NeXTSTEP VS. OTHER DEVELOPMENT ENVIRONMENTS

Comparative Study

BOOZ•ALLEN & HAMILTON INC.

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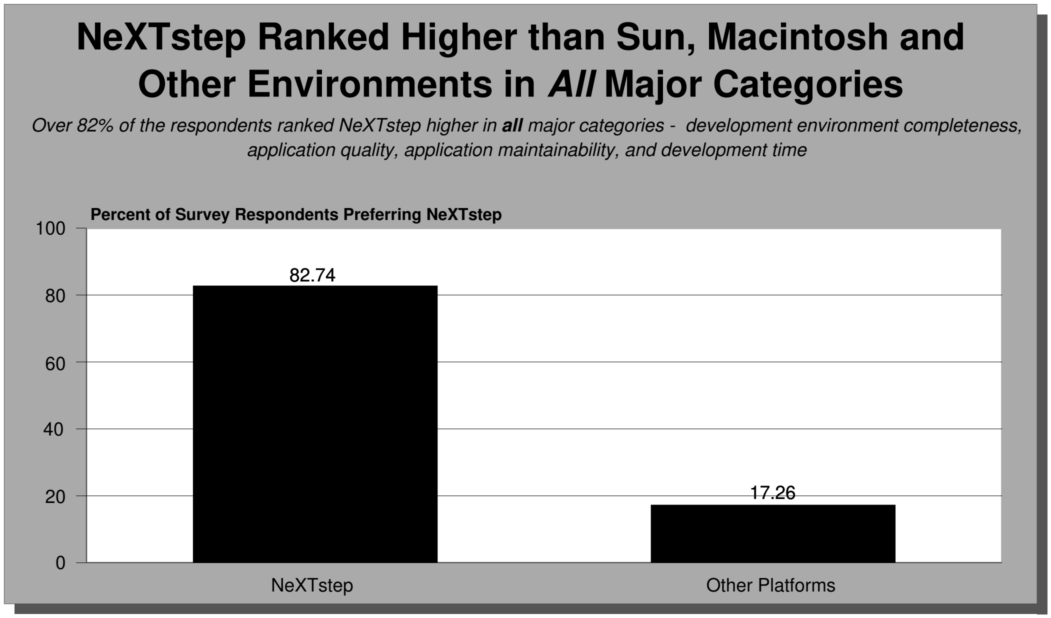
This report summarizes the key findings from a Booz·Allen & Hamilton, Inc. study comparing developers' and programmers' experience with NeXTstep to their experiences with Sun®, Macintosh®, and other desktop application development environments. The study had five key objectives:

1. Assess the completeness of the NeXTstep development environment relative to environments on other platforms;
2. Assess the impact of NeXTstep on the time to develop applications relative to development experience on other platforms;
3. Assess the effects of NeXTstep development on application quality;
4. Assess the impact of developing with NeXTstep on application maintainability;
5. Assess the technical risk of developing NeXTstep applications.

GENERAL CONCLUSIONS

- Over 82% of the developers and programmers surveyed ranked NeXTstep higher than other environments they had used (Sun, Macintosh, MS DOS) in *all* major areas – development environment completeness, application quality, application maintainability, and development time.

- Developers believe that NeXTstep applications are higher quality with regard to such critical factors as software maintenance, application integration, and end-user satisfaction.



- Developers and programmers *with Sun and NeXT™ workstation development experience* consistently rated NeXTstep a significantly better software development environment than Sun.

- 100% of the respondents *with Sun and NeXT workstation development experience* stated that the ease and speed of software development using NeXTstep was better than their experience with Sun workstations.

COMPLETENESS OF DEVELOPMENT ENVIRONMENT

- Over 91% of the developers and programmers surveyed found the NeXTstep software development environment more complete than development environments on other platforms.

DEVELOPMENT TIME

- The average NeXTstep application was reported to take approximately *half the time to develop* compared to similar applications written on other platforms. Respondents reported time savings as high as 90% (NeXTstep development 9 times as fast.)

- Respondents report that programmers write 83% fewer lines of code using NeXTstep.

APPLICATION QUALITY

- Over 91% of the developers surveyed ranked the quality of NeXTstep applications to be higher than the quality of other applications developed on other platforms.

APPLICATION MAINTAINABILITY

- Over 92% of the developers surveyed rated the applications developed using NeXTstep as more maintainable than applications developed using other development environments. The combination of significantly reduced development time and significantly reduced maintenance time indicates that overall life cycle cost savings of NeXTstep applications versus other applications would be substantial.

DEVELOPMENT RISK

- Over 75% of the respondents reported that NeXTstep software development is “low risk”. This, in Booz·Allen’s opinion, compares favorably to the riskiness of software development on other platforms.

AREAS OF CONCERN

- Portability was a primary concern among the developers surveyed regarding NeXT and NeXTstep. Many of them expressed a strong desire to be able to develop NeXTstep applications which could be run on other hardware platforms. It is Booz·Allen’s understanding that NeXT's decision to port NeXTstep to the i486™ platform will help address this concern.

- Several respondents also mentioned the need for database tools. It is Booz·Allen's understanding that NeXT's Database Kit (scheduled for early 1992 release) will address the need for database tools.

QUOTES FROM DEVELOPERS AND PROGRAMMERS

When asked their overall opinion of the NeXTstep environment, developers and programmers gave consistently positive responses such as:

"By far the best out there."

"The reason we bought the machine."

"Dynamite, unbelievable, rewarding."

"Fantastic, the most advanced and productive environment."

"The best thing you can find. Nothing compares - certainly not Sun."

"Top notch."

"Fastest platform I have ever developed on."

"I won't work with anything else (but NeXTstep) except under duress."

"Best I've ever used in 17 years."

RESEARCH PROCESS

Over one hundred software developers and in–house programmers experienced with the NeXTstep™ development environment and other development environments (Sun, Macintosh, and MS DOS) were surveyed by telephone. Among the organizations surveyed were Eli Lilly, TRW, AT & T Labs, Boeing, Phibro Energy, First National Bank of Chicago, Bozell, Stanford, MIT, Union Bank of Switzerland, Aldus and WordPerfect.

