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Methodology for Analyzing the Costs and Benefits of Video Teletraining (VTT)

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Summary

Background

New technology is changing the way we train people. The Director of Naval Training (N7) has stated that the Navy needs to incorporate more of this new technology into its training environments. To achieve this goal, the training community must meet several challenges. First, it must decide on the technologies (or applications of technology) in which to invest. To do this, it needs to analyze and evaluate the different technologies and determine which ones (or which applications) offer the biggest improvements in training or the best paybacks.[1] Once the investment strategy has been formulated, the training community must justify these investments within the Navy's Planning, Programming, and Budgeting System (PPBS) process. To ensure success, it needs to provide the programmers and comptrollers with well-defined, quantitative analyses that clearly show the expected costs and benefits of these investments.

Tasking

N7 asked CNA for help in structuring a cost-benefit analysis of training technology. It wanted CNA to develop a methodology (or set of methodologies) for analyzing and evaluating the potential benefits that new technologies can bring to Navy training. N7 stated that the methodology should define quantitative measures for assessing the benefits, specify mathematical relationships and procedures for computing these measures, and identify the data to be collected.

Through discussions with the Office of Training Technology (N75), CNA agreed to look at two technologies: Video Teletraining (VTT) and the Automated Electronic Classroom (AEC).

1. This process involves determining what training will benefit most from each technology (or where each technology would be best applied).

Approach

Because VTT and AEC affect different aspects in delivering training (i.e., VTT primarily affects where the training is conducted, whereas AEC affects how the information and instruction are prepared and presented to the student), CNA has developed two methodologies—one each for analyzing the costs and benefits of VTT and AEC. We've also incorporated these methodologies into easy-to-use, computer-based analysis tools, which automate the calculations and also allow the user to analyze other pertinent issues and relationships associated with each technology.

The VTT methodology, described in this report, estimates the annual costs, savings, and quality-of-life (QOL) benefits that result from delivering formal Navy training by VTT. In computing these measures, this methodology considers all aspects of a VTT training program, from the costs and configuration of the VTT network to the temporary additional duty (TAD) and instructor savings for each course that is delivered as part of the training scenario. The methodology and analysis tool for AECs estimate the costs and savings of converting paper-based training to AEC training. We describe this methodology and tool in a separate report [1].

VTT analysis tool

Based on discussions with the sponsor, we designed the VTT analysis tool to apply specifically to the Navy's current VTT program for active-duty personnel (i.e., the CNET Electronic Schoolhouse Network). This tool computes the following measures for a user-defined training scenario:[2]

- Annual costs, savings, and QOL benefits that result from delivering training by VTT vice the traditional way[3]

2. The training scenario defines which courses are delivered by VTT and the cost and configuration of the VTT network.

3. By traditional way, we mean either sending students to a training activity or school that provides the training in-house, or sending instructors to student locations to provide the training locally.

- Annual TAD and instructor costs by course and by location for both VTT training and traditional training
- VTT classroom use at each site
- VTT initial and recurring operating costs (i.e., equipment, communications, course conversion, classroom facilitators, and program overhead).

In addition to outputting these measures for a specific scenario, this tool enables the user to examine key relationships between VTT costs/savings and various components of the training scenario. For example, the tool can show how the savings vary with VTT classroom use, and how this use depends on the individual courses delivered by VTT. The ability to analyze these types of relationships can help the Navy determine the most cost-effective VTT training program.

Applications

We believe that the VTT methodology and analysis tool have several applications:

1. N7 can use it to support the training assessment process by estimating the annual costs and savings for the Navy's VTT training program over the FYDP.
2. CNET and Fleet Training Commands can use it to help determine the most cost-effective size of the Navy's VTT network, addressing such questions as:
   - — Should the VTT network be expanded?
   - — If so, which sites should be added?
   - — Should more VTT classrooms be added to existing sites?
3. CNET and the schoolhouses can use it to help determine which courses (and how many courses) to deliver by VTT. Though our methodology does not address whether a course can be *effectively* delivered by VTT (i.e., whether students actually learn as much in a VTT environment), it does estimate the savings that would result from delivering individual courses by VTT.[4] Thus,

4. Determining whether a course can be effectively delivered by VTT must be considered before its selection.

we recommend that this tool be used in conjunction with the Navy's Training Delivery Assessment Model (TRADAM) to review the current inventory of Navy courses for VTT delivery.[5]

4. VTT system managers can use it to help schedule VTT courses—that is, determine where each course should be delivered remotely and where it should be taught live. By using its capability to quickly estimate the costs and savings of different delivery scenarios, the managers can formulate schedules that maximize overall program savings.

5. VTT system managers can also use this analysis tool to determine the most cost-effective type of communication service for each VTT site—specifically, whether full-time dedicated service is more cost-effective than pay-as-you-use-it service.

Findings

In developing this methodology, we discovered several important issues about the investment in or implementation of VTT technology:

- Because the Navy pays for its VTT network in advance (i.e., it leases a year of capability up front), the overall net savings depend heavily on VTT system use. The more fully the system is used, the higher the savings. Thus, the Navy should strive to deliver enough courses to fully use its current system. In fact, the cost to deliver additional courses to achieve this is minimal because most of the VTT infrastructure is already paid for.

- From a cost savings perspective, two categories of courses are potentially good candidates for VTT delivery:

  — Courses that run less than 2 weeks and have a significant demand (i.e., enough student throughput to fill at least one convening) at several (at least three) locations.

5. The TRADAM provides a semiautomated approach for reviewing formal Navy training courses to identify opportunities to reduce training costs through the application of advanced training technologies.

- Courses that are currently offered locally at several sites and for which the throughput requires only a fraction of an instructor man-year. If the instructor cannot be used to teach other courses, delivering this course by VTT could reduce the instructor requirement at several sites.

- Our research suggests that the Navy should deliver more training by VTT. It currently delivers about 50 courses, only half of which are in the Catalog of Navy Training Courses (CANTRAC). Considering that the Navy has over 4,600 active courses (755 of which run 5 days or less and have less than 25 percent lab instruction), this is a very small number and suggests the potential to deliver many more by VTT. In addition, recent studies by the Navy Personnel Research and Development Center (NPRDC) show that it is feasible to deliver some courses with lab instruction by VTT [2–7].

- We feel that the lack of documented/well-defined requirements (i.e., who really requires this training) for the group of courses currently delivered by VTT prevents an accurate, detailed analysis of the future costs and benefits of the Navy's VTT program.[6] It also suggests that these courses may not be high on the fleet's training priority list (otherwise they would be listed in the fleet's training manuals).

- VTT offers other benefits that are difficult to quantify or relate to costs. Nonetheless, they should be considered when assessing the overall value of this technology to the Navy. Examples include (1) enhanced capability to provide training when and where it is most needed and most effective (i.e., "just-in-time training"), (2) the ability to better utilize instructor expertise and specialties throughout the Navy, and (3) increased access to military and civilian educational institutions, which makes it easier for sailors to further their education and professional development.

6. Our methodology requires as input (1) how many people need to take the courses that will be delivered by VTT each year and (2) where these people are located.

Organization of document

This research memorandum comprises four sections. The first gives a general overview of VTT. We define the technology, review its potential benefits, and discuss the major factors affecting the level of these benefits. The second section describes our methodology for analyzing the costs and benefits of using VTT. The third section shows how to use this methodology (and analysis tool) to address some important VTT investment issues. The fourth section addresses other issues to consider when assessing the value of VTT technology. Appendix A describes our VTT analysis tool, and appendix B describes a method for projecting course training requirements by location.

Video teletraining

In this section, we review the technology known as video teletraining (VTT). First, we define it and discuss the various types of VTT systems. Next, we describe the Navy's VTT system: the CNET Electronic Schoolhouse Network (CESN). We then review the benefits that can result from using VTT technology to deliver Navy training. We end by discussing the major factors that affect the level of these benefits.

What is VTT?

VTT is a method of distance learning that uses television technology to deliver training to students at geographically separate sites. More specifically, VTT involves delivering training to remote sites by televising an instructor, usually in real time and usually while he or she teaches a class of local students.

