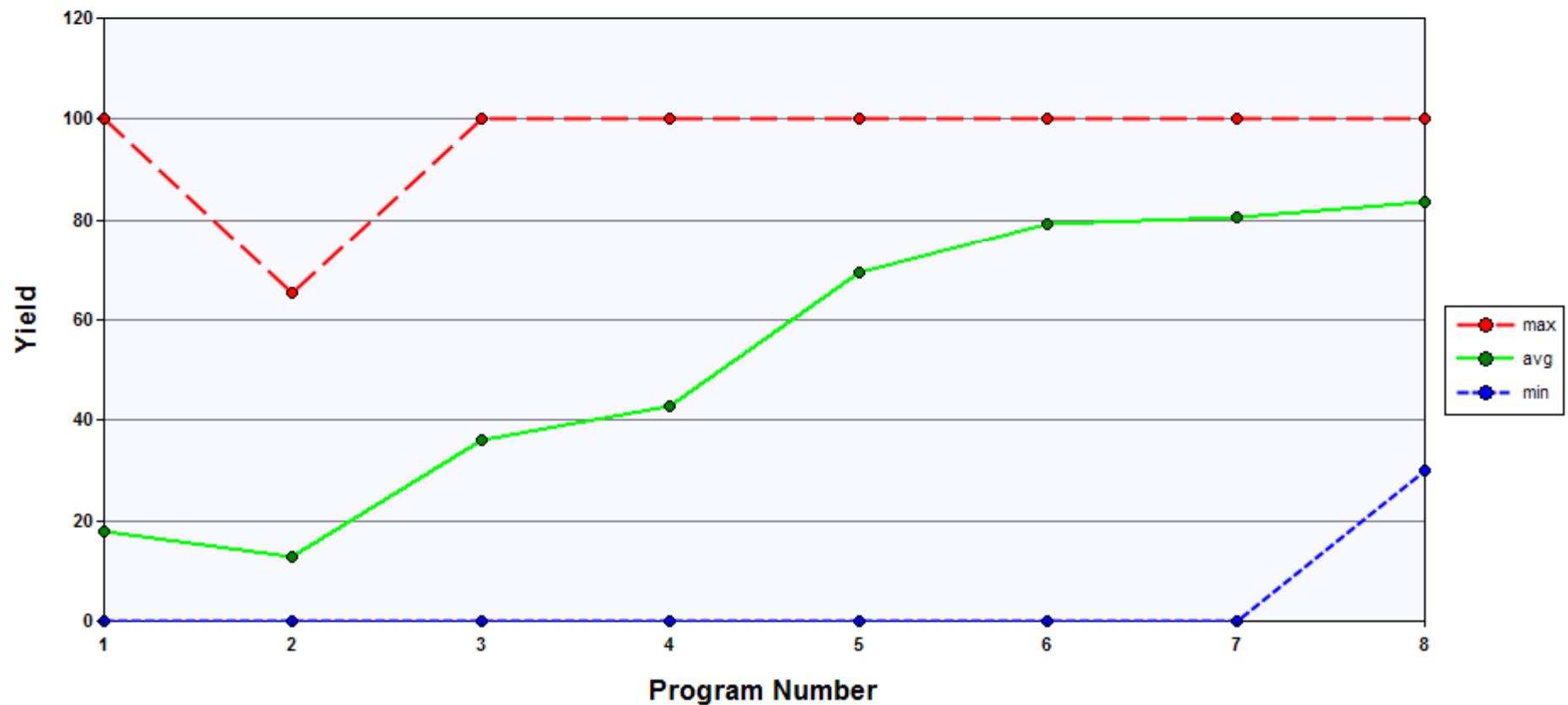




They achieved great yield

Yield - All Students, All Programs

n = 50





In summary

n = 50

	First Program	Last Program	% Diference
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%

Answer: undergraduate students can achieve the same level of improvement that industry software engineers achieve with PSP



What do they think about PSP?