Those surveyed had an average of 10.4 years of software development experience. The respondent's experience was dispersed between Sun, Macintosh and an array of PC platforms.

NOTE: Throughout this report, “survey respondents,” “developers,” and “developers and programmers” are terms used interchangeably to represent the surveyed population.

BACKGROUND & OBJECTIVES

BOOZ·ALLEN & HAMILTON

Booz·Allen's Engineering Center in San Diego has been involved in numerous product evaluations as part of a continuing effort to advise clients on the application of technologies and products from the information technology marketplace. The Engineering Center is a software engineering and development resource, providing workstation and desktop technology development and application expertise to a wide variety of commercial and government organizations.

Booz·Allen has a strong history of assisting commercial and government clients with analyses and decisions regarding information technology, including the evaluation of software development environments, the use of software engineering tools and environments, and software development planning.

Booz·Allen approached NeXT Computer, Inc. regarding this study as part of a continuing interest in investigating the impact of new software development products and technologies on the cost, manageability, and reliability of software development practice. NeXT Computer, Inc., headquartered in Redwood City, California, agreed to support Booz·Allen's research.

NeXTstep

NeXTstep, which is furnished on workstations manufactured by NeXT Computer, Inc. (and, as of 1992, will be available on certain i486 workstations), is object-oriented systems software combining an operating system, user environment and a software development platform. NeXTstep's development tools include:

• Interface Builder™ - for designing and implementing graphical interfaces for applications and managing objects;

• The Application Kit™ - object-oriented building blocks (objects) which provide the core framework needed by any NeXTstep application;

• An object-oriented programming environment providing a simplified, modular approach to programming, including the Objective C and C++ languages;

STUDY OBJECTIVES

Booz·Allen & Hamilton, Inc. proposed that a comparative study be conducted to measure the effectiveness of using NeXT Computer's NeXTstep software development environment for custom software application development.

Booz·Allen, with NeXT's assistance, identified five key objectives:

1. Assess the completeness of the NeXTstep development environment relative to environments on other platforms;
2. Assess the impact of NeXTstep on the time to develop applications relative to development experience on other platforms;
3. Assess the effects of NeXTstep development on application quality;
4. Assess the impact of developing with NeXTstep on application maintainability;
5. Assess the development risk of developing NeXTstep applications.

STUDY RESULTS

This section summarizes the findings from a survey of software developers who have experience in multiple platforms -- including NeXT workstations. This covers both general conclusions and specific findings relative to completeness of the development environment, development time, application quality and maintainability, and development risk.

GENERAL CONCLUSIONS

- Programmers rated NeXTstep a significantly better software development environment than other environments that they had used (Sun, Macintosh, MS DOS, and other environments).

- Over 82% of the developers and programmers surveyed ranked NeXTstep higher than other environments they had used (Sun, Macintosh, MS DOS) in *all* major areas – development environment completeness, application quality, application maintainability, and development time.

- Programmers believe that NeXTstep applications are of higher quality with regard to such critical factors as software maintenance, application integration, and end-user satisfaction than those developed under other environments.

Developers who participated in the survey enthusiastically praised the software development environment and its consistency and completeness in supporting software development. Some respondents offered to rate experiences with NeXTstep more highly than the scales in the questionnaire would allow.

In reviewing this ranking of NeXTstep, and taking into account our prior experience with other platforms and our own experience with the NeXTstep environment, Booz·Allen has concluded that there are key elements of the NeXTstep software development environment that contribute heavily to the survey respondents' enthusiasm about NeXTstep. The following features of the NeXTstep environment were mentioned frequently by users as significant in reducing many of the usual obstacles to quality software
development.

- Interface Builder - significantly reduces the complexity and consistency problems in developing user interface functions;

- The Application Kit - provides a significant advantage in developing applications due to the availability of reusable, extensible objects which can be used in applications;

- Display PostScript® - the PostScript graphics orientation of NeXT systems enables software developers to develop programmatic constructs within applications which can not be as easily attempted in other graphics/windows environment standards.

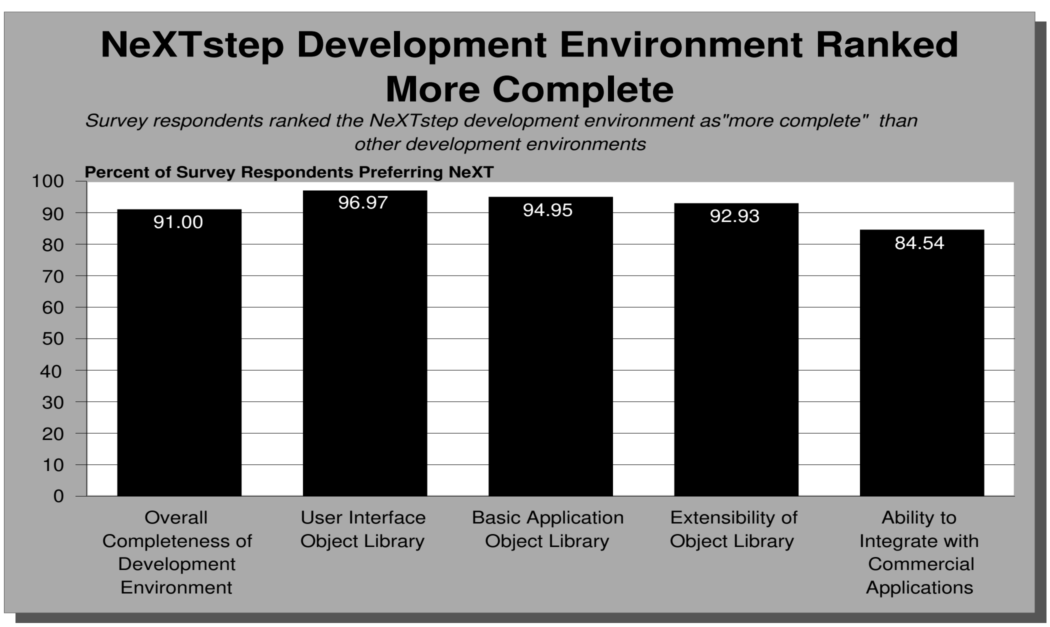
At the conclusion of each survey, respondents were asked to make their own general assessment of NeXTstep. The most frequent reply, reported by at least half the respondents, was that NeXTstep was the best development environment in which they had ever worked.