There are several types of VTT systems. They differ in their equipment, communications, overall design, and intended audience. Some systems use analog technology; others use digital technology. Some use primarily satellite communications; others use primarily landline communications. Some have two-way audio / two-way video interaction, some have two-way audio / one-way audio interaction, and some have one-way audio / one-way video interaction.[7] Some systems are designed to deliver training to large groups of students at remote sites (e.g., remote classrooms with large-screen monitors), whereas others are designed for small groups or individuals (e.g., desktop video systems).

7. One-way audio / one-way video means that the students at remote sites can see and hear the instructor at the originating site, but the instructor can't see or hear the students at remote sites. Two-way audio / one-way video means the instructor can hear the students at remote sites. And two-way audio / two-way video means the instructor can see and hear the students at remote sites.

To a large extent, the type of VTT system determines the type of training that can be effectively delivered. Generally speaking, the higher level systems (e.g., two-way audio / two-way video) do a better job replicating the experience and interactions of a live classroom at the remote sites.[8] This allows more types of training to be delivered. For example, you would not want to deliver training that requires significant student-to-instructor or student-to-student interaction using a system with only one-way video capability. On the other hand, higher level systems cost more. Thus, if you plan on only delivering lectures or general information-type presentations, two-way video capability may not be warranted (i.e., you may be paying for capabilities you don't need).

CNET Electronic Schoolhouse Network (CESN)

The Navy has delivered training using VTT to over 36,000 students since 1989. Their current system is known as the CNET Electronic Schoolhouse Network (CESN). CESN represents the high end of VTT technology. It's a digital two-way audio / two-way video, multipoint, secure system, which means that the Navy can deliver training to multiple shore and shipboard sites and the students can interact both verbally and visually in real time with the instructor or students at any of the connected sites.[9]

As of September 1996, CESN has 19 sites and 27 classrooms nationwide. Table 1 lists the site locations, the year each site came on-line, and the number of classrooms currently at each site. (Note that two of these sites are on aircraft carriers.) CESN also has the capability to link with international sites and other educational networks through the Integrated Services Digital Network (ISDN). CESN land sites are

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8. We refer to a VTT site as either an originating site or a remote (or receiving) site. An originating site is where the instructor is located. This is the site that broadcasts the training. A remote site is a classroom that receives the televised instruction from the originating site.

9. A major reason why the Navy selected this system was to minimize the effects of using this technology on its instructors, course curricula, and instructional materials.

connected via T-1 landlines. Connectivity to ships at sea is through satellite communications from an uplink at either Holmdel, NJ (east coast), or Steel Valley, CA (west coast). The system currently operates at a fractional T-1 data rate of 384 kilobits per second and is encrypted to the Secret level [8].

Table 1. Current CNET Electronic Schoolhouse Network

Location	Year	Classrooms
FTCL, Dam Neck, VA	1989	2
FTC, Norfolk, VA	1989	2
Charleston, SC	1989	1
FTC, Mayport, FL	1989	2
NETC, Newport, RI	1989	1
FTC, San Diego, CA	1993	3
FTCD, San Francisco, CA	1993	1
TTF, Bangor, WA	1993	2
NTSC, Great Lakes, IL	1994	1
MCM, Ingleside, TX	1994	1
NSTC, Pearl Harbor, HI	1994	1
TTF, Kings Bay, GA	1995	1
NSHS, Bethesda, MD	1995	1
NSHS, Portsmouth, VA	1995	1
NSHS, Balboa, CA	1995	1
USS *George Washington*	1995	1
USS *Carl Vinson*	1996	1
NAVSTA, Everett, WA	1996	1
SUBBASE, Groton, CT	1996	1
NAVSTA, Pascagoula, MS	1996	1

CESN has two hubs: Dam Neck on the east coast and San Diego on the west coast. Each hub houses a VTEL Multipoint Control Unit II (MCU II), which it uses to connect sites in any desired combination. The MCU II automatically switches between sites at a selectable interval to allow the instructors to continuously monitor students at each remote site. The system also automatically displays the site where a student is speaking or asking a question (providing virtual eye-to-eye contact) [8].

Each VTT classroom is configured to accommodate 24 students and can serve as an originating site or a receiving site. The standard classroom configuration includes three high-resolution 40-inch monitors for viewing the instructor, graphics, or another site, and a 25-inch monitor for previewing graphics. A handheld remote control unit controls the camera and graphic selections [8].

Benefits of VTT

The fundamental benefit of VTT is that it allows the Navy to deliver training to multiple locations without having to stand up separate courses at each location or physically send instructors to these locations. Favorable implications include the following:

- Reduced student and instructor travel
- More efficient use of instructors
- More training opportunities
- More just-in-time training.

Reduced travel

The primary benefit of providing training locally is that the students do not have to travel. This reduces TAD costs (i.e., transportation, lodging, and per diem costs), frees up more time for additional training or command work (because students spend less time traveling), and improves quality of life because sailors spend more time at home. Reduced travel accounts for most of the cost reductions that occur when delivering training by VTT.

More efficient use of instructors

Delivering training by VTT can, in some cases, reduce instructor requirements. This occurs for two reasons. First, when a course is taught by VTT, it is usually delivered to several remote sites at one time. This effectively increases the class size and, hence, the student-to-instructor ratio. The result is that each instructor teaches more students at a time, so fewer instructors are needed overall. Second, VTT eliminates the need to have different instructors teaching the same course at different sites. VTT requires instructors only at the originating site (which is usually one or, at most, two sites).

In addition to reducing the instructor requirement, VTT enables the Navy to better utilize instructor expertise and specialties that are unique to certain training activities. For example, instructors who teach A- or C-School courses at centers of excellence (e.g., surface propulsion at Great Lakes) can also teach refresher training at fleet locations by VTT.

More training opportunities

By offering training locally at more sites, VTT increases the training opportunities for sailors stationed at these locations. It allows sailors to attend training they would otherwise miss either because of no TAD funds or because their units or commands do not want them to leave the area. While the latter situation is more apt to apply to longer courses, short courses are not immune. For example, if the ratio of travel time to training time is high (say, 2 travel days for 1 day of training), it may be hard to justify sending a person away for 3 days to get only 1 day of training.

Just-in-time training

VTT allows more flexibility in scheduling training, particularly for deploying units with VTT capability. For these units, training can be delivered at sea, either during transit or while on station. This capability affords three advantages:

1. It allows for more training than could otherwise be conducted during the unit's normal work-up cycle.
2. It can increase the effectiveness of the training by providing it when it is most needed and most beneficial (i.e., the concept of just-in-time training).
3. It provides a capability to train deployed personnel for new or unforeseen missions or threats.

Factors affecting the cost-effectiveness of VTT

While the cost-effectiveness of using VTT to deliver Navy training depends on many factors, two usually dominate: the training (i.e., individual courses) that is delivered by VTT and the configuration of the VTT system.

VTT training

The cost-effectiveness of VTT depends not only on the amount of training delivered, but also on the individual courses that make up this training. Some courses produce more savings than others. Two key factors in determining good candidates are course length and the geographic distribution of the people who require this training.

Short courses generally produce a higher savings rate—that is, more savings per VTT classroom day used. This is because transportation costs, which tend to make up the bulk of the TAD savings, do not depend on course length. Thus, for short courses, this cost gets distributed over fewer days, resulting in a higher savings rate.

All else being equal, courses for which the demand (i.e., the people who require the training) is spread out over many locations are better candidates for VTT than courses for which the demand is concentrated at one or two location. This is because, in general, more students would have to travel to receive this training if VTT were not available. For example, if 95 percent of the people who required a course were in the Norfolk and San Diego areas, the most cost-effective way to deliver this training probably would be to stand up traditional courses at each of these two sites. If, on the other hand, only 40 percent of the people were in these two areas and the rest were elsewhere, this course probably would be a good candidate for delivery by VTT.

VTT system configuration and costs

The size and configuration of the VTT network determines how much VTT training the Navy can conduct and which locations will benefit the most. The key characteristics are the number and locations of VTT sites and the number of VTT classrooms at these sites.

