

Exploring the Outer Limits:

How much software can be developed in a year?



In today's world, customers expect to see software projects delivered in increasingly shorter cycles. The maximum time most IT customers seem willing to wait is about one year. In this fast-paced environment, the question becomes: just how much software can a typical IT shop create in 12 months?

Doug Putnam, VP of Quantitative Software Management, Inc., examines recently completed software projects and offers reasonable guidelines for assessing software delivery dates.

On the surface, this seems like a fairly simple question. Yet given the software industry's longstanding track record of missed deadlines, it would appear to be a bit more complex. It seems reasonable to assert that the amount of software that can be developed in 12 months depends on two factors:

- team or process productivity
- resources (people) deployed to develop the system.

In this paper, we will explore the actual experience of IT developers to find evidence about the technical limits of software development.

Background

QSM, Inc. maintains the most complete software project repository in the world. As of January 2002, the QSM database contained metrics collected from 6,322 completed and validated projects. Projects included in the QSM database must:

1. Have completed the development cycle and be successfully deployed
2. Have measured as a minimum the SEI core metrics: Size, Schedule, and Effort

As one might imagine, the database contains a diverse set of performers. Some are real success stories; others are just this side of abysmal disasters. In any event, the data affords us the capability to ask questions and then make empirical observations about what has actually happened.

For this analysis, we looked at IT projects completed after January of 2000 to give us a reasonably good sample of contemporary projects. We also wanted to study the similarities and differences between **public sector defense** and **private sector IT** project performance.

Project Demographics

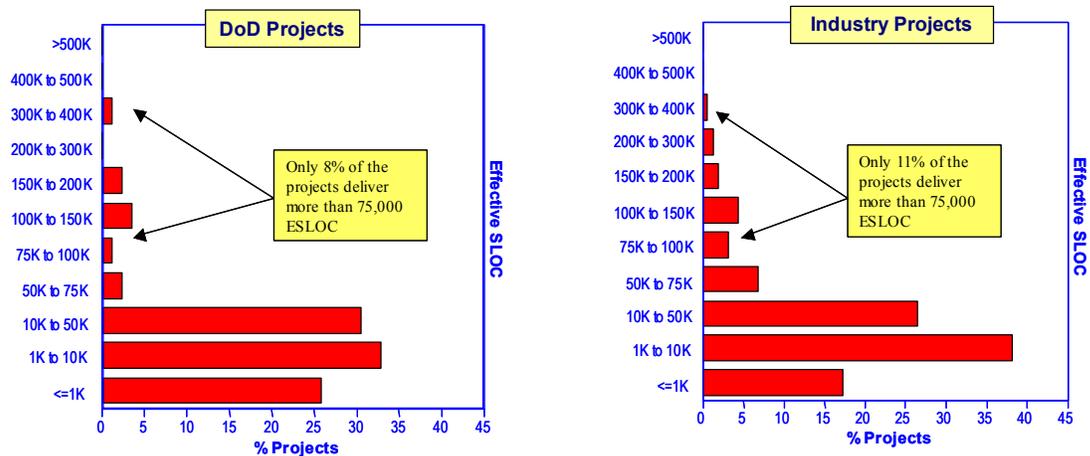
We used three criteria to pull up a diverse, yet contemporary set of projects. The first criterion was the project must have been completed in 2000 or 2001. The second condition was that the primary application domain was Business (IT) projects. The final condition was used to separate the results into projects developed for the Department of Defense (DOD) and those developed for private industry.

The selection criteria resulted in total of 281 projects. Of these, 119 projects comprised the DOD sample and 162 projects made up the private sector sample. Both samples were quite diverse, including new development, major enhancements, and minor enhancements; package modifications; object-oriented projects; and web developments. Project team sizes ranged from less than 1 full time equivalent person to 129 people.

How much software can be built in 12 months?

To answer this question, we took each sample and separated it into projects that were developed in **12 months or less** and those that took **longer than 12 months**. First, we examined projects completed in 12 months or less. *Figure 1* shows the distribution of projects in different size bins. Each size bin shows the range of new and changed source lines of code developed by the projects.

Characteristics of Projects Completed in 12 Months



- Approximately 10% of the projects built more than 75,000 SLOC in 12 months
- Average staff required for projects less than 75,000 ESLOC is approximately 5-10
- Staff required for projects exceeding 75,000 ESLOC is approximately 20-100, depending on size

Figure 1. Frequency Distribution of new and modified software developed with a 12-month time period for DoD and private industry.

Only about 10% of the projects completed more than 75,000 SLOC in 12 months or less.

In both the DOD and private sector samples, there is a noticeable decline of projects above 75,000 SLOC. In fact, only about 10% of the projects were able to build more than 75,000 SLOC in one year or less. This was consistent in both data samples, indicating that there must be some technical limitation influencing what typical development teams are able

to accomplish. In analyzing project staffing levels, we found that the projects teams producing 75,000 SLOC or less rarely exceed 10 people and more typically used 3 – 6 people.