COMPLETENESS OF DEVELOPMENT ENVIRONMENT

Over 91% of the developers surveyed find the NeXTstep software development environment more complete than development environments on other platforms.

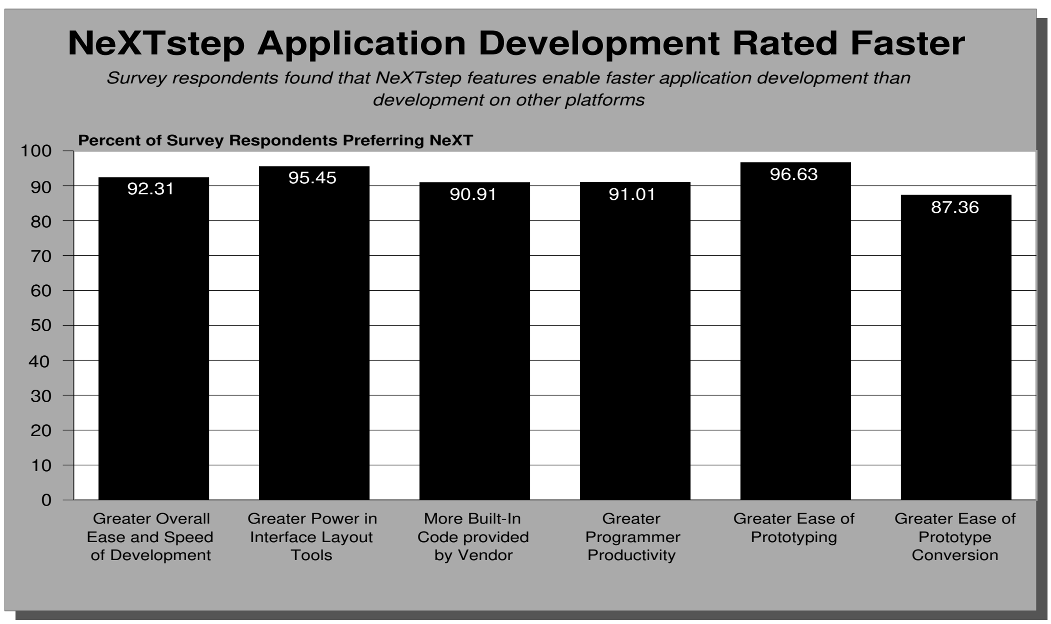
Specifically, the study revealed that developers found:

- The NeXTstep development environment was a more complete appli-ication development environment;
- The user interface object library and the basic application object library are more complete in NeXTstep;
- The NeXTstep object library is more extensible;
- The ability to integrate with commercial applications is better.



DEVELOPMENT TIME

The average NeXTstep application was reported to take approximately *half as long to complete* as comparable applications on other platforms. Booz·Allen believes this is probably a conservative estimate of time savings, since many applications features which NeXTstep developers count on, such as printing rich text, faxing information, voice annotation and the ability to incorporate graphical information are too difficult to even be attempted on other platforms, particularly in those organizations developing in-house applications.



Developers consistently stated that NeXTstep delivered significant time savings over development experiences on other platforms using other environments. Often the time savings reported were quite large; a number of respondents reported time savings as significant as 90% (development on the NeXT was over 10 times as fast).

Many respondents indicated that developing using NeXTstep was not only faster, but also that the applications were “better” (more features, better user interfaces, more maintainable, more extensible). For instance, one respondent stated that the NeXTstep developed product “blows the PC version away” and “there is no comparison.”

- Survey respondents reported that the average time to develop an application using NeXTstep was 6.4 months. This represents an average time savings of approximately 47% over software development experiences on other platforms.

- NeXTstep, on average, saved 83% of programmer written lines of code. The average application was reported by respondents to be 60,787 lines of code. Two high responses of 4 and 14 million lines of code were removed from the average.

- The average NeXT application development project was reported to be within 36% of the software development schedule and within 18% of the budget. Booz·Allen's interpretation of this data is that developers can reliably estimate the effort involved in NeXT programming and come very close to their targeted schedule and budgets. One developer stated, for example, that he was pleased that the time to develop was within 10 - 20% of his estimate -- compared to the 80 - 100% overrun he experienced on other platforms.

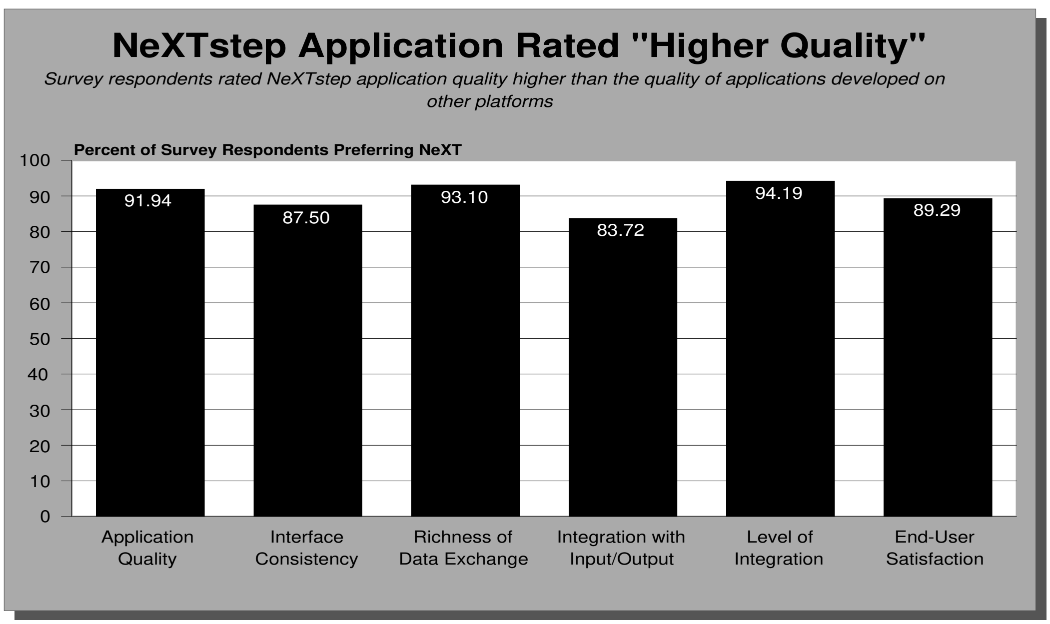
- The ease and speed of software development as well as the power of the software development and user interface layout tools were ranked higher by a significant majority of the developers.