The number of sites directly affects how many people have local access to VTT training. Increasing local access reduces the number of people who would otherwise have to travel to get training. The number of classrooms at each site determines how much VTT training can be conducted at that site. This can also affect the number of people who have to travel because you can't train more people than your facilities can support.

On the other hand, the costs of the VTT system depend almost entirely on the number of VTT classrooms. Under the current Navy funding for CESN, each classroom costs about $75,000 per year (roughly $48,000 for the equipment and $27,000 for the communications).[10] For this, the Navy gets a system that's theoretically available 24 hours a day, 365 days per year.

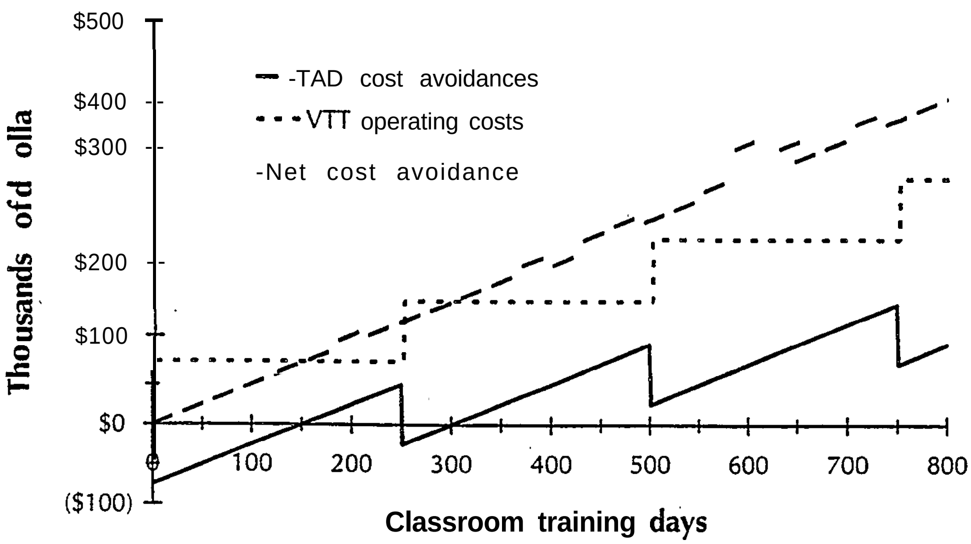
VTT capacity utilization

Earlier, we mentioned that the savings from using VTT depends on the amount of training conducted. In general this is true, but there is another issue that complicates this relationship. Because of the way the Navy pays for its VTT system, the net cost/saving depends on how fully the Navy utilizes its VTT classrooms.

Figure 1 illustrates the general relationship among the net cost/saving, VTT classroom capacity, and VTT classroom utilization. The short dashed line shows the VTT operating costs as a function of classroom training days. As discussed above, the Navy pays about $75,000 per year for a classroom. This buys about 250 days of training capacity (50 weeks times 5 days per week). The Navy can increase the capacity by buying more classrooms at roughly the same costs, with each classroom providing the capacity to conduct another 250 days of training. The long dashed line represents TAD savings. These savings increase with the amount of training conducted (which on this graph equates to the number of classroom days used). The slope and exact nature of this relationship depend on the particular scenario in which VTT is used. (Recall from our earlier discussion that some courses offer more TAD savings per VTT classroom day used than others.)

10. Actual costs vary somewhat by site, mainly because of differences in the communications costs. For example, the communication costs at Pearl Harbor are higher than at CONUS sites.

Figure 1. Relationship among the net cost/saving, VTT classroom capacity, and VTT classroom utilization



The solid line shows the net cost/saving (i.e., TAD savings - VTT operating costs) as a function of the amount of training conducted. The relationship illustrates two points. First, overall net savings increase as more VTT training is conducted.[9] Second, the net savings also depend on VTT classroom utilization-the higher the utilization rate, the greater the savings. In other words, because the Navy buys capacity in chunks (250 days), to achieve maximum savings, it needs to fully utilize the existing capacity. NPRDC reported that cost data from the VTT program office indicate that a VTT classroom must be used about 50 percent of the time to become cost-effective [2].

Although this point may seem obvious, we feel its implications are not always understood. Many times during our study, we heard people talk about the need for a model that can evaluate individual courses, one by one, to determine which courses would be cost-effective to deliver using VTT.

9. For savings to occur, the slope of the TAD savings must be steeper than the average slope of the VTT operating costs.

Figure 1 tells us is that you can't compute the overall costs/benefits of delivering a single course without knowing what other training is being delivered. Even if you try to prorate the cost of the VTT system to individual courses (e.g., based on the number of classroom days used), you still need this information to distribute the costs proportionally.

In actuality, whether it's cost-effective to deliver a particular course by VTT depends mainly on overall system utilization. If the system is not fully utilized, there is very little additional cost to deliver a course using VTT, unless there is a substantial cost to prepare a course for VTT delivery, which normally is not the case. The capacity is already there and paid for. If, on the other hand, the system is fully utilized, adding courses would necessitate increasing the capacity (by adding VTT classrooms), which increases the system's cost. In this case, it may not be cost-effective to add one or two courses, but it may be cost-effective to add 10 or 15 courses (to more fully utilize the additional capacity). (See the discussion on page 52 for advise on determining which courses to delivery when the system is fully utilized.)

Methodology

In this section, we present a methodology for analyzing the costs and benefits of using Video Teletraining to deliver Navy training. We start with a general overview of the method. Here, we discuss the scope of our methodology, define what we mean by VTT costs and benefits, list the individual training costs and QOL measures used in our method, and discuss key assumptions. We then outline the methodology and describe, in detail, each of the main steps.

Overview

Scope

We defined the scope of our methodology through discussions with our sponsor. Two N75 decisions shaped our efforts. The first was that the methodology would look *only* at the costs and benefits of using VTT technology to deliver formal Navy training to active-duty personnel. As a result, our methodology (and analysis tool) does not consider potential benefits from other uses of this technology, such as:

- Video teleconferencing—using this technology to allow people at different locations to participate in meetings or conferences without traveling
- Telemedicine—using this technology to transmit medical results and help on-scene doctors diagnose and treat medical problems
- At-sea maintenance support—using this technology to support ship maintenance by enabling subject experts on shore to help afloat personnel troubleshoot and repair systems
- Reserve training—using this technology to train SELRES units at reserve centers that do not have access to CESN sites

- Voluntary education—CESN has the capability to communicate with the Naval War College, Naval Post Graduate School, universities, and other educational networks, thus providing additional opportunities for Navy personnel to further their education.

The second decision was that the methodology be tailored around the Navy's current VTT system (i.e., CESN). Because the Navy has already selected a VTT system, it was not looking for a methodology to evaluate different types of systems. Instead, it wanted a methodology to analyze the costs and benefits of its current program or an expanded version of this program.

Definition of VTT cost-benefits

We defined the savings from VTT as the difference in costs between delivering training the traditional way and delivering it by VTT.[12] By traditional way, we mean either sending students to a training activity or school that provides the training in-house, or sending instructors to student locations to provide the training locally.

Based on this definition, our approach is to calculate and compare the costs (and QOL measures) to deliver the training using each method. That is, we first calculate the individual costs and QOL measures to deliver training using VTT. Next, we calculate the individual costs and QOL measures to deliver the same training the traditional way. We then total and compare the costs and QOL measures to determine if VTT provides any cost or QOL benefits.

Training costs

We consider the following costs to deliver training:

- *Transportation costs*. These are the costs to get the students (or instructors) to and from their duty stations to the training site. They include airfare, where appropriate, and local transportation (e.g., from airport to training activity or duty station). We do not include the cost of rental cars or other types of daily transportation.

12. We use the same definition for quality-of-life benefits.

- *Per-diem costs*. Per-diem costs include allowances for meals and incidental expenses (M&IE) and lodging that students (or instructors) receive while on TAD. We calculate per-diem costs based on the total time away from home (i.e., the time spent at the training site plus the time spent traveling to and from this site).

