SIMULATOR QUALIFICATION TESTING-SHARING THE RISKS

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ABSTRACT

The qualification testing of most Air Force aircrew simulators has stretched out far beyond the original test schedule estimates. The result has been additional costs and extensive delays in getting the simulators into the field in a ready-for-training status. This paper examines the historical data, identifies the persistent problem areas, assesses the inherent risks, and offers some recommendations for reducing the risks to both the government and the contractor.

INTRODUCTION

The qualification testing period of Air Force simulators has historically been a very troublesome period in the acquisition cycle for both the contractor and the Air Force. Qualification testing is the Air Force conducted test and evaluation of simulators which is the equivalent of development test and evaluation (DT&E) in other acquisition programs. It is the "proof of the pudding" where we rigorously determine the contractor's compliance with the product specification.

When the time comes to start qualification testing, the contractor is aware that problems still exist, but he plans to keep a few steps ahead of the Air Force team rather than delay the start of testing. As testing progresses, the contractor comes under increasing pressure to stay ahead of the Air Force test team. Not only must he fix the known discrepancies before the team gets to that area of test, but he must also fix the newly discovered problems and maintenance difficulties which fall into the category of immediate "showstoppers." Experience shows that the contractor team is sooner or later overcome by events, and testing grinds to a slow walk and may even be forced to halt. This can hardly be a more inopportune time since the schedule reserves are probably all gone and the contractor is struggling just to preserve some portion of the profit he had originally counted on. At this point the "finger pointing" starts or increases in intensity and the whole mess is exacerbated by strong adversary relationships between the government and contractor. These in turn are further aggravated by frustration, 16 hour work days, and red ink on the bottom line. We eventually pick up the pieces and get back on track, but not without paying the price of a nonrecoverable schedule slip.

Obviously, this all too familiar scenario places both the Air Force and the contractor in undesirable positions. The contractor is motivated to minimize his losses while still getting the system out the door. It is easy for an error in judgment to result in prolonging the agony through the reduction of project resources and use of short cuts at a time when just the opposite approach should be taken. The Air Force, on the other hand, must tell users and the higher headquarters managers that the much needed training system will not be available as scheduled. This notification must be explained and justified up to the Air Force Council because of the impact on Air Force operational costs and readiness. It is easy to understand why the delay at the point of qualification tests results in letters of direction, claims, and other legal actions—all of which both the Air Force and the contractors would like to avoid.

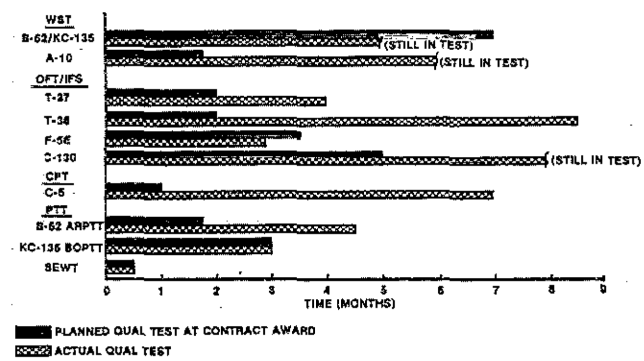
THE PROBLEM

In order to better define the problem, some research into the historical records of the Air Force Simulator Systems Program Office (SPO) has been accomplished. Data were surveyed on some 18 programs which have been or are being managed by the Simulator SPO. In each case we compared the planned qualification test period to the actual time spent, or in the case of the ongoing programs, the time spent to date.

The results for the completed or mature programs are shown in Figure 1. Note that in all cases except three, the qualification test periods exceed the planned test periods, in most cases by a significant amount. Although this result was not surprising, it was rather sobering to view our very poor track records on a collective basis.

QUALIFICATION TEST TIME

FIGURE 1



NOTE: TIME PERIODS REPRESENT IN-PLANT QUAL TEST ONLY. DOES NOT INCLUDE R/M DEMO's.