- Most of the developers stated that the amount of built-in code provided by NeXTstep was greater than in other environments with which they were experienced, leading to substantial time savings. Programmer productivity was also ranked higher; Booz·Allen believes that the built-in code provided by the NeXT environment contributed to this savings.

• NeXTstep was consistently reported to be an easier environment to use for application prototyping. It was also ranked higher as an easy environment to use for converting prototype applications to final applications.

APPLICATION QUALITY

Over 91% of the respondents reported that the overall quality of applications developed using the NeXTstep development environment is superior to the quality of applications developed using other development environments.

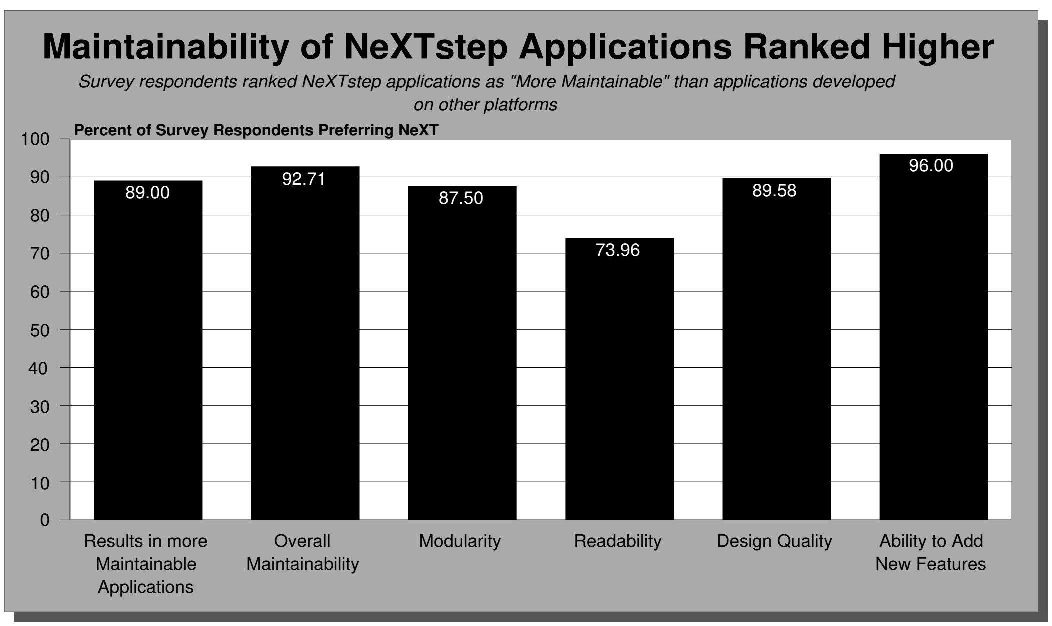


Respondents felt that end-users' satisfaction when using NeXTstep application was very high when compared to other platforms. NeXTstep naturally delivered high application quality which translates into ease of use and a high level of end-user satisfaction. As one developer related, “In a public area where Sun and NeXT machines run similar applications, the users invariably prefer the NeXT applications.”

Developers consistently ranked NeXTstep applications superior in interface consistency, data exchange between applications, integration with I/O media, integration of applications, and overall end-user satisfaction.

APPLICATION MAINTAINABILITY

Over 92% of the developers surveyed rated the applications developed using NeXTstep as more maintainable than applications developed using other development environments.