- *Instructor costs*. These are the instructor costs to prepare and deliver the training. We measure these costs two ways: by instructor billets (i.e., number of instructors) and by MPN dollars.

- *Travel time costs*. These costs represent the unproductive time students spend traveling to and from their training site. We consider this a cost because it is wasted time in the sense that the person is not available for duty or other training. We measure these costs by man-years and by MPN dollars.

- *Travel processing costs*. These are the costs to make travel arrangements and process travel claims for each student who travels. We measure these costs by the number of claims processed and by dollars.

- *VTT system costs*. These are the costs to set up, operate, and manage the VTT network. They include equipment costs, communication costs, manpower costs (both classroom facilitators and network managers), and course implementation costs (i.e., costs to prepare and supply a course for VTT delivery).[13]

Quality-of-life measures

We tried to address quality-of-life issues that would benefit from delivering training by VTT. Unfortunately, most QOL issues are difficult, if not impossible, to quantify. Consequently, we were able to identify only one measure that we could tie directly to VTT: the time students spend away from their home duty station to attend schoolhouse training. Most people view the amount of time spent at home as a QOL issue (i.e., the more time spent at home, the better the quality of life).

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13. Base operating support costs (e.g., electricity, heat, water, and telephone service) are not included.

Key assumptions

To simplify the calculations, we make several assumptions. We feel that each of these is reasonable and does not significantly affect or predetermine the results. The key assumptions we make are:

- VTT courses will be taught in a traditional classroom at the originating site if all the remote site requirements have been satisfied. In other words, the Navy won't use a VTT classroom to teach only local students. (We discuss this issue in more detail in the VTT network capacity section.)
- When a course is exported (i.e., an instructor travels to where the students are to teach the course), each convening is taught by a single instructor.
- There is no difference in the quality of instruction that affects training costs, such as higher failure rates (which could increase training costs because the Navy would have to send more people through training).
- There is no limit on the number of VTT sites that can be physically connected at one time (a feature of CESN). (This does not mean that every course can be effectively delivered to all sites at one time; we discuss this issue in step II).
- Each VTT site can serve as either an originating site or a remote site (a feature of CESN).
- Instructors (and classroom facilitators) are available when needed.

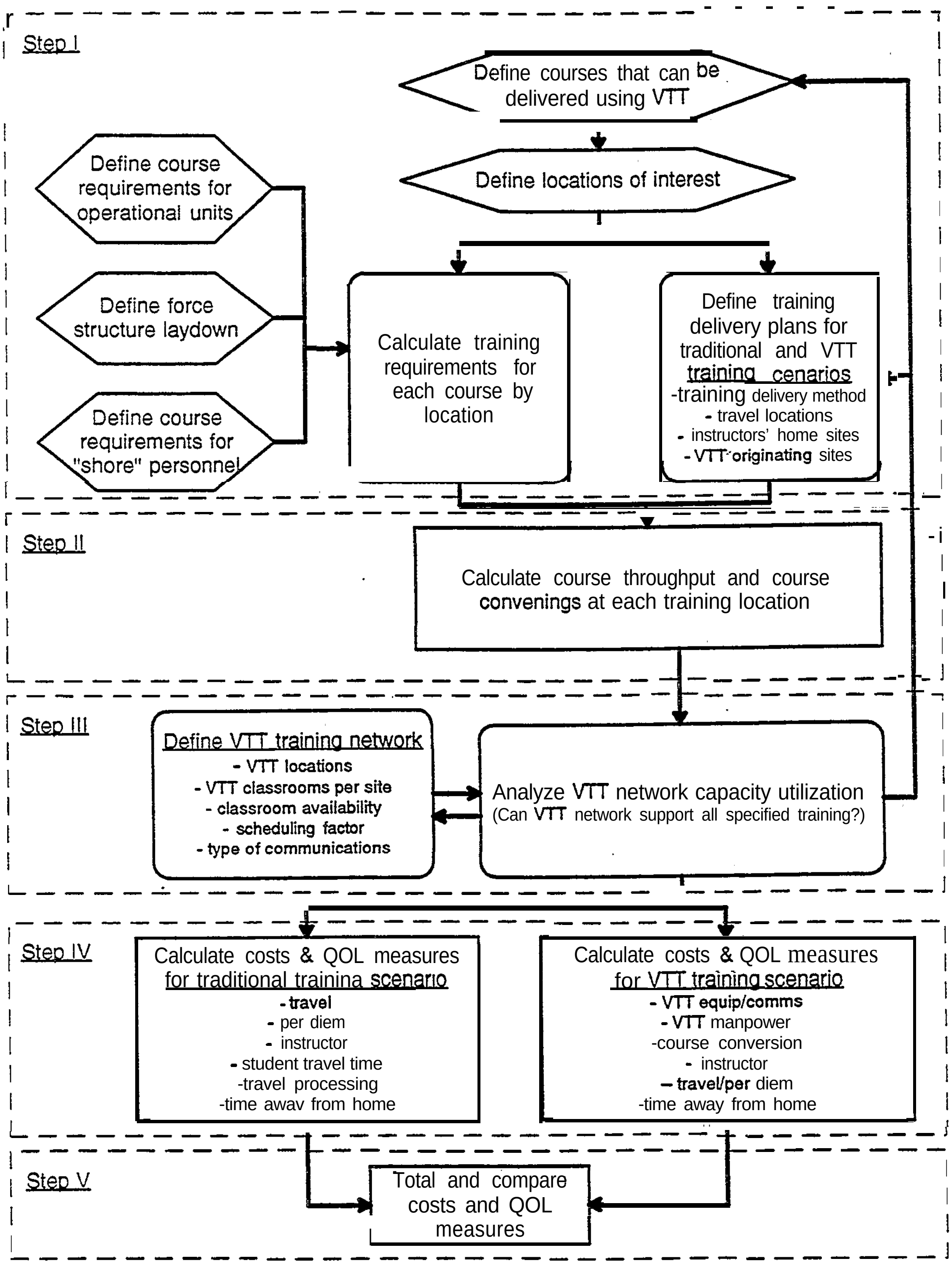
Most of these assumptions manifest themselves in the data sets and not in the general methodology. Thus, in most cases, the data sets could be tailored to change these assumptions.

Description

Figure 2 outlines our methodology, which comprises five steps:

1. Define the training scenario.

Figure 2. Methodology **for analyzing the costs and benefits of** VTT



2. Calculate course throughput and course convenings at each training location.
3. Define the VTT network and analyze its capacity utilization.
4. Calculate individual training costs and QOL measures for both VTT training and traditional training.
5. Total and compare costs and QOL measures.

We now discuss each of these steps in detail.

Step I. Define the training scenario

The cost and QOL benefits that result from delivering training by VTT depend greatly on the scenario in which it is used. For example, using VTT to deliver high-throughput, short-duration courses for which the demand is geographically dispersed should produce more TAD savings than delivering low-throughput, long-duration courses for which the demand is concentrated in one or two areas. Thus, the first step in analyzing the costs and benefits of VTT is to define the training scenario in which it will be evaluated.

The training scenario that you define depends on what issue (or issues) you want to address (i.e., the analysis objective). For example, if you want to estimate the costs and benefits of the current VTT program, you would define a scenario that describes the current VTT network and the current training delivered over this network. If you want to analyze a scenario in which the Navy delivers more training over a larger network, you would simply define that scenario accordingly.

We define the five main elements of a training scenario as follows:

- Training (i.e., courses) to be delivered by VTT
- Locations affected by VTT training
- Number of people requiring this training at each location
- VTT network configuration (site locations and number of classrooms)
- How the training is delivered to each location (i.e., the delivery plans for both traditional and VTT training).

We now discuss how to define each of these elements.

VTT-delivered training

VTT-delivered training refers to the individual courses (or training events) that will be delivered by VTT in your scenario. Because our methodology works at the course level (i.e., we compute the costs to deliver each course individually), you need to define each course separately. For example, if you want to analyze the current VTT program, you would list all 50 courses (by their course identification code (CIN) and title) currently delivered by VTT.