Those of you who have dealt with statistics and the necessary analysis to support meaningful conclusions know that the next step was to examine each program and ask the question, "Why did qualification testing extend beyond the planned period?" In an attempt to answer this question, several factors were considered:

-Number of SRs/TDs (Service Reports/Test Discrepancies) written

-Test versus fix time

-Requirements definition

-Data base inadequacies

-Quality of hardware design

-Quality of software design

-Spare core/time deficiencies

-Test readiness

-Contractor support during test

-Government management/support

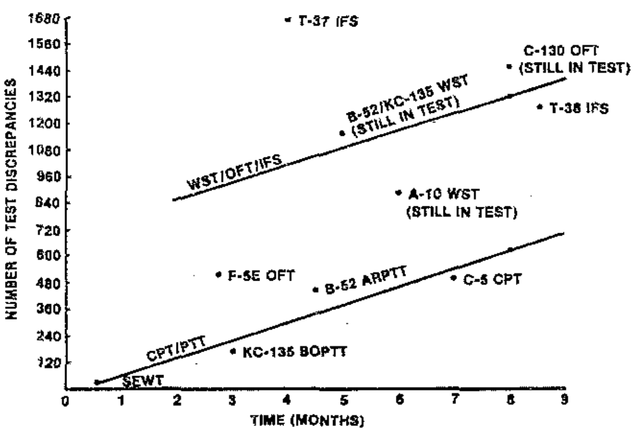
-Subjective tweaking

Of the above considerations, the first two, number of SRs/TDs and test versus fix time, lend themsleves to quantification. The others are judgment calls and subject to disagreement, depending on perspective. Therefore, our analysis treated the factors in just that fashion. On the judgment side, we reviewed the records and talked to the Air Force program managers to reach a conclusion. It should also be noted that there is no intention to publish judgmental data which is critical or reflects poorly on the performance of any contractor. Consequently, our conclusions on the judgmental factors are not aligned by program.

Figure 2 is a plot of the number of SRs/TDs versus the qualification test period. The diagonal lines are least square lines approximating the PTT/CPT (Part Task Trainer/Cockpit Procedures Trainer) devices and the WST/OFT/IFS (Weapon Systems Trainer/Operational Flight Trainer/Instrument Flight Simulator) devices. As would be expected, the more complicated simulators were subject to more writeups than the less complex PTTs and CPTs. It would appear in general that the systems which require more fixes must stay in test longer. Of course one can also argue that the longer a device is in test, the more writeups it receives. The noticeable difference between the nominal CPT/PTT line and the OFT/IFS/WST line is due to the relative complexity of the systems, and may also be driven in some cases by deficiencies in the design data base. It is worthwhile to note that the SEWT (Simulator for Electronic Warfare Training) and KC-135 BOPTT (Boom Operator Part Task Trainer), two of our on-time systems, had relatively few writeups. Even so, we did not find these data in themselves to be conclusive, nor did they reveal any results that drive us toward specific corrective recommendations.

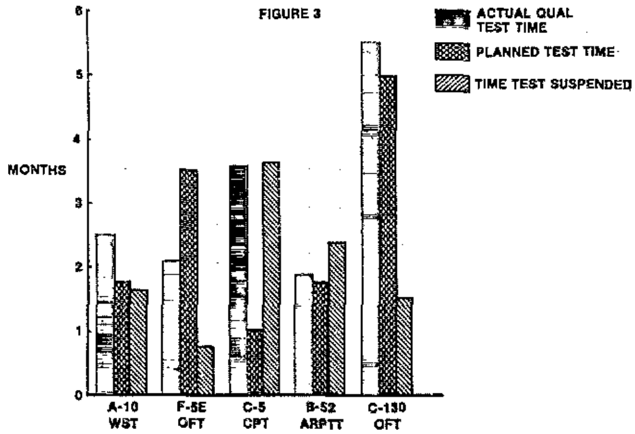
TEST DISCREPANCIES-VS-TIME

FIGURE 2



The comparison of test time to fix time turned out to be somewhat more interesting and more conclusive. Figure 3 reveals that the actual time spent in test closely approximates the planned qualification test period in 3 out of 5 cases. Since we have not previously recorded the individual test and fix times specifically, we used only those programs for which the data could be gleaned from the records. It is believed that the close approximation between actual test time and planned test time supports our original estimate for total qualification test period where the assumption has always been made that the system will have successfully completed contractor testing and DCAS observed testing prior to going into Air Force qualification testing, and, therefore, will be largely fault free. As we examine the records and our own experience, however, we must conclude that our basic premise is false. Contractors do not always perform thorough independent QTP systems tests and the DCAS role is more QC oriented than performance oriented.