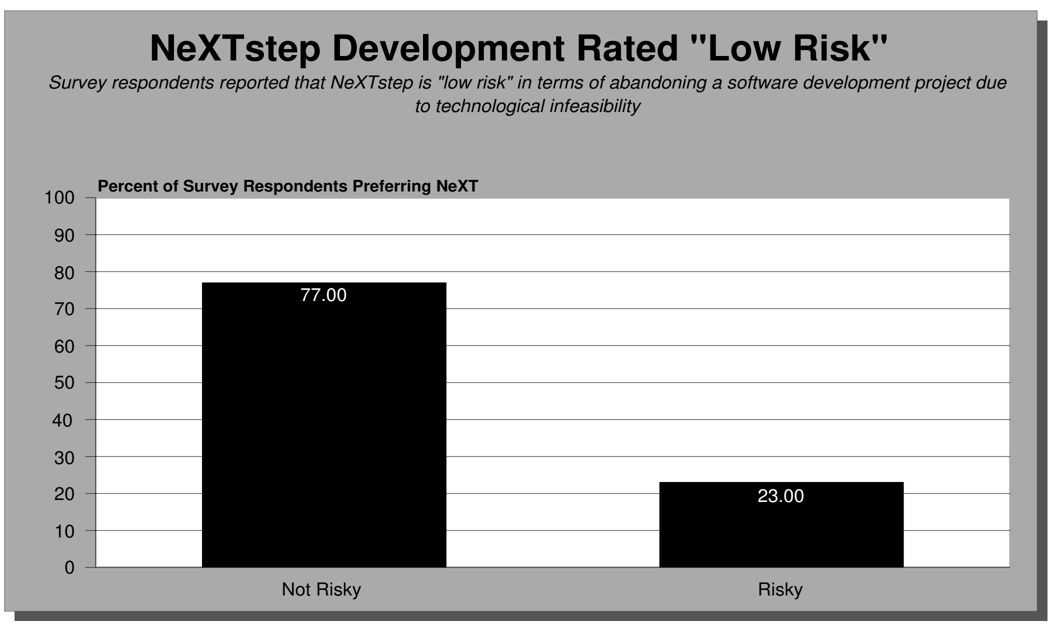


Developers consistently ranked NeXTstep application modularity, readability, and design quality higher. They also reported that the ability to add new features to applications was better for NeXTstep applications. Many developers attributed their preference to the ease and power of Interface Builder and the Application Kit provided by NeXTstep.

DEVELOPMENT RISK

Of the developers who have assigned mission critical software development projects to the NeXT machine, approximately 75% reported that development with NeXTstep was considered technically "low risk."

The survey addressed development risk with questions related to the critical nature of NeXT applications and the risk to develop them. Risk was defined for the purposes of this study as the risk of "abandoning a development project or not achieving the end goal."



In Booz·Allen's years of experience with software developers, we have found that software development on any platform is generally a very high risk activity. Booz·Allen believes that the fact that the large majority of NeXT developers rate development on NeXT “low risk” demonstrates a strong vote of confidence in NeXT. The 25% of respondents who felt that development on NeXT was “moderately risky” to “risky” is, in Booz·Allen’s opinion, on a par with or better than industry standards.

One developer described a custom application that was planned for development on both the NeXT and Sun workstations - to be developed on a parallel schedule. The application relied heavily on graphics. The NeXT application was competed in a little over four months. The Sun application was abandoned as “not completable after about a year of effort.” The respondent related that the success of the NeXT development was largely attributed to the Display PostScript capabilities inherent in the NeXT computer.

Additionally, as a measure of technical risk, some developers offered that they had developed software on the NeXT that they would not even attempt to develop on another platform.

Although most developers rated NeXTstep applications development as “low risk,” many expressed some reservations in the area of portability to other platforms. Booz·Allen believes that NeXT's decision to port to the i486 platform should help address this concern.

NeXT vs. SUN STUDY RESULTS

The Sun workstation was the workstation platform (high-resolution, multitasking, high-performance desktop system) with which a significant number of the developers had the most experience (approximately 50%.) This section examines the comparative data from developers who had Sun and NeXT workstation development experience.

Our objective in this analysis is to determine how NeXT compares to the Sun as a development platform.

Booz·Allen's experience in software development at its San Diego Engineering Center tells us that Sun workstation software development can be difficult. The programmer who is new to Sun is faced with the challenge of selecting from and learning a wide range of development environments, tools, and approaches. Additionally, the C++ and object-oriented product communities in the Sun marketplace are relatively new. It is typical in a Sun workstation environment to run into problems such as trying to use graphical user interface development tools which are not yet compatible with object–oriented C++ compilers.

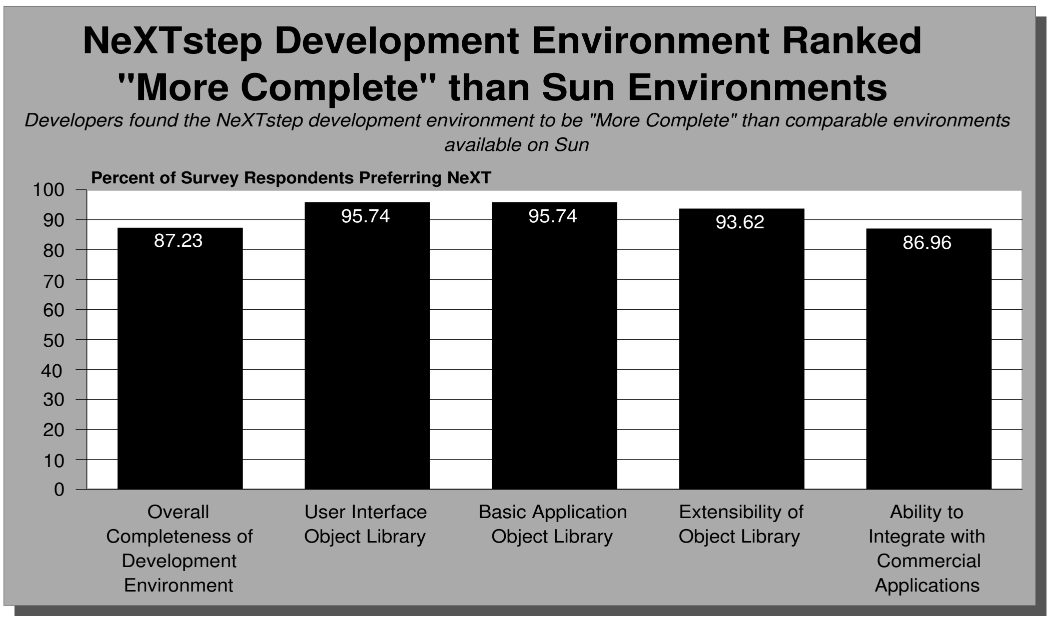
GENERAL CONCLUSIONS

- Programmers *with NeXT and Sun workstation development experience* rated NeXTstep a significantly better software development environment than Sun.

- Programmers *with NeXT and Sun workstation development experience* believe that NeXTstep applications are higher quality with regard to such critical factors as software maintenance, application integration, and end-user satisfaction.