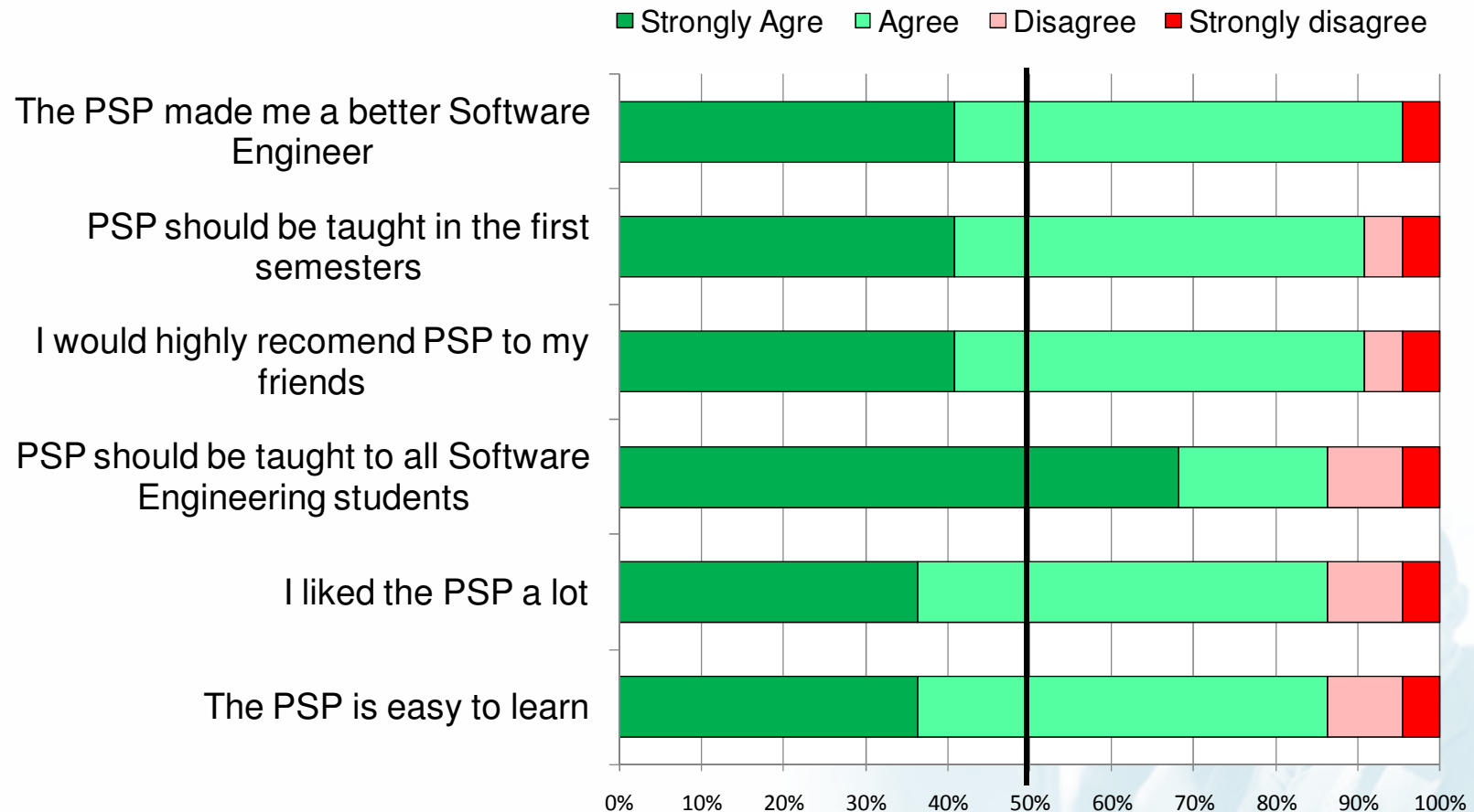


Survey

- **On December 2007 a survey was sent to 40 students that have passed the class in Monterrey Campus**
 - ❑ The survey was anonymous to foster honesty
 - ❑ 22 (55%) responded the survey
 - 6 of them have graduated and were working in industry
 - ❑ They were presented with a series of affirmations and were asked to answer if they strongly agreed, agreed, disagreed, or strongly disagreed with that statement
 - ❑ They were also asked if they were using PSP, and why



