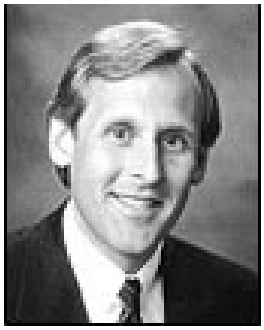
Perspectives
QuantitativeSoftwareManagement® QSM®
Spring 1997 Volume 20 Number 1

Team Size Can Be the Key to a Successful Project



by Doug Putnam

How many people should I use on my development team?

People frequently ask if there is an optimum staffing level for a software development project? At one extreme, the number of people could be below a critical mass and the project is vulnerable to the loss of a key person. Very small teams are also highly dependent on the skills of the "individual". At the other extreme, large teams experience human communication complexities. Large teams quickly gravitate toward the average skill set of the group. Somewhere in the middle there should be an optimum situation. So, the quick and dirty answer to the question is; yes there is an optimum team size, but it is dependent on a number of variables. Some obvious variables are:

- The size of code to be developed and reused
- The application complexity
- The degree to which schedule or cost is the overriding schedule constraint

The goal of our research was to find the optimum team size for building medium-sized information systems.

The Research

In this research, we set out to find the optimum staffing for a specific application domain and size regime. In this work we will define optimum staff size as the team size most likely to achieve the highest productivity, the shortest schedule, the cheapest cost with the least amount of variation in the final outcome.

Our Method

To minimize the variables that could impact our results we decided to select a set of medium sized information systems that were completed in the last 3 years. Medium sized was defined as products that contained 35,000 to 95,000 new or modified source lines of code. There were 491 projects that satisfied the conditions. The sample was then stratified into team size groupings, which is shown in Figure 1. Notice that all of the data sets are fairly well distributed across the entire size regime. The average size of all 5 data sets is 57,412 ESLOC. None of the data set averages are more that 3,000 SLOC away from the overall average size.

The Results

The average productivity, schedule and effort were analyzed for each of the data sets along with the standard deviation. We plotted the averages and compared them to see which had the best performance and observed overall trends if they were apparent.

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Figure 1. Data stratified by team sizes.

Productivity Data:

The average Productivity Index (a measure that uses size, schedule and development effort in it's calculation) was calculated for each of the 5 data sets. The Productivity Index for the 1.5-3, 3-5 and 5-7 person data sets were very similar and had the highest level of efficiency. The "smaller teams" were 2 or more Productivity Indices higher than the "larger teams". The 5-7 person data set had approximately 9% less variation than the 3-5 person projects and 12% less variation compared to the 1.5 - 3 person projects. The variation is displayed using the high-low bars which represent one standard deviation from the average.

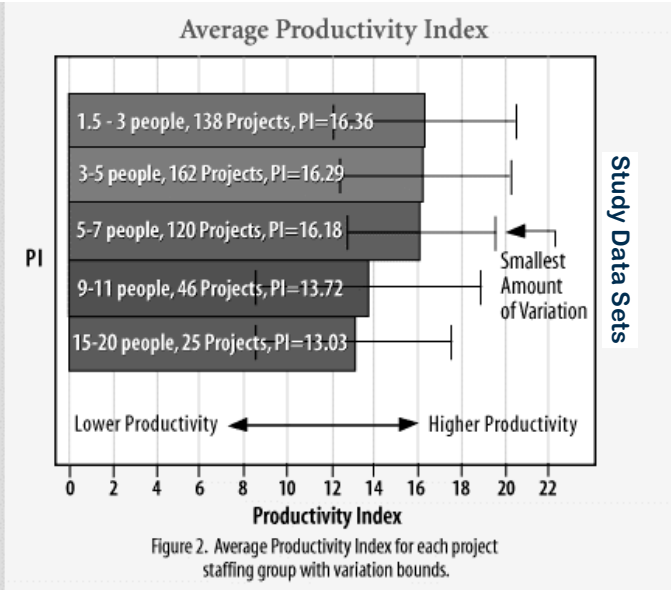

Figure 2. Average Productivity Index for each project staffing group with variation bounds.

Schedule Data:

The schedule data shows that there is a decreasing trend in schedule performance as the team sizes get larger until the team size reach 9-11 people where the average time starts to increase. The schedule performance data show the 5-7 person data set as having the best performance, however the 3-5 person data set is a very close second.