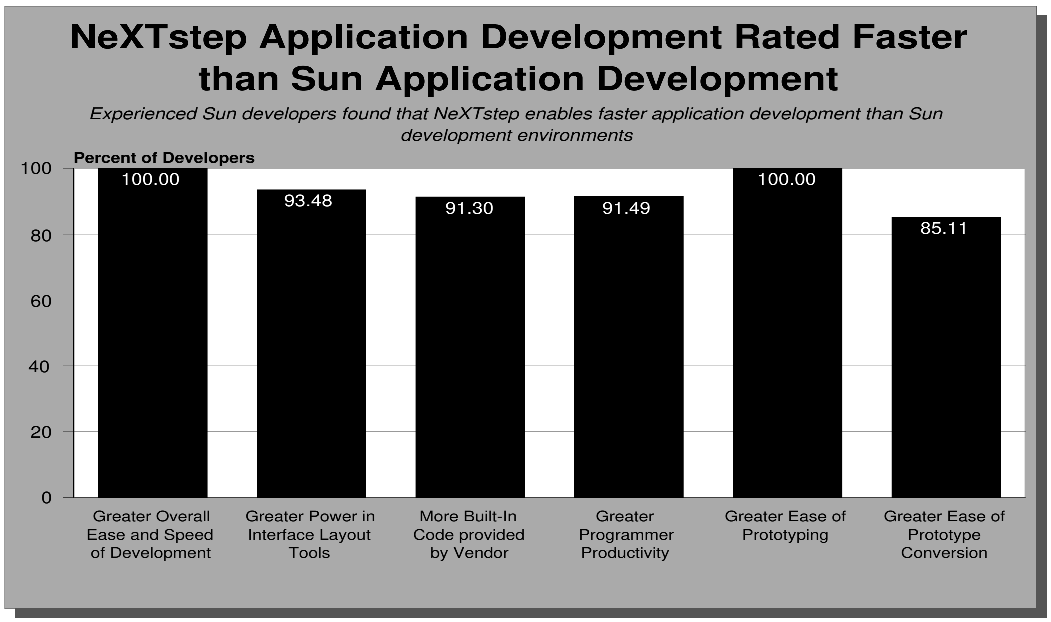
COMPLETENESS OF THE DEVELOPMENT ENVIRONMENT

The developers and programmers who compared Sun to NeXT in their comparative responses where consistently enthusiastic in their ratings of NeXTstep: over 85% of Respondents with Sun and NeXT experience ranked NeXTstep more complete on all five attributes of "environment completeness."



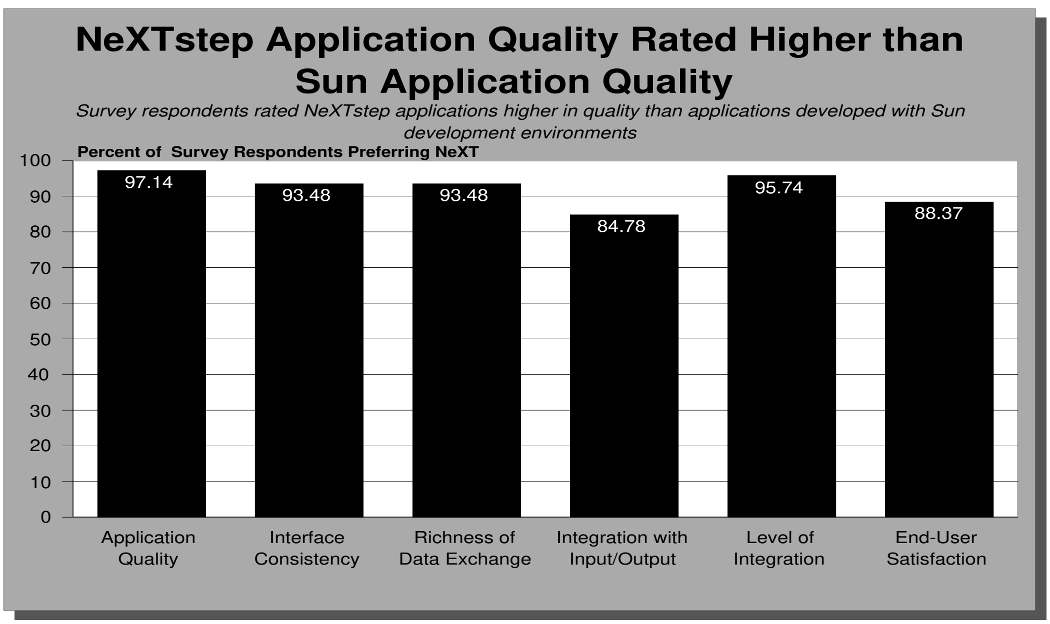
DEVELOPMENT TIME

100% of the respondents with NeXT and Sun workstation experience stated that the speed of software development using NeXTstep was better than the speed of software development using Sun workstations. 100% of the respondents also indicated that NeXTstep was an easier environment to use for application prototyping.