It is important to understand that when you include a course in your scenario you are, in essence, saying that this course can be *effectively* delivered by VTT. This means that the quality and effectiveness of the VTT training do not differ significantly from traditional training. We did not design this methodology to identify which courses can and cannot be effectively delivered using VTT. That determination must be made off line. (See page 58 for a discussion on what types of training are better suited for delivery by VTT.)

Locations

Our methodology also works at the location level (i.e., it calculates training costs for individual courses by location). Therefore, in defining the scenario, you need to define the locations where you want to calculate the costs to train people. A location usually refers to a Navy installation (e.g., a naval station, air station, training activity, and hospital) or a ship equipped with VTT capability.

Again, deciding which locations to include depends on the analysis objective. Obviously, you want to include all locations that have VTT capability. But you might want to include other locations as well. Why? One reason is that sites without VTT facilities can still benefit from VTT training. For example, suppose there were 20 people at NAS Lemoore who required TQL training. Further suppose that, under the traditional training scenario, this course is offered only at Dam Neck, but under the VTT scenario it is offered remotely at San Diego. Because it costs more to send a person from Lemoore to Dam Neck than to San Diego, Lemoore would experience cost savings even though it has no VTT facilities.

Another reason for including additional locations is to examine their training requirements and the costs to deliver this training the traditional way. This is useful in determining whether to expand the VTT network.

Training requirements by geographic location

Our methodology computes training costs based on the number of people at each location (defined in the scenario) who require each course (defined in the scenario). Therefore, in defining the scenario you need to define the training requirement for each course at each location.

There are two basic ways to derive this information. One is to look at historic course throughput data to see how many people took each course in the past and, if possible, identify where those people originated. The other approach is to project requirements by location from the operational unit-level requirements for each course and a geographic laydown of these units. That is, you define, for each ship and submarine class and each type of aviation squadron, the number of people from one unit that, on average, need to take the course each year. You then calculate the total course requirement at a location based on the forces stationed there. The requirements for shore-duty personnel, if significant, would be estimated by looking at the number of billets (perhaps by job function or activity) within the local area.

Although each approach has advantages and disadvantages, we recommend the second so-called “projection” approach for several reasons. First, the Navy’s force structure is continually changing, and, to the extent that course throughput is tied to force structure, it too is changing. Second, the laydown of ships and aircraft also changes. So even if the total requirement for a course stays the same, the geographic distribution of these requirements is likely to change. This is particularly true over the next few years when the Navy shuffles its forces to comply with upcoming base closings and realignments. Third, historic data do not exist for all courses, in particular, informal courses (those not in CANTRAC or NITRAS) and new courses. Also, historic data may not always tell from where the students came.

We included in our VTT analysis tool the capability to compute training requirements using the "projection" approach. Appendix B provides a more detailed description of this approach.

VTT network

You define the VTT network by identifying the locations that have VTT capability and specifying the number of VTT classrooms at each of these locations. We also require some additional information about each site, namely:

- The number of days per year the classrooms are available
- The scheduling inefficiency factor[14]
- The type of telecommunications (i.e., dedicated landline, pay-as-you-use landline, or satellite)
- The number of classroom facilitators required to support all the VTT-delivered training at that site.

Table 2 shows a sample VTT network configuration data set.

Table 2. Sample VTT network configuration data set

Location	Number of classrooms	Available days per year	Scheduling inefficiency factor (%)	Type of tele-communications	Number of facilitators
Mayport	2	250	85	Dedicated T-1	1.5
Newport	1	250	85	Dedicated T-1	1.0
Norfolk	2	250	85	Dedicated T-1	2.0
Great Lakes	1	250	85	ISDN	0.6

To compute the cost of equipping and operating this network, we required the following cost data for each site:

14. The scheduling inefficiency factor accounts for the fact that it's nearly impossible to schedule training so that a classroom is used every available day. We define it as the percentage of available classroom days that realistically can be scheduled for training. We give representative values for this factor in a later section.

- The average equipment cost per classroom
- The average fixed communications costs per classroom.
- The variable communications costs per hour of use (if the site has a pay-as-you-use-it communications agreement)
- The average cost of a full-time classroom facilitator.

Training delivery plan

The last piece of information that needs defining is how the training will be delivered to each location. We refer to this as the training delivery plan. Because training under a traditional scenario will be delivered differently than under a VTT scenario, you need to define a training delivery plan for each method.

The training delivery plan specifies how each course will be provided to each location in the scenario. For the traditional method, the first option is to offer the training locally (either by teaching it in-house at one of the local training activities or exporting it from another location by sending instructors). If the course is not offered locally, two other options exist: 1) send the students to a location where the training is provided, or 2) don't train the people at that location.

For VTT training, the same options exists with one exception. The training can be delivered locally using VTT. This can occur at a VTT originating site or at a VTT remote site.

We define the training delivery plan using four data sets (actually three for traditional training and four for the VTT training). The first data set specifies how the training will be provided at each location for each course. The options are:

- "**Local**"—deliver course in-house at a local training activity
- "**Export**"—export course to that site by sending instructors
- "**Travel**"—students travel to another site where the course is offered
- "**None**"—do not train personnel at the site
- "**VTT-O**"—deliver course by VTT at a VTT originating site
- "**VTT-R**"—deliver course by VTT at a VTT remote site.

Tables 3 and 4 show a sample data set for traditional and VTT training, respectively. In this example, under the traditional scenario the Navy teaches course A-123-4567 at Norfolk, and sailors at Mayport, Newport, and Ingleside who require this course must travel to another location to get this training. Under the VTT scenario, the Navy delivers this course by VTT to all sites except Great Lakes, with Norfolk serving as the originating site.

Table 3. Sample training delivery plan data set for traditional training

Course	Location				
	Mayport	Newport	Norfolk	Great Lakes	Ingleside
A-123-4567	Travel	Travel	Local	None	Travel
B-123-4567	Export	Export	Export	Local	Export
C-123-4567	Local	Travel	Local	Travel	Local
D-1E-2345	Travel	Local	Travel	None	Travel

Table 4. Sample training delivery plan data set for VTT training

Course	Location				
	Mayport	Newport	Norfolk	Great Lakes	Ingleside
A-123-4567	VTT-R	VTT-R	VTT-O	None	VTT-R
B-123-4567	VTT-R	VTT-R	VTT-R	VTT-O	VTT-R
C-123-4567	VTT-O	VTT-R	VTT-O	VTT-R	VTT-R
D-1E-2345	VTT-R	VTT-O	VTT-R	None	VTT-R

The second data set specifies where the people actually get trained. If the training is offered locally (either in-house, by MTT, or by VTT), the training location is simply the local site (i.e., enter "Local"). If the training is not offered locally (i.e., people must travel), the training location represents the site where these people go for training. (We assume that for each course all the people from one site go to the same location). For VTT training, this could be to either a VTT originating site or a VTT remote site, whichever is cheapest to get to. Likewise, for traditional training, it could be to an in-house site or an MTT site. Table 5 shows a sample training location data set that corresponds to the training delivery plan in table 3. In this example, the people at Mayport, Newport, and Ingleside who require course A-123-4567 travel to Norfolk for training.

Table 5. Sample training location data set

Course	Location				
	Mayport	Newport	Norfolk	Great Lakes	Ingleside
A-123-4567	Norfolk	Norfolk	Local	None	Norfolk
B-123-4567	Local	Local	Local	Local	Local
C-123-4567	Local	Norfolk	Local	Norfolk	Local
D-1E-2345	Newport	local	Newport	None	Newport

The third data set contains, for each course, the home location(s) for instructors who export training. Table 6 shows a sample data set for our traditional scenario. Here, the instructors who export Course B-123-4567 come from Great Lakes. The fourth data set, which pertains only to VTT training, specifies the VTT originating site for each VTT remote site. Table 7 shows a sample data set for our VTT scenario. In this scenario, course C-123-4567 has two originating sites: Mayport and Norfolk. The Mayport site serves the remote site at Ingleside, whereas the Norfolk site serves the remote sites at Newport and Great Lakes.