Effort Data:

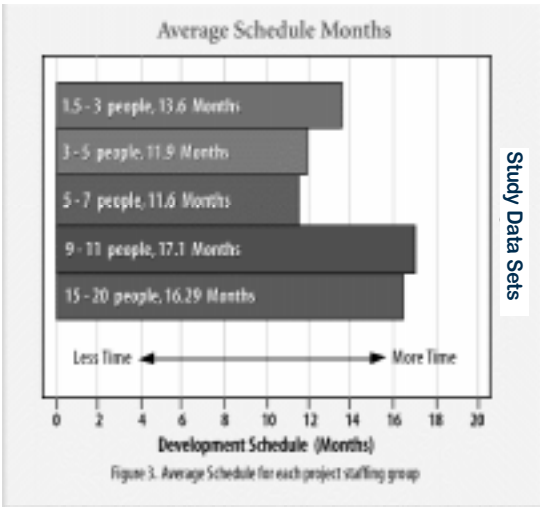

Figure 3. Average Schedule for each project staffing group

The development effort statistics show that larger teams translate into more effort and cost. The trend appears to have a exponential behavior. The most cost effective strategy is the smallest team, however the extreme nonlinear effort increase doesn't seem to kick in until the team size approaches 9 or more people.

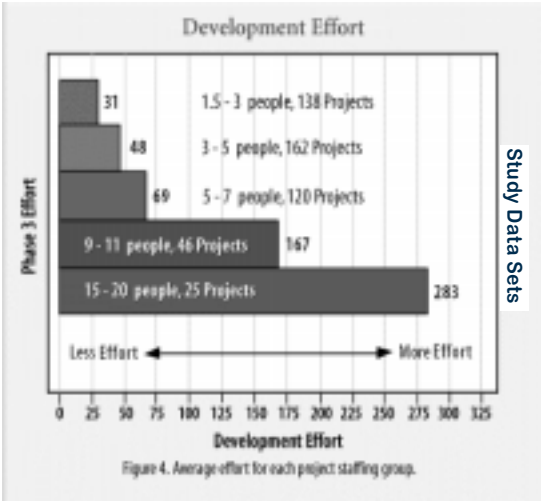

Figure 4. Average effort for each project staffing group.

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The Economics of Software Product Development

by Mike Ross

What actions can I take that will have an immediate and lasting positive impact on my development project(s)?

There are some very favorable ***tactical*** (short term) trade-offs that we can make to improve current projects. There are also some ***strategic*** (longer term) capital investments we can make and some process improvement policies we can adopt that will have a large impact on reducing cycle time, cutting costs, and increasing quality on future projects. The benefits of these actions can be quantified through the notion of ***process productivity***.

Process Productivity

Process productivity (Productivity Index or PI), as developed by QSM, represents the level of an organization's software development efficiency applied to a particular application domain. The PI is derived from the constant of proportionality in a ***metric*** that relates three of the ***four key management measures***: size, effort (peak staff or cost), and cycle time (schedule).

PI is also closely coupled with product reliability (the fourth key management measure). A lower PI, given constant size and cycle time, significantly increases the required peak staff. QSM's 4000+ project database shows that product reliability is a monotonically decreasing function of staff size; therefore, a lower PI, given constant size and cycle time, significantly increases the number of defects that must be found and fixed in the resulting product.