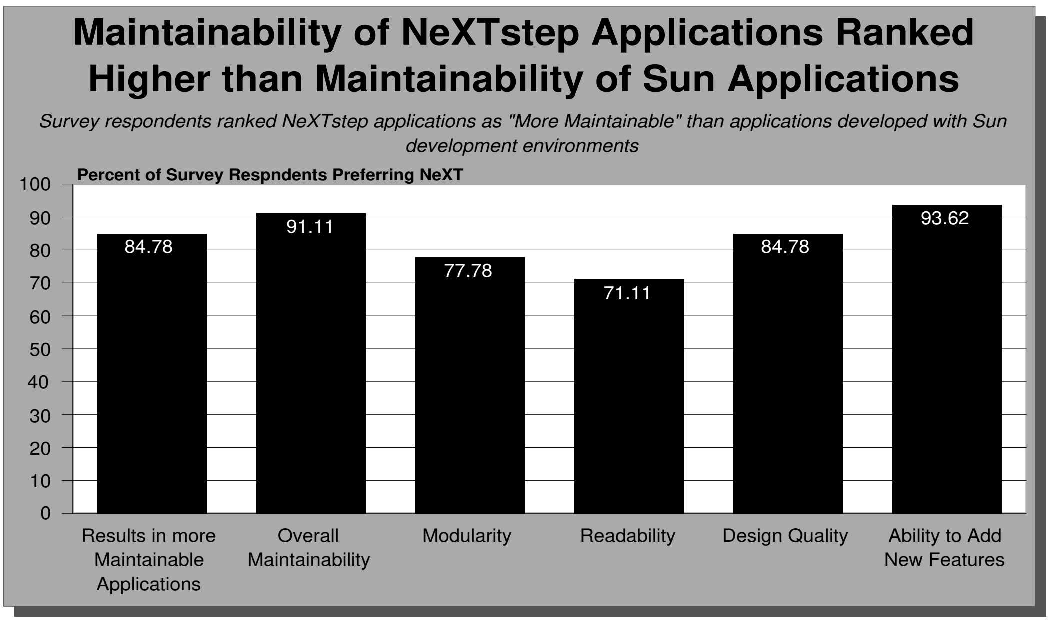
APPLICATION QUALITY

NeXT application quality was ranked higher than Sun application quality, by over 97% of respondents with NeXT and Sun experience. NeXT application quality was consistently praised by developers who not only reported that NeXTstep produces better applications, but, in some cases, applications could be developed with NeXTstep that would not even be attempted on Sun platforms. This was often attributed to the ability to use Interface Builder with the Application Kit and Display PostScript to construct applications with more features.



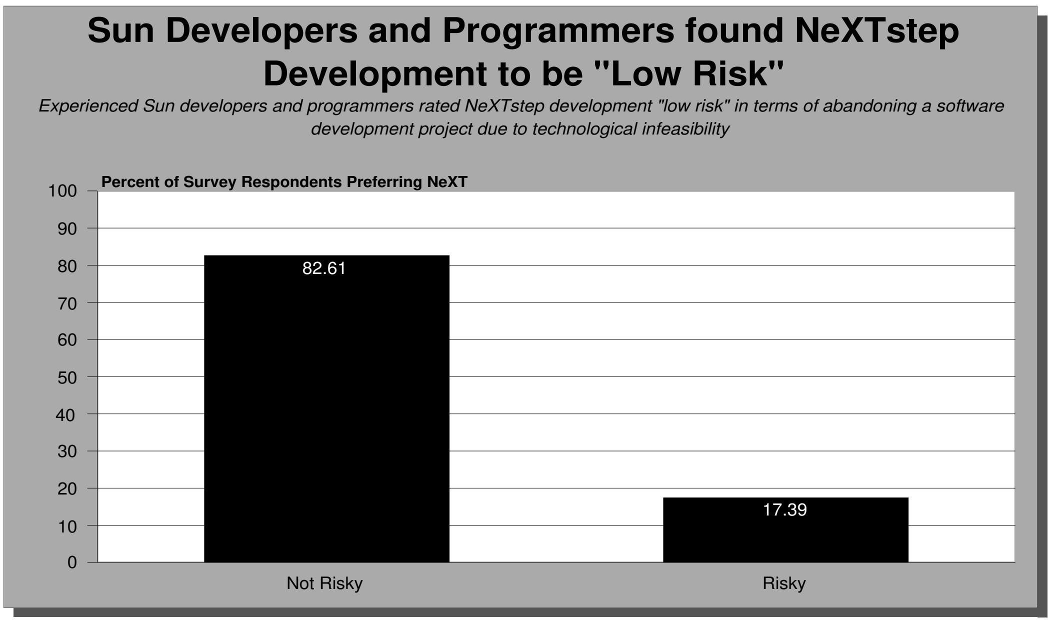
APPLICATION MAINTAINABILITY

Over 91% of the survey respondents with NeXT and Sun development experience ranked the overall maintainability of NeXTstep applications better than the maintainability of Sun applications. In addition the modularity, readability, design quality, and the ability to add new features were ranked higher for the NeXT environment than for Sun.



DEVELOPMENT RISK

Over 81% of the experienced Sun developers indicated that they did not view NeXTstep development as technically risky. They felt generally more confident that the application development effort would not be abandoned because it was "not do-able" or would overrun the allotted budget.



RESEARCH PROCESS

Traditionally, it has been an extremely difficult task to quantify the advantages and disadvantages of software development environments. Because two development environments are not exactly comparable in terms of cost, power or capability, hard quantifiable data is difficult to obtain. Comparisons need to be derived from individual experiences and perceptions.

Booz·Allen determined that a telephone survey of developers and programmers was the most effective research approach for this study. Our strategy was to gather information from software developers and programmers who had significant development experience on NeXT and on other platforms (Sun, Macintosh, MS DOS). These experienced individuals would have the basis to make valid comparisons between the NeXT computer and other development platforms. Respondents included customers of NeXT and other workstation and pc vendors from government agencies, higher education institutions, value added resellers, developers of commercial products, and in-house programmers from a variety of industries.

This section reviews Booz·Allen & Hamilton's approach to the questionnaire design survey implementation and the analysis and interpretation of findings.

QUESTIONNAIRE DESIGN

The questionnaire was designed to garner data related to the elements of the software environment Booz·Allen determined are most critical to software developers. Survey participants were queried on:

- The completeness of the NeXTstep relative to their experiences with other software development environments;
- The time required to develop applications including the average development time for applications and programmer productivity relative to other platforms;
- The quality of applications developed with NeXTstep relative to the quality of applications developed on other platforms in terms of end-user satisfaction, integration of features and capabilities, and completeness;
- The maintainability of their NeXT applications relative to the maintainability of applications on other platforms in terms of size, readability of the code, and ease of enhancement;
- The risk of developing software for NeXT in terms of the risk of "abandoning or not completing a software development project;"
- Purchase motivation when purchasing application development machines;
- The importance of various characteristics of the system including system responsiveness, network interpretability, user friendliness, availability of third party application software, and price/performance.