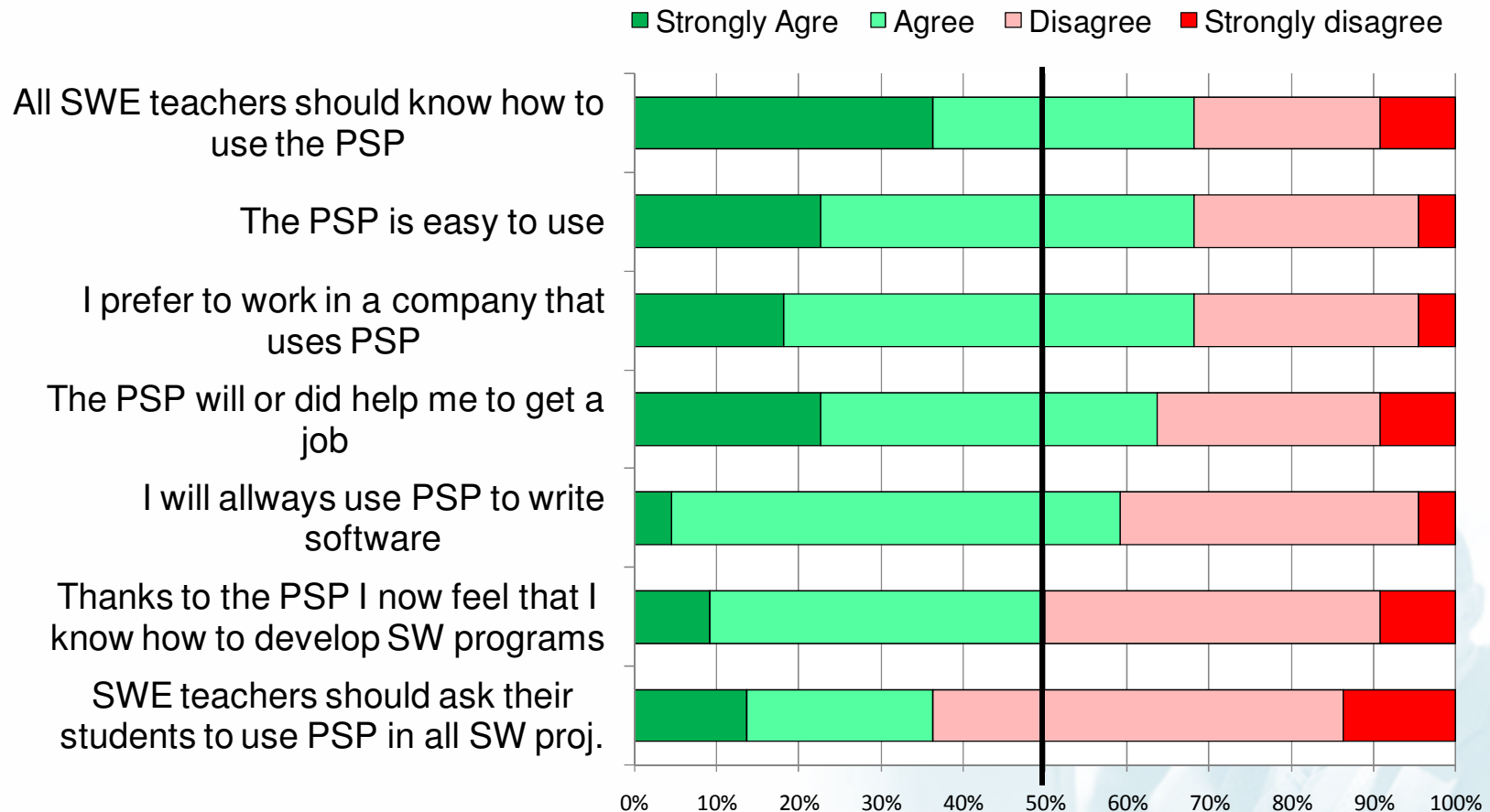
Answers to the survey (better → worse)