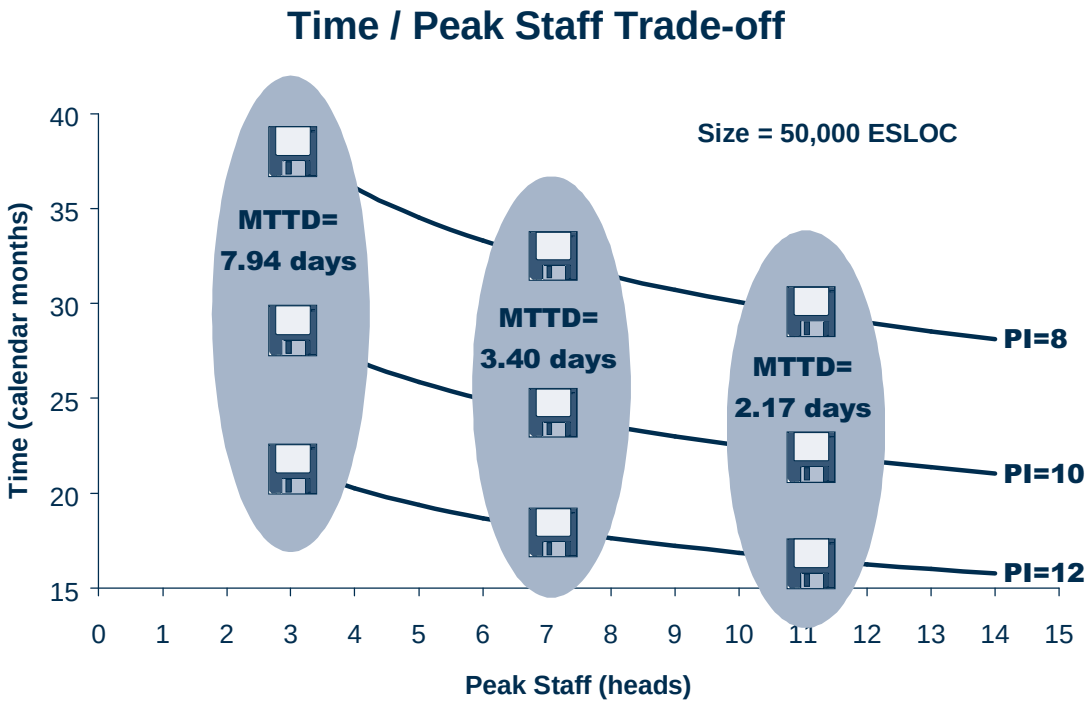
Tactical Action

Short term, we can influence cost and quality by how we staff projects. *The key is to employ small teams taking a little bit longer to produce a much higher quality product at much less cost.* The graph (below) shows the dynamics of this relationship. MTTD stands for Mean Time to Defect at the point in the development process where full functionality exists

The key is to employ small teams taking a little bit longer to produce a much higher quality product at much less cost.

New Clients and Old Clients with New Needs

Allied Assurance
Allied Dunbar
Blue Cross-Blue Shield
Cisco Systems
CMG
Daimler-Benz
Gerber Scientific
ING Bank
Lucent Technologies
National Savings
NCR Corporation
Nortel
Tandem Computers



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Conclusions

The goal of our research was to find optimum team size for building medium-sized information systems. We conclude that a 3-7 person team has the best performance (3-5 would be the best, but 5-7 people is a very close second). Some possible reasons for this behavior are:

- This team size provides some protection against the loss of a key person.
- Individual performance is not overcome by group dynamics.
- Team size is probably close to optimum in building motivation and cohesion.
- There is minimum human communication complexity among team members.
- It doesn't require significant management overhead.

Next time you are planning a project think hard about the optimum staffing levels because it can clearly have a significant impact on the overall results. This study gives you some insights into an application and size domain where many systems are being built today. Coupled with good peopleware practices you should be able to make a real impact on your organization's bottom line performance.

QSM Calendar

March

18-19	SLIM/SLIM Control Training	London, UK
26-27	SLIM/SLIM-Control Training	McLean, VA

April

9	DEC SLIM Training	Nashua, NH
25	DEC SLIM-Control Training	Nashua, NH
17-18	SLIM/SLIM Control Training	Utrecht, Neth.
23-24	SLIM/SLIM Control Training	McLean, VA
27-2 May	STC Conference	Salt Lk City, UT

May

6-7	Sprint SLIM/SLIM-Control Training	Dallas, TX
5-9	STAR Conference	San Jose, CA
15-16	QSM Users Conference	McLean, VA
27-28	SLIM/SLIM-Control Training	London, UK
28-29	SLIM/SLIM-Control Training	McLean, VA
28-29	Sprint SLIM/SLIM-Control Training	Overland Pk, KS

June

19-20	SLIM/SLIM-Control Training	Utrecht, Neth.
25-26	SLIM/SLIM-Control Training	McLean, VA

July

30-31	SLIM/SLIM-Control Training	McLean, VA

Registration and Support Phone Numbers

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with 95% of the total defects discovered.

Strategic Action

Long term, we must invest in a process improvement program. We need to measure the current state of our process, determine its weaknesses, and invest in methods, tools, and training designed to correct those weaknesses. We need to re-measure the process regularly to determine the direction and magnitude of progress. Measuring the PI on each completed project and plotting the results as a function of elapsed calendar time is a good way to quantify direction and magnitude.

Low PI values generally are associated with poor project management, poor working environments, poor processes (task flow, methods, tools, skills/expertise), high requirements volatility, high product complexity, severe product and project constraints, and/or high required reliability. Improving these attributes improves process productivity.

Static (or worse yet, declining) process productivity perpetuates the dilemma that results in trading cost and quality for schedule. Instead of robbing Peter to pay Paul, we must improve process productivity in order to reduce cycle time ***and*** reduce cost ***and*** improve quality.