TEST PLANNING ACCURACY



JUDGEMENT FACTORS

FIGURE 4

PROBLEM AREAS	PROGRAMS 1	2	3	4	5	6
TEST READINESS	X	X	X	X	X	X
SOFTWARE DESIGN	X	X	X	X	X	X
CONTRACTOR SUPPORT	X	X	X		X	X
HARDWARE DESIGN	X	X	X	X		
REQUIREMENTS DEFINITION	X	X	X		X	
DATA BASE (INADEQUACIES OR POOR USE)	X	X		X		X
SUBJECTIVE TWEAKING	X	X		X		
SPARE CORE/TIME DEFICIENCIES	X		X		X	
GOVERNMENT SUPPORT		X		X		

Figure 4 serves as a synopsis of the judgment factors as they were evaluated in six programs. The question we asked ourselves in each case is whether the factor had an impact on the extension of the qualification testing period. In all programs, the lack of test readiness and problems in software design were schedule drivers. You will note that lack of contractor support, which was defined as the lack of qualified personnel at the right time or in the correct numbers, also ranked high as a *schedule extender. It is believed, however, that lack* of test readiness made the personnel problem more acute than would normally be the case. Surprisingly, the subjective tweaking problems were seen as significant drivers in only three out of the six programs surveyed. It must be noted, however, that when subjective testing was relied on as a major part of making the simulator perform in an acceptable fashion, it had a substantial impact on the schedule. The collection and correct use of the data base was considered a significant factor in four out of the six cases. All of these four programs involved aerodynamic qualities and three of these four also suffered in test schedule because of subjective tweaking.

In summary, it is suggested that test readiness and associated contractor support rank as major problems. The data base, software design, and subjective tweaking appear to be interdependent problems with major impact. We will consider these problems in our discussion of risk and in our recommendations for improvement.

RISK ASSESSMENT

The uncertainty of the time required to complete qualification testing presents risks to both the contractor and the government. These risks are not only associated with the test period, but are also linked back through the project to the very beginning. Actions of both the contractor and the Air Force throughout the life of a project are in many ways the result of risk assessments and perceptions. The following paragraphs present some analyses and insights into the problem of qualification testing as viewed from the perspective of risks.

Cost is obviously an area of risk that affects both the contractor and the government. The costs for the contractor are a direct function of the time in test. On the other side, any delays run up the government costs for test support, and more importantly, delay the availability of the system for training. From the contractor point-of-view, the government may test as long as desired, provided the contractor is being paid for the testing. However, since most contracts are FFP or FPIF, testing beyond the planned period results in a loss, or at best a shared arrangement due to the incentive provisions of the contract (assuming costs fall between target and ceiling on the FPIF contract).

There is a tendency to attack the overall problem of risk from a very limited perspective. Industry would feel comfortable with a cost reimbursement arrangement for the test period. However, that would place all the risk on the government. On the other hand, a FFP contract shifts all risk to the contractor. From the contracting view, the risk should be proportional to the ability of each party to control that risk.

Test cannot be viewed to be bounded by just that time period during which the qualification test occurs. It is, indeed, much broader than that. The success or failure during qualification test starts at the very beginning of the formulation of requirements and does not end until the completion of the qualification test period. What we must do in considering the risk is to take a systems approach, e.g., look at each element of the acquisition process that affects test and assess the individual and collective impacts on risk.

<u>Requirements Definition</u>

The definition of training requirements, hopefully *through the ISD (Instructional Systems Development)* procedure, becomes the basis for the determination of the system to be built. The training requirements drive us toward a specification which describes a device somewhere along the continuum from a PTT to a full WST. The intended use of the device in training may necessitate a full fidelity approach or may allow little resemblance between the trainer and the actual operational hardware. It is the full fidelity trainer that this paper will emphasize since the authors have little experience with the other types of trainers. Furthermore, it is trainer fidelity that we normally strive for, and it is this same fidelity that is the source of the risk for both the government and the contractor. A large portion of our testing activity is to prove that the simulator looks, feels, and performs just like the operational hardware. One of our favorite specification references reads, "Simulator performance characteristics shall not be perceptibly different from characteristics of the real world aircraft."

If the performance of the operational hardware, which we seek to simulate, was fully defined in quantit*ative engineering terms with no areas of uncertainty*, the risks in designing, building, and testing a simulator would be simply those associated with the application of appropriate existing technology to achieve the desired result. These are the risks which every contractor must take in doing business. However, the risk in achieving acceptable performance (within planning estimates) increases dramatically when the performance of the device is poorly defined, or in some cases not defined, and the contractor must guess at what the final performance should be.