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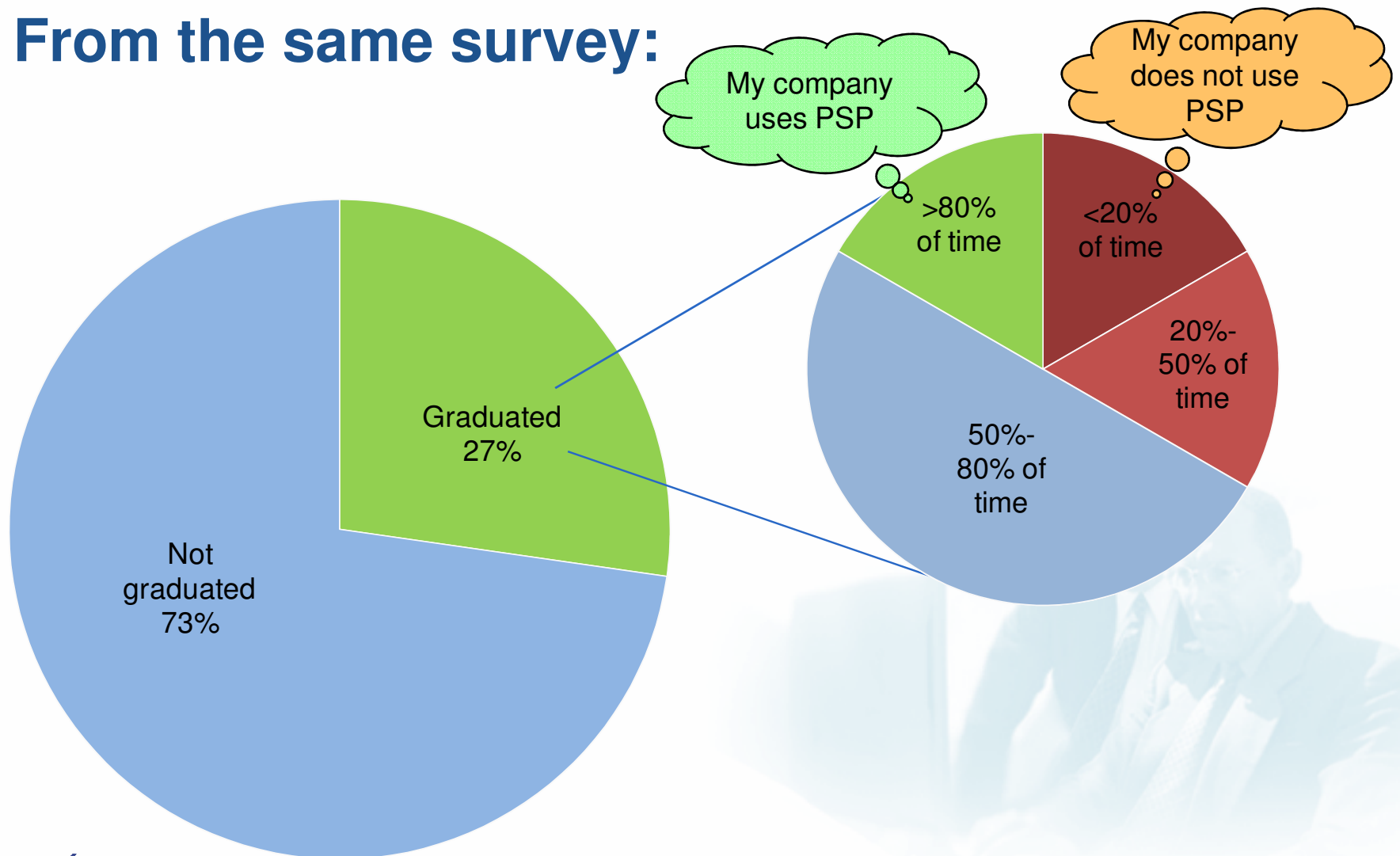
Answers to the survey (better → worse)





But... Are they using it?

■ From the same survey:





Challenges and future work



Challenges

- **Getting faculty to understand the importance of “process discipline”**
 - ❑ Faculty think that the only thing needed for students to develop zero-defect code is showing them “how to write code”
- **Getting the industry to demand Disciplined Software Engineers**
 - ❑ Still they don’t pay more salary to the disciplined SWE (i.e. certified PSP developers)
- **Too much time required from the instructors to properly teach PSP**
 - ❑ In industry courses 1 instructor = 10 students
 - ❑ How do we handle sections with > 10 students?
- **Getting funds to train all needed faculty**



Future work

- **Teach PSP gradually through all years of undergraduate curriculum**
 - Currently working on it
 - Challenge: train all faculty involved
- **Develop tools to reduce the time needed by an instructor to teach PSP**
 - Challenge: get funds (initial work + maintenance)
- **Develop better tools to use PSP/TSP**
 - Challenge: get funds (initial work + maintenance)
- **Find a class to teach TSP to undergraduate students**



Conclusion

- **PSP has showed us that it is possible to teach our students how to develop near-zero-defects software without sacrificing productivity**
 - It shows them the importance of process discipline
- **But success will come from industry...**
 - Demanding disciplined software engineers, and
 - Using process discipline in all their software development projects
- **In Mexico government, industry, and universities are working in tight collaboration to achieve our goal of being...**
 - #1 in high-quality software development**



**TECNOLÓGICO
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Thanks

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