Table 6. Sample instructor location data set[a]

Course	Location				
	Mayport	Newport	Norfolk	Great Lakes	Ingleside
A-123-4567	N/A	N/A	N/A	N/A	N/A
B-123-4567	Great Lakes	N/A	Great Lakes	Great Lakes	Great Lakes
C-123-4567	N/A	N/A	N/A	N/A	N/A
D-1E-2345	N/A	N/A	N/A	N/A	N/A

a. "N/A" indicates data are not required for these course-location pairs (because the training is not exported).

Table 7. Sample VTT originating site data set[a]

Course	Location				
	Mayport	Newport	Norfolk	Great Lakes	Ingleside
A-123-4567	Norfolk	Norfolk	VTT-O	None	Norfolk
B-123-4567	Great Lakes	Great Lakes	Great Lakes	VTT-O	Great Lakes
C-123-4567	VTT-O	Norfolk	VTT-O	Norfolk	Mayport
D-1E-2345	Newport	VTT-O	Newport	None	Newport

a. "VTT-O" indicates that a location is a VTT originating site for that course.

Step II. Calculate course throughput and course convenings

In defining the training scenario, we specified, for each course and location, the number of people who require this training and where they will receive it (i.e., locally or at another location). In this step, we use this information to compute the number of people who actually go through training at each location and the number of times a course must be held (i.e., convened) at those locations to accommodate this throughput.

Course throughput

Course throughput refers to the number of people who go through the training at a location where the course is taught. (The course can be delivered live, either in-house or by mobile training teams, or by VTT). We calculate course throughput at a location by summing the training requirements for that course at all sites that will send students to this location for training (as defined in the training delivery plan) and then adding the local training requirement. For example, if the requirements for TQL training at Norfolk, Newport, and Mayport were 250, 45, and 95, respectively, the course was only taught at Norfolk, and students at the other sites would travel to Norfolk, the throughput at Norfolk would be 390 (250 + 45 + 95).

Course convenings

Once we've calculated how many people will go through training at each location, we calculate the number of times each course must convene. For reasons that will become apparent, we use different methods for the traditional and VTT training scenarios.

Traditional training. For traditional training, we calculate the number of course convenings at a location by

$$Convenings = \text{Int}\left\{\left[\frac{Course\ Throughput}{Max\ Class\ Size}\right] + 0.8\right\},$$

where "Int" means take the integer component. The 0.8 component reflects current Navy policy which is not to convene a course for a group smaller than 20 percent of the maximum class size.

VTT training. For VTT training, we divided convenings into two types: those held in VTT classrooms (VTT convenings) and those held in traditional classrooms (non-VTT convenings). (We do this to support the VTT classroom utilization analysis in step III.)

All convenings for a VTT-delivered course at a remote site are VTT convenings. We calculate the number of VTT convenings at each remote site the same way we calculate convenings for traditional training, that is

$$Convenings(Remote) = \text{Int}\left\{\left[\frac{Course\ Throughput(Remote)}{Max\ Class\ Size}\right] + 0.8\right\}.$$

The situation at VTT originating sites is more complex because there can be both VTT and non-VTT convenings for a VTT-delivered course. The number of VTT convenings at an originating site depends on the total number of VTT convenings at all the remote sites that this originating site serves. We calculate this number by

$$VTT\ Convenings(Orig) = \text{Int}\left[\frac{\sum Convenings(Remote)}{Max\ Classes}\right],$$

where *Max Classes* is the maximum number of remote classrooms that can be taught at one time. This number varies by course. Data obtained from the VTT program office show that three remote classrooms is the maximum for most CANTRAC courses. Exceeding this number can reduce student-instructor interaction to a level where the quality of training begins to suffer. For courses or training events that require little or no student-instructor interaction (e.g., general information presentations), it may be possible to deliver training to more than three remote classrooms at one time.

Non-VTT convenings occur when the number of convenings required to satisfy the local demand at an originating site exceeds the number of VTT convenings needed to satisfy the demand at remote sites. The assumption here is that you don't tie up a VTT classroom to teach only local students; you use a traditional classroom.

To calculate the number of non-VTT convenings, we first calculate the number of convenings required to train the local demand. If this exceeds the number of VTT convenings at this site, the number of non-VTT convenings is just the difference between the two. For example, if a course originating at Norfolk requires 10 convenings to train the throughput at all the remote sites that it serves and 12 convenings to train the throughput at Norfolk (which includes any students who travel to Norfolk for training), there would be 10 VTT convenings and 2 non-VTT convenings.

Step III. Analyze VTT classroom utilization

In defining the training scenario, we specified the training that will be delivered by VTT and the size and configuration of the VTT network. In our discussions, we did not place any constraints or give any guidance on either the amount of training or the size of the network that could be defined. We could have listed 1 course or 500 courses, 5 sites each with 1 VTT classroom or 50 sites each with 5 VTT classrooms. Nowhere did we state that either the network must be sized to accommodate all the VTT-delivered training or that the training must be constrained by the network capacity.

If, however, the analysis objective is to estimate the costs and benefits of a specific VTT network configuration, we need to make sure that all the training we defined in our scenario can, in fact, be delivered by the network we defined in our scenario. We can't take credit for savings from training that can't be delivered.

Data requirements

We use the following data to calculate VTT classroom use:

- Number of VTT classrooms at each site
- Number of days per year a classroom is available for training
- Scheduling inefficiency factor
- Number of VTT convenings by course at each site
- Under-instruction days for each course.

We've already defined the first three items in our training scenario, and we've computed the fourth item in step II. As mentioned earlier, VTT classrooms are generally available 250 days per year for active-duty training. The scheduling inefficiency factor accounts for the fact that it's nearly impossible to schedule training so that a classroom is used every available day. Short-duration courses (i.e., less than a week), which are the most cost-effective courses to deliver by VTT, pose a problem because you normally don't want to schedule them over a weekend. So, for example, if you schedule a four-day course from Monday to Thursday, in most cases the only feasible option for scheduling the classroom for Friday would be a one-day course. In our methodology, the scheduling inefficiency factor should represent the best classroom utilization rate that can realistically be achieved.

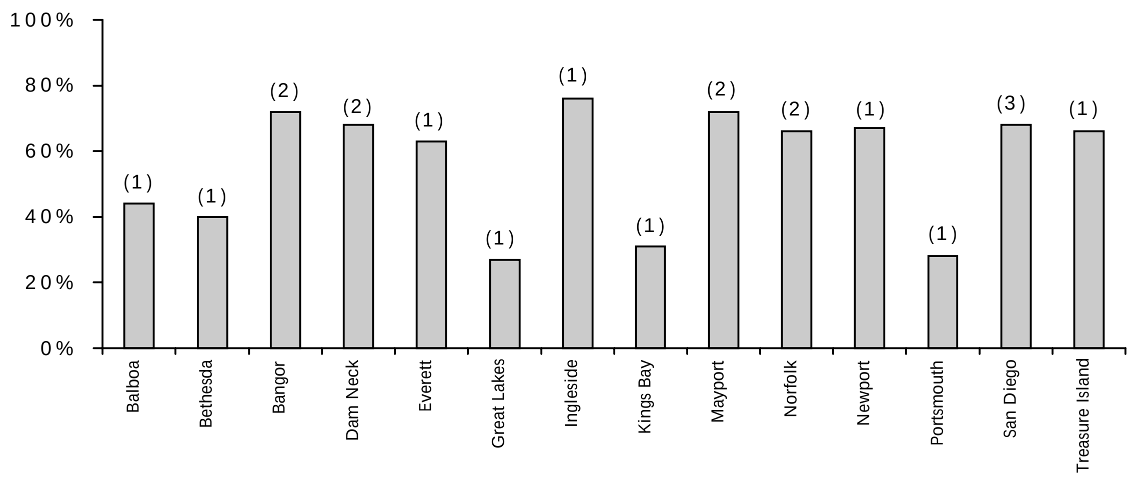
What is a reasonable scheduling factor? To gain some insight, we looked at FY 1996 VTT classroom utilization data for CESN. Figure 3 shows VTT classroom utilization (i.e., percentage of available classroom days used) for each CESN site. Ingleside has the highest utilization rate at 76 percent. Using this as a lower bound (we do not know if these utilization rates are constrained by the number of VTT-delivered courses, so it may be possible to achieve higher rates if more courses were delivered by VTT), it appears that 80 percent is a reasonable scheduling factor.