<u>Data Base</u>

The data base for simulator design is usually the responsiblity of the contractor. He is required to collect existing data from any available source in order to firmly establish the design basis for the simulator. We assist in this collection process by requiring that the airframe contractors supply data to the simulator contractors. However, the required data are not always complete or in a format which is usable by the simulator contractors. These deficiencies result in risks to the simulator contractors since the quality of the data can only be ascertained through detailed analysis—a process which seldom occurs during the proposal stage.

It has been suggested that all baseline data be gathered and certified by the procuring agency to relieve the contractor of the risk over which he has only limited control. This has been considered, and is, in fact, being done by some government agencies. However, in order for the government to collect and supply the data to the contractor, a team of engineers, technicians, and clerks must be dedicated to the task, and the government must assume the risk associated with the data base process. This risk in turn spills over into the design process since the design is data base dependent. It is our opinion that the contractor, as the simulator design agency, can perform the data task in a more efficient manner, and in general, should be held responsible for obtaining the data needed for design. It is recognized, however, that should a number of contractors need to operate from a common data base in either a cooperative venture or a competitive one, it may be appropriate for the government to directly control the data base.

Design

The risk associated with the design process falls squarely on the shoulders of the contractor. It is the contractors expertise in this area that serves as a foundation for his business. The Air Force has no intention of designing simulators for which industry is being paid to design. This statement is not meant to deny the fact that we place a number of constraints on the design. But the performance of the simulator during test, as it relates to design, is a contractor responsibility and any performance discrepancy which is clearly not in accordance with the available data must be fixed by the contractor.

Qualification Test Procedure (QTP)

The QTP is frequently an area of contention between the government and the contractor, and is, therefore, a source of risk. The government wishes to perform a rigorous series of tests to assure that the simulator meets every requirement of the specification. Although the contractor agrees in principle, there is a tendency to feel that a less thorough test program will accomplish the same objective. The preparation of the QTP is frequently delayed until the very last minute. This delay results in compression of the effort, and inadequate time for review, revision, and approval. We, therefore, enter qualification testing without full definition of all the tests and corresponding success criteria. These uncertainties lead to disagreements and less efficient implementation of testing.

Test Readiness

The test-fix-recheck process is central to the problem of stretchout of the qualification test period. We presented data in Figure 3 which was the basis for our conclusion that our test estimates are not all that bad, but that unscheduled downtime for fixes is the real culprit in the schedule slips. In other words, if the machine could undergo testing without the resulting writeups, our test estimates would be fairly accurate. It is, of course, unrealistic to expect that no writeups will be necessary. However, if a system has been thoroughly and successfully tested by the contractor and DCAS prior to the official start of government qualification testing, the testing should progress smoothly with few interruptions to correct deficiencies or equipment failures.

Tweaking

Perhaps the biggest risk to the contractor stems from the contract requirements to make it fly like the aircraft—particularly when the success criteria cannot be established on a firm quantitative basis. What we must deal with then are subjective evaluations by Air Force test personnel. This evaluation process is obviously person dependent and can lead to numerous tweaking and redesign efforts because of non-repeatable tests. The separation of interactive variables becomes cloudy and very dependent on the capability of the Air Force test pilot. The tests can easily stretch out and frustrations on both sides run high since progress is slow and there is no way to fully establish responsiblity of the stretchout. Industry has accepted this risk in the past, but cost overruns have reduced the willingness to continue in this fashion.

RECOMMENDATIONS

Having examined the problem and the risks, it is now appropriate that we consider how we should approach the test period in the future to better assure schedule compliance, avoid additional unforeseen costs, and share the risks in a more equitable fashion. The following paragraphs address and briefly explain a number of recommendations.

Requirements

It seems elementary to state that requirements should be defined by the operational command and that these requirements should be clearly developed and reflected in the RFP. However, our experience has shown that much work still needs to be done in the requirements area. The ISD process is being emphasized and further defined in an attempt to attack the problem. High level visibility is also being focused through the actions of the Air Force Simulator Advisory Group (SAG) and by the rejection of some Program Management Directives (PMDs) for further definition before action will be taken. We are also trying to improve our specifications and reduce the potential for misunderstandings. Our program teams have been directed to avoid informal changes which can have an impact on cost or schedule (including test) or lead to later disagreements, claims, etc. In other words, we must use existing techniques to formalize all changes. Industry needs to cooperate fully with us in this attempt to avoid test problems which are requirement related.