The survey questions that were organized into the following groups:

I. Background information
II. Purchase motivation
III. Starting/setting up for application development
IV. Comparison of the NeXTstep development experience to other dvelopment environments
V. Quality of completed applications

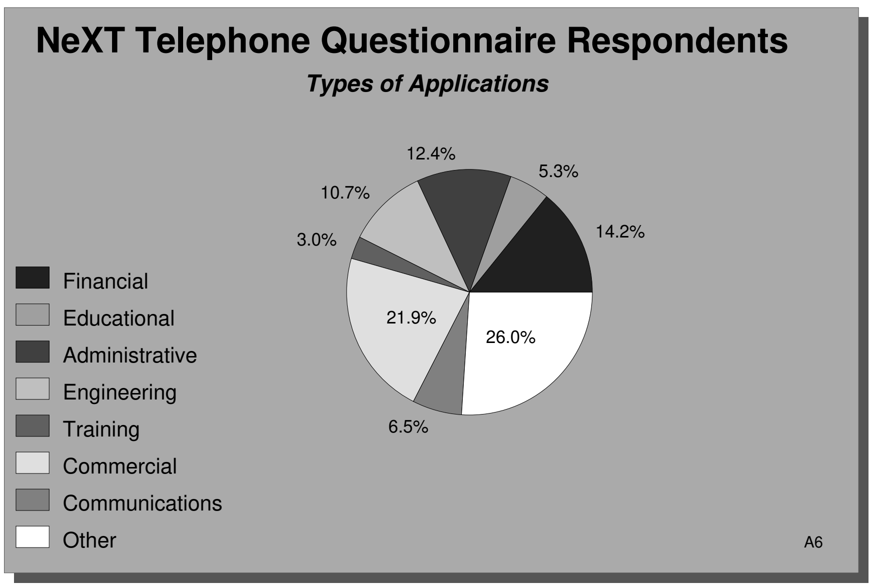
Most of the questions were of a comparative nature. There was no intention to provide hard quantifiable measures on all issues. The questionnaire was intended to capture developers' own comparisons of NeXT to other development environments.

The comparative questions used a rating scale ranging from 1 to 5. The rating of “5” by a respondent indicates that NeXT is perceived to be “Much Better”; it is the top ranking. A “3” indicates that NeXT compared to another platform is perceived to be “About the Same”. A “1” indicates that NeXT compared to another platform is perceived to be “Much Worse”. In general, a score of “4” or “5” means that the respondent rates NeXTstep superior to the competing platform.

SURVEY IMPLEMENTATION

Over one hundred software (150 + received survey, 104 responded) developers experienced with the NeXTstep development environment *and* other development environments were interviewed regarding their experiences. Booz·Allen & Hamilton randomly chose the respondents from lists of NeXT customers, attendees at NeXTstep programming classes, and commercial developers developing products for NeXT and other platforms. All respondents were initially screened to ensure they also had experience with Sun, Macintosh, and/or MS DOS environments. Booz·Allen reviewed the respondent population and we believe that the variety of platform and application experience is a fair representation of developers/programmers in general.

Survey respondents were involved in a broad array of application development including financial, administrative, commercial, educational, and training applications:



Those surveyed had an average of 10.4 years of software development experience. The developers' experience was dispersed between Sun, Macintosh and an array of PC platforms:

- 49% of respondents had Sun workstation development experience;
- 51% of respondents had Macintosh development experience;
- 69% of respondents had PC development experience.

Each individual who agreed to participate was sent a copy of the questionnaire and was then, contacted by an interviewer. Interviews were conducted by trained engineers who were familiar with the goals and the objectives of the survey. Questions which the respondent did not understand were clarified once by the interviewer. If the respondent was still unclear as to the meaning of the question, the question was passed.

The survey was conducted over five weeks, including a short test period where the questions were “tuned” for understandability.

ANALYSIS AND DATA INTERPRETATION

This survey sought to compare NeXTstep to other platforms. While each was compared to NeXTstep, the other platforms were not compared to each other. The results are stated primarily in terms of the percentage of developers who prefer NeXTstep to a competing platform. The developer preferred NeXTstep if they answered the question with either a “4” or a “5.” The developer found no difference between NeXTstep and another vendor platform if they answered a score of “3.” The developer preferred another vendor platform if they answered with a score of
“1” or “2.”

For this study, the confidence level of our findings is 95% (which is to say that the 'true' values of each statistic reported are most likely to fall within two standard deviations of the reported data). The range of probable values is presented in the Summary Detail.

SUMMARY DETAIL

NeXT users who have developed on multiple platforms (including NeXT) compared the NeXTstep development environment to other development environments by comparing the following environmental attributes. All ranges are percentages of respondents who ranked NeXTstep as better than competing environments.

ATTRIBUTE	PERCENTAGE RANGE of ESTIMATE	CONFIDENCE LEVEL
NeXTstep environment completeness	83.68-96.32%	95%
User interface object library	92.80-100.00%	95%
Basic application framework object library	89.50-99.26%	95%
Extensibility of object library	86.43-97.84%	95%
Ability to integrate with third party applications	78.81-93.60%	95%
Ease and speed of development	85.91-98.94%	95%
Power of user interface layout tools	91.11-99.90%	95%
Amount of “built-in” code provided by the vendor	84.95-97.07%	95%
Programmer productivity	85.11-97.11%	95%
Ease of prototyping	92.88-100.00	95%

Ease of turning prototype into final application	80.45-94.55%	95%
Similar application: end-user application quality	85.25-98.87%	95%
Consistency of interface with other applications	79.28-93.76%	95%
Richness of data exchange between applications	87.81-98.56%	95%
Integration of application with input/output media	76.03-91.79%	95%
Level of integration between applications	89.26-99.24%	95%
End-user satisfaction	82.74-96.09%	95%
Development environment impact on development of easily maintainable applications	80.87-94.68%	95%
Overall maintainability of applications	86.12-97.79	95%
Modularity of applications	80.01-94.41	95%
Readability of applications	62.83-82.00	95%
Design quality of applications	81.87-95.40%	95%
Ability to add new features	92.88-100.00%	95%
NeXTstep riskiness	67.75-85.58%	95%