The under-instruction days for each course can be found in NITRAS's Master Course Reference File [9].

Procedure

To calculate classroom utilization, we first determine the number of VTT classroom days needed to deliver the training at each site. Next, we calculate the number of classroom days available at each site. We then calculate the utilization rate by comparing what's required against what's available. If the requirement exceeds the capacity, we need to redefine the scenario, either by reducing the VTT training or by increasing the capacity of the VTT network (i.e., number of classrooms).

Figure 3. FY 1996 VTT classroom utilization at each CESN site[a]



a. The numbers in parentheses represent the number of VTT classrooms at each site.

Calculate VTT classroom requirements. To determine the classroom days required for each course, we simply multiply the number of VTT convenings times the under-instruction days for each convening, that is

$$Classroom\ Req(crs, loc) = VTT\ Convenings(crs, loc) \times UI\text{-}Days(crs) \ .$$

To get the total number of classroom days required to support the VTT training load at each site, we sum the classroom days over all courses taught by VTT at that site, that is

$$Classroom\ Req(loc) = \sum_{crs} Classroom\ Req(crs, loc) \ .$$

Calculate VTT classroom capacity. We define VTT classroom capacity as the number of available classroom training days per year. We calculate this capacity at each site by

$$Classroom\ Cap(loc) = Classrooms(loc) \times Trng\ Days(loc) \times Sched\ Factor \quad ,$$

where *Classrooms(loc)* is the number of VTT classrooms, *Trng Days(loc)* is the number of available training days per classroom per year, and *Sched Factor(loc)* is the scheduling inefficiency factor we discussed earlier.

Calculate VTT classroom utilization. We define VTT classroom utilization as the percentage of available classroom capacity needed to conduct the VTT training. We calculate this measure at each site by dividing the classroom requirement by the classroom capacity, that is

$$Classroom\ Utilization(loc) = \frac{Classroom\ Req(loc)}{Classroom\ Cap(loc)} \times 100 \quad .$$

At this stage, before proceeding with the cost and benefit calculations, we need to check the utilization rate at each site to see if the requirement exceeds the capacity (i.e., a utilization rate greater than 100 percent).[15] If all the training can be conducted, we can proceed. If not, we need to adjust our scenario, either by reducing the amount of VTT training or by expanding the VTT network (i.e., adding more classrooms); otherwise, we would be overestimating the benefits.

Revise training scenario. There are two ways to reduce the level of VTT training. One is to cut back on the number of VTT courses in the scenario until all the training can be conducted. We recommend this approach if most sites (especially the major originating sites) are over capacity. The other way is to not deliver some courses by VTT to those remote sites that are over capacity. That is, redefine the training delivery plan so that people at these sites would travel to one of the other sites where excess capacity exists.

15. Our VTT analysis tool automatically highlights (in red) those sites where the requirements exceed the capacity.

Step IV. Calculate training costs and QOL measures

We calculate two sets of training costs and QOL measures; one for the traditional training scenario and one for the VTT training scenario.[16] For each set, we first calculate these costs by course, and for each course, by location (i.e., the cost to deliver course "A" to location "Y"). We then total the costs for each course by summing over all locations and for each location by summing over all courses.

Transportation costs

We calculate the transportation costs by multiplying the number of people at a location who will travel to take this course elsewhere by the transportation costs to get to and from that site. That is,

$$Trans\ Cost(crs, loc\ A) = Students(crs, loc\ A) \times Trans\ Cost(loc\ A, loc\ B) \ ,$$

where *Students(crs, loc A)* is the number of students at location A who will travel to location B for training and *Trans Cost(loc A, loc B)* is the two-way transportation costs between this sites. We use the same approach (with the number of students replaced by number of convenings) to calculate the transportation costs for instructors who export training.

We compiled two-way transportation costs between major Navy locations using a commercial airfare algorithm developed at the Naval Air Logistic Organization (NALO). This algorithm estimates commercial air transportation costs based on the distance between two sites. NALO uses this to determine whether commercial travel is cheaper than using military aircraft.

Per-diem costs

Per-diem costs comprise meal and incidental expenses (M&IE) allowances and lodging allowances. We calculate M&IE costs by

$$\begin{aligned} M\&IE\_Cost(crs, loc\ A) = {} & Students(crs, loc\ A) \times ((On\_Base\_M\&IE(loc\ B) \\ & \times \%On\_Base(loc\ B)) + (Off\_Base\_M\&IE(loc\ B) \\ & \times \%Off\_Base(loc\ B))) \times (Trng\_Days(crs) \\ & + Trav\_Days(loc\ \mathrm{A}, loc\ \mathrm{B})) \ , \end{aligned}$$

16. A VTT scenario can have travel and per-diem costs (e.g., if a location without VTT capability is included).

where:

Students(crs,loc A)	= number of students at location A who will travel to location B for training
On_Base_M&IE(loc B)	= on-base meal rate at location B
%On_Base(loc B)	= percentage of students who stay on base
Off_Base_M&IE(loc B)	= off-base M&IE rate at location B
%OffBase(loc B)	= percentage of students who stay off base
Trng_Days(crs)	= length of training (in days)
Trav_Days(crs)	= 2-way travel time between locations A and B.

We calculate the lodging costs by

$$\begin{aligned} Lodging\_Cost(crs, loc\ A) = {} & Students(crs, loc\ A) \times Trng\_Days(crs) \\ & \times (On\_Base\_Lodging(loc\ B) \times \%On\_Base(loc\ B) \\ & + Off\_Base\_Lodging(loc\ B) \times \%Off\_Base(loc\ B)) \ , \end{aligned}$$

where:

Students(crs,loc A)	= number of students at location A who will travel to location B for training
Trng_Days(crs)	= length of training (in days)
%On_Base(loc B)	= percentage of students who stay on base
On_Base_Lodging(loc B)	= on-base lodging rate at location B
%Off_Base(loc B)	= percentage of students who stay off base
Off_Base_Lodging((loc B)	= off-base lodging rate at location B.

For enlisted courses, we use on-base M&IE and lodging rates for enlisted personnel. For officer courses, we use officer rates. For courses attended by both officers and enlisted personnel, we use average on-base rates. We compiled off-base rates, which are the same for officers and enlisted, for the major Navy locations from DOD’s Per Diem Web site. We also constructed a data set that contains the two-way travel time (in days) between any two locations.

Instructor costs

CNET Instruction 5311.1C provides a standardized procedure for computing the number of instructors needed to teach a course. We use this procedure, with one modification, in our methodology to calculate instructor requirements. Because we are interested in the difference between the instructor requirement for the VTT scenario and that for the traditional scenario, we excluded the curriculum control model manager (CCMM) component because it is the same for both scenarios. This also simplifies the calculations.

The computation we use can be described by

$$Instructors = \frac{\sum_i \left[\left(\frac{Class\_Size}{Ratio_i}\right) \times Per_i\right] \times Convenings \times IPRD \times Sup}{1{,}867} ,$$

where:

Instructors	= number of instructors
Class_Size	= class size
$Ratio_i$	= student-to-instructor ratio for the *i*th section
Per_i	= contact periods (i.e., hours) for the *i*th section
Convenings	= number of convenings
IPRD	= instructor preparation and related duties factor
Sup	= instructor / course supervisor factor
1,867	= annual available work-hours per instructor.

Recently, the training community has been investigating whether VTT training requires more preparation on the part of the instructor. We account for this by allowing the user to define a different IPRD factor for VTT training. Finally, we assign the instructor requirement for exported training to the instructor's home location as defined in the training scenario (as opposed to assigning it to the location where the students are taught).

Travel time costs

Travel time costs represent the unproductive time students spend traveling to and from their training site. We calculate this measure, first in terms of wasted man-days, by multiplying the number of students who travel times the two-way travel time.