Data Base

The proper collection, analysis, and utilization of the data base is absolutely essential if we are to make significant progress in reducing the risks associated with qualification testing. What we need is a means of moving from qualitative testing toward quantitative testing. Through proper use of the data base we can quantify the expected results for most tests, and in some of the remaining cases, establish design tolerances which will allow for relatively easy qualitative tweaking to achieve the required fidelity. There may still be some areas where the data are of little use, but we can at least recognize these and avoid surprises.

The data base becomes the support structure for all subsequent design and test actions. It must be as complete as possible. Where holes exist, they should be filled by such actions as further data search, actual tests, or estimates in collaboration with government representatives. If data are inconsistent, the contractor should, through analysis, resolve the inconsistencies or seek government resolution if judgment must be exercised. The completeness and accuracy of the data base cannot be overemphasized since it will serve as the necessary resource for both design and testing.

Design

The design must be traceable to the data base. Where data are precise with little variation, the design can be accomplished with little allowance for tolerances or tweaking. If data so indicate, the design should be accomplished in such a fashion as to permit significant performance adjustment without total redesign. Experience and technical insight into simulator performance has shown that there are three categories of data which require different design approaches:

- firm, precise data to support design

- suspect data with large spread

- extrapolated or estimated data in substitution for actual measurements

Design and test to the first category of data is straightforward. Data with large spread requires a more cautious approach to allow for adjustments in order to meet required performance. Estimated data derived to fill holes in the data base provide design guidance but obviously place the designer in a risk position with respect to meeting acceptable performance. Creative approaches to allow easy changes are in order to reduce the risk.

Qualification Test Procedures (QTP)

The QTP should be prepared in parallel with the design effort and should be closely correlated with it. When a design is accomplished to meet a given parameter or performance curve, the testing procedure to prove or confirm that the design is correct should be accomplished also. Note the very important point that the design and the testing should both be related to a common baseline contained in the approved data base. Therefore, the ultimate success criteria to be used during subsequent testing, including qualification test, are the same as the original design objectives and the loop is closed. Of course, it is not always that easy. There may be many interim steps in both design and testing before a primary performance criterion contained in the data base can be achieved. Furthermore, the interaction of parameters, particularly in the total realm of aerodynamic performance, can make both the design and the testing a very complex problem. Nevertheless, in order to get a handle on the qualification test process we must quantify to the extent possible the test goals and the logical source for that quantification is the data base which serves as a foundation for the design.

One further point needs to be stressed. A poorly prepared QTP, produced at the last minute in isolation from design, invariably has a negative impact on test. The procedures simply don't work and the goals, objectives, and success criteria are not correlated with the design and data base so that orderly, effective testing can be accomplished. As a result, the test team is forced to set aside the official plan and create a new plan which is workable and will yield the desired results. This slow, laborious process is wasteful of valuable test time. In addition, there is a tendency to substitute subjective success criteria for the objective criteria which are contained in the data base. In other words, a poorly prepared QTP increases the risk during test for both the contractor and the government.

Test Readiness

Government and industry collectively have done a poor job in determining readiness to start qualification testing. Perhaps our different persepectives have led to different expectations from the qualification testing. Industry may be primarily driven by cost and schedule while still wishing to field a simulator of acceptable performance. Government, on the other hand, places simulator performance at the top, with cost and schedule a close second. These different priorities are more understandable when we recognize that our current contract structures lead to limitation of government liability to contract ceiling or price (FPIF or FFP). Furthermore, the government acquisition agencies have firm commitments to the operational units to provide high quality simulators which meet original requirements. Anything less will likely fail to be used to full advantage and the result will be a waste of taxpayers money.

When we enter qualification testing the government representatives expect to test a machine which is prepared to be put through its entire operating envelope to demonstrate full compliance with the specification. This testing should require few changes or adjustments to the system during the tests and these should largely be a result of the minor adjustments or tweaking required to make the simulator respond correctly in the more subjective areas where quantitative data are unavailable or inadequate. If this readiness goal is to be achieved, we must make several changes in the way we currently do business:

A complete, well-defined design and test baseline must be established

- Discipline must be exercised to relate actions to the baseline

- The contractor must accomplish his own tests before government qualification testing in order to sort out the problems and make fixes to bring the simulator into compliance with the specification.