Duration (Months) vs Effective SLOC

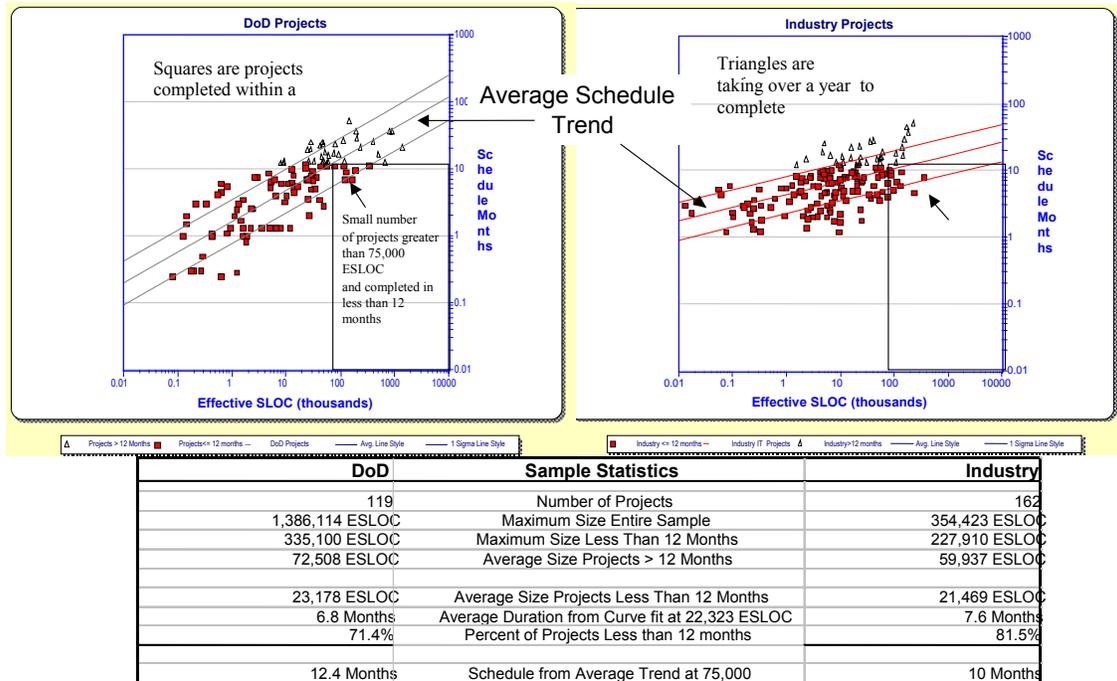


Figure 2. Schedule in Months vs. Delivered SLOC

We then examined projects that produced more than 75,000 SLOC in 12 months. The projects are shown as the squares inside the rectangle in **Figure 2**. These projects were able to develop more software primarily through the use of additional manpower. Not surprisingly, the additional staff also had the effect of significantly increasing the cost.

The team size on these projects ranged from 30 to 141 FTE people at peak staffing. The cost was 117% to 419% above the average of the projects at a comparably larger size of 139,000 SLOC, as is demonstrated in Figure 3.

Effort Premium to Achieve Schedule Compression

5 of the 7 projects that were larger than 75,000 ESLOC and completed less in than 12 months. These projects required more effort than the average trend from the database.

The minimal additional effort was a multiplier of 1.17
The maximum was a multiplier of 4.16

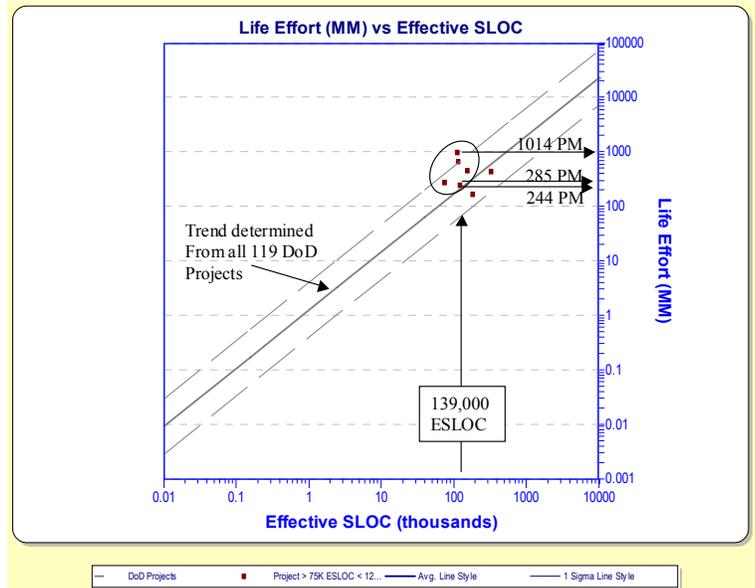


Figure 3. Projects developing over 75,000 SLOC in 12 months used more people and effort than the average, once again demonstrating Fred Brooks' observation of the diminishing schedule returns resulting from the application of additional staffing.

Conclusions

We concluded that is possible for a team of 3 – 10 people to build 50,000 to 75,000 SLOC in a year. Building more than 75,000 SLOC per year is possible, but typically requires:

- Significantly greater staffing and cost
- A relatively low level of complexity in the developed software
- Recognition that the risk of exceeding 12 months is high
- Recognition that the risk of low reliability is even greater

The largest system built within a 12-month period was 335,110 SLOC. Based on the data, QSM believes the practical upper limit on size is approximately 180,000 SLOC per year, using a team of 70–100 people. For projects of this magnitude, one can expect a total cost up to 2–4 times more than comparably sized projects not constrained to a 12-month deadline. So, when adopting this development strategy, make sure that the modest schedule benefit outweighs the increased costs and risks cited above.