This approach does not mean that government experts will not be available to assist where they are needed in preparing the system for qualification testing. Recent contracts have committed government testers to provide early assistance in evaluating the simulator performance, particularly in the realm of aerodynamics. It is our impression that this government assistance has been well received and is valuable in catching problems at an early stage. The use of on-site government representatives (DCAS or similar) to go through the QTP with the contractor can be much more effective than it is now if QTPs are better prepared and provide a better measure of system readiness.

What must be done if we are to avoid the test-fix-retest syndrome is for contractors and government to make a commitment to use the qualification test period as it was intended to be used--a time to make the thorough tests to assure that contract specifications are met, rather than a time to make the system meet the specifications.

Qualification Test Period

Assuming that things have been done correctly up to this point in the project, the qualification test period should be anticlimactic. The major system problems will have been sorted out and corrected during the contractor and DCAS testing periods. All that is left to be done is thorough confirmation by the Air Force test teams that the system is in compliance with the data baseline and a final tweaking period to make minor adjustments in order to satisfy those subjective feel judgments which could not be quantified or accurately predicted by the government/contractor technical team.

As a check on test readiness it is suggested that a functional check flight (FCF) be designed and included in the QTP to provide a quick overall system check prior to starting the detailed test procedures. This FCF would be accomplished after the software cold start is complete. Should major problems still be evident, the contractor would be given time to make corrections before starting the detailed subsystem tests.

After tests are completed to confirm that the system meets the QTP success criteria as related to the original data base, the period of subjective testing and adjustment would begin. It is at this point that it may be argued that we should depart from the traditional way of doing business and find some means of more equitably sharing the risk associated with making the system fly like the aircraft. At one extreme is the position that the contractor has no way of predicting or controlling the actions which will be required by the government to accomplish the required performance. At the other extreme is the argument that the contractor through experience and insight into the necessary simulator performance and through assessment of the data base and requirements should be able to predict the extent of necessary tweaking.

We submit that the real world lives somewhere between these extremes. There is little doubt that a capricious and arbitrary government test team, should such a team exist, can drive subjective testing for an unnecessarily long period of time and run contractors costs beyond expectations. An inadequate data base can, of course, load the testing with subjective criteria which can lead to the same result. The current constraints on such activity are the contractor's reluctance to cooperate and the need by the government to get the system into the training inventory. On the other hand should the government agree to accept all responsibility for the subjective test period, the contractor would have little motivation to take the necessary steps through data collection/analysis and heads-up design to avoid an extended period of subjective testing and tweaking. There might even be a contractor tendency to unload activity into the subjective test area rather than expend the effort to avoid it. It should be noted that even under the full contractor risk scenerio currently in effect, it can be argued that some contractors are not making a maximum effort to stay away from subjective tweaking.

Contracting Arrangements

What then is the answer? How can we structure our contracts to more equitably share the risks associated with simulator development which culminates in the qualification testing period?

-Maybe a cost type of contract for the subjective test period is more appropriate in light of the risks involved.

-Perhaps better management of risks could lead to reduction or elimination of them to the point where FFP is reasonable.

-Maybe it is simply better utilization of FPIF type contracts which, after all, allow for the sharing of risks.

-Maybe a definition phase is required to allow for data collection and analysis.

-Perhaps the FPIS contract can be applied to provide a flexible technique in more closely aligning responsibilities and risks.

Let's briefly look at each of these alternatives in our search for a better way.

A cost type of contract for the subjective tweaking period does not seem appropriate because it places all of the risk on the government and does not provide any incentive for the contractor to minimize subjective tweaking. In fact, it would provide an incentive for the contractor to maximize his profit under a FPIF or FFP basic contract and unload the other effort into the subjective test part of the project. This approach would be difficult to control from the government point of view.

If we have a firm and complete data baseline to serve as a foundation for our entire design and test activities, there is little risk involved and contracting guidance would drive us toward a FFP arrangement. Our experience to date has shown that complete and accurate data do not exist for those simulators which we have built. However, it is our opinion that we have failed to make optimum use of the data which has been available to us. If we had done so, the risks on past and existing programs would have been reduced. In the future, it is possible that careful planning with the acquisition agency for a new aircraft might allow us to obtain most of the required data which could serve as a foundation for a FFP approach. It is probably unrealistic to totally eliminate all risk associated with subjective testing, but the risk might be minimized to the point where FFP is reasonable. This approach is at best in the future and may never be feasible if concurrency of the simulator and the aircraft continues to be a goal. Nevertheless, better use of current data will reduce risk but not eliminate the problems associated with our present contracting structures.

Better utililization of our FPIF type contracts may help resolve the problem. Present experience, of course, indicates that most contracts go to ceiling and contractor's costs actually exceed ceiling. Obviously, the sharing of costs and risks between target and ceiling is not providing the cushion required in our current way of doing business. Perhaps our negotiated targets are too low, or maybe we are simply doing a poor job of management. Competition has doubtless forced many in industry to ignore risks and go against their own better judgment in making BAFOs (Best And Final Offers). Assuming the subjective tweaking is the unknown risk which is being suppressed, we have considered defining and setting aside this period of testing in the early stage of the contract and seeking to establish an equitable share ratio over and beyond the basic contract should the ceiling be exceeded. For example at PDR or CDR (Preliminary or Critical Design Review) we would have an in-depth review of the data base/analysis and identify those parameters which would likely be subject to qualitative tweaking. With this knowledge we would negotiate some share ratio based on our risk assessment which would come into effect only if the ceiling of the basic contract were exceeded. This share ratio would place more burden on the contractor than the basic contract share ratio in order to encourage completion of the project within ceiling and discourage the shifting of work from the basic contract to the above ceiling sharing arrangement.

There are some problems with this proposal:

-It's open ended

-Government budgeting would be difficult

-It may be tough to reach agreement on the above ceiling share ratio

-We would have to find some way to identify and contain the basic low risk work within the primary FPIF contract

Because of the above problems, the contracting community does not support this approach.

It has been suggested that the big unknown facing industry at the time of proposal and negotiation is the availability of complete and accurate data on which to base the simulator design and testing. Furthermore, because of the magnitude of the task to collect and analyze the data, contractors have neither the time or the resources to resolve this unknown during the proposal phase. In order to reduce the risk associated with the data base, it has been suggested that a definition phase contract be awarded. This approach would remove much of the risk, but it would also extend this time required to provide a training device to the field. Since the time delay between definition of requirements and ready-for-training status is already considered much too long, this approach cannot be recommended.

Another way of contractually recognizing the problem of the data base availability and content, along with its impact on testing, is through the use of a FPIS arrangement. This contracting technique allows the target to be reset at some well defined contract milestone. In the case of the simulator, we could define the reset to occur at PDR or CDR, a point in the program where we should have the data base problem under control and, therefore, have a much better idea of the subjective tweaking required to achieve our fidelity objective. Although ceiling and share ratio would remain the same, the adjustment of target would allow full recoupment of some costs and reduce the risk to the contractor at a point when those risks are more fully defined. This FPIS approach is recommended as the most appropriate method to more closely align the risks and responsibilities involved in the simulator acquisition process.

SUMMARY

The historical record and our own experience indicates that qualification testing is requiring much more time than we include in our program plans. This extension of test time impacts both contractor costs and system deployment. The problem of test extension is not limited just to the test period but permeates the entire program starting with requirements definition. Our look at the principle elements of requirements, data base, design, qualification test procedures, test readiness, and actual tests, as these relate to the problem, has led to a number of recommendations to improve our performance and reduce the risks for both government and industry. The importance of the data base as a foundation for subsequent design and testing activity has been stressed. We have examined the risks and concluded that they can be reduced by better government/contractor management of the program and through more suitable contracting arrangements. Specifically, it is recommended that an FPIS approach be used with reset at the PDR or CDR milestones in order to make allowances for unknowns relative to the date base and the effects of these on qualification testing schedules.

The recommendations contained herein will not serve as a panacea for all the problems we jointly face in trying to provide the best possible aircrew simulators to our operating forces, but it is hoped that these ideas will serve as a catalyst for further improvements in the way we do business, particularly as they relate to the tough problem of qualification testing. Let us not forget that we have a responsibility to ourselves and this country to provide the means for our aircrews to be the best trained in the world. This objective demands our continued efforts to produce high quality simulators, which are delivered on time and within cost. Solution of the qualification test problems will be a giant step toward this objective.

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