We convert this to dollars by dividing the total wasted man-days by the number of man-days in a man-year and then multiplying by the average cost of a man-year (i.e., salary plus allowances). We use the average cost of an officer for officer courses, the average cost of an enlisted person for enlisted courses, and a combined officer and enlisted average for courses attended by both.

Travel processing costs

Travel processing costs are the costs associated with making travel arrangements and processing travel claims for students who travel. To calculate these costs, we first determine the number of travel claims that will need to be processed. This is simply equal to the number of students who travel. We then convert this to dollars by multiplying the number of travel claims by the average cost to arrange a trip and process the claim (which the user defines).

Time away from home

We calculate our QOL measure, student time away from home, by multiplying the number of students who travel by the total time they spend away from home (i.e., time in training plus time spent traveling to and from the training site).

VTT course conversion costs

There are two types of course conversion costs—the costs to prepare and supply a course for VTT delivery. One is the cost to prepare the course presentation material for VTT delivery. For example, overheads and other presentation graphics may need to be redone so they can be more easily viewed by students at remote sites. The other is the cost to provide special, course-specific supplies or equipment to each remote site where that course will be offered. For example, the Celestial Navigation course requires a special set of publications and plotting tools, which are fairly expensive. To be able to deliver this course using VTT, the Navy must supply these materials to each remote site (as opposed to buying them for just the in-house site(s) under a traditional training scenario).

We calculate the annualized course conversion costs by

$$Conv\_Cost(crs) = \frac{Prep\_Cost(crs) + [Sup\_Cost(crs) \times Remote\_Sites(crs)]}{Life\_Cycle} \quad ,$$

where *Prep_Cost(crs)* is the cost to prepare the presentation, *Sup_Cost(crs)* is the cost of the supplies and equipment needed at each remote site, *Remote_Sites(crs)* is the number of remote sites where the course will be taught, and *Life_Cycle* is the service life of the supplies and equipment (i.e., how often they have to be replaced or updated).

VTT system costs

We calculate two types of VTT system costs: site-specific costs and system overhead costs.

Site-specific costs. These are the costs to equip, operate, and staff the VTT classrooms at each site. We calculate equipment costs simply by multiplying the number of classrooms times the average equipment cost per classroom. Likewise, we calculate facilitator costs by multiplying the required number of facilitators times the average annual cost of a facilitator.

To address all the different communication options, we define the communication costs by two components: a fixed cost component and a variable cost component. The fixed cost component represents those costs that are independent of how much the system is used (e.g., under the current contract, the Navy pays a fixed cost for dedicated, full-time T1 communication service). The variable cost component represents those costs that depend on system use. For example, if the Navy decides to connect to a site using ISDN, there would be a small fixed cost (i.e., monthly fees to connect to this service), but most of the cost would depend on how much the site is used (similar to a long-distance phone bill).

We calculate total communication costs at a location by

$$Comm\_Cost(loc) = Fix\_Cost(loc) + (Var\_Rate(loc) \times Hours\_Used(loc)) \quad ,$$

where *Fix_Cost(loc)* is the fixed cost, *Var_Rate(loc)* is the variable cost rate (cost per hour of usage), and *Hours_Used(loc)* is the total number of VTT classroom hours used during the year. The latter is estimated by multiplying the number of VTT classroom days required at a site (from Step II) by 8 classroom hours per day.

System overhead costs. These are the costs associated with managing, coordinating, and scheduling the VTT system. They include the costs for the VTT program managers (including hub coordinators) and the multipoint control units. We calculate these costs for the entire system by

$$Overhead\_Cost = (\#Managers \times Salary) + (\#MCUs \times Unit\_Cost) ,$$

where *#Managers* is the number of VTT managers, *Salary* is the average annual cost of a manager, *#MCUs* is the number of MCUs, and *Unit_Cost* is annual cost of an MCU.

Step V. Aggregate and compare cost benefits

So far, we've defined a training scenario and estimated the costs and QOL measures (for each course by location) to deliver this training using VTT and to deliver it the traditional way. We now need to aggregate the individual course-location costs, add in the VTT system costs, and compare the results to determine which method is more cost-effective and by how much. We do this in two steps.

First, we total, for each method, the individual costs to deliver each course. That is, we calculate the total transportation costs, total per-diem costs, total instructor costs, total travel time costs, and total travel processing costs—for each course by summing over all locations.[17] We then add the VTT course conversion costs. Table 8 shows what the output looks like at this stage. It allows the user to see where the bulk of the savings, if any, comes from for each course.

17. This calculation is straightforward except for instructors. Our instructor computation outputs fractional instructor requirements (e.g., Course A requires 1.25 instructors). But what does 1.25 instructors mean? Does it mean you need one or two instructors? In most cases, it means you need two instructors. The extra 0.75 instructor goes into a residual pool, which may be used to teach other courses if the instructors are compatible. (The Master Course Reference File identifies courses that can cross-utilize instructors [9].) Thus, the issue in totaling the instructor requirement is whether to round up the requirement at each location before summing or sum before rounding. In our analysis tool, we let the user decide which method to use for each course.

Table 8. Format of output table showing course training costs for each delivery method

Course	Training delivery costs												
	Transportation		Per diem		Instructor		Travel time		Admin		Conv	Total	
	Trad	VTT	Trad	VTT	Trad	VTT	Trad	VTT	Trad	VTT	VTT	Trad	VTT
A	$$	$$	$$	$$	$$	$$	$$	$$	$$	$$	$$	$$	$$
B	$$	$$	$$	$$	$$	$$	$$	$$	$$	$$	$$	$$	$$
C	$$	$$	$$	$$	$$	$$	$$	$$	$$	$$	$$	$$	$$
D	$$	$$	$$	$$	$$	$$	$$	$$	$$	$$	$$	$$	$$
E	$$	$$	$$	$$	$$	$$	$$	$$	$$	$$	$$	$$	$$

Second, we sum the costs in each cost category over all courses to get the total costs by category to deliver training. We then total the VTT site costs over all sites. Finally, we consolidate these costs into a table and calculate the total cost for each method. Table 9 shows what the final cost output looks like. It shows a breakout of the annual costs by category for each method and the total annual costs. Table 10 shows the final QOL output.

Table 9. Format of output table showing total training costs for each delivery method

Cost category	Training costs	
	Traditional[a]	VTT
Transportation	$$$	$$$
Per diem	$$$	$$$
Instructor	$$$	$$$
Travel time	$$$	$$$
Travel admin	$$$	$$$
VTT equipment	N/A	$$$
VTT communications	N/A	$$$
VTT facilitators	N/A	$$$
VTT course conversion	N/A	$$$
VTT overhead	N/A	$$$
Total:	$$$$	$$$$

a. N/A indicates that cost does not pertain to traditional training.

Table 10. Format of output table showing QOL measures for each delivery method

QOL Measure	Traditional	VTT
Time Away From Home (student-days)	XXX	XXX

At this stage, the user would compare the total costs and QOL measures to determine which method is more cost effective and by how much.

Utility of VTT analysis tool

The analysis tool that we developed can be used to address most investment issues surrounding the use of VTT technology to deliver Navy training. In this section, we illustrate some of the more important applications.

Estimate cost reductions and QOL benefits

The primary function of the VTT analysis tool is to estimate, for a user-defined scenario, the costs and benefits of delivering training by VTT. Depending on how the user defines the scenario, this tool can estimate the cost-effectiveness of the Navy's current VTT program, either for the current year or for any future year (provided the requirements are known), or an expanded or modified version of this program. For example, it can estimate the costs and benefits of a program in which the Navy delivers more training by VTT and/or increases the size of the VTT network (either by adding more sites or adding more classrooms to existing sites).

The tool can also be used to examine how changes in training requirements (e.g., due to changes in the force structure or its laydown) would affect the cost-effectiveness of the current VTT program. Similarly, it can be used to examine the effects of changes in VTT system operating costs or capabilities.

To illustrate this capability, we'll work through an example in which we estimate the costs and benefits of the fictitious training scenario depicted in tables 11 through 14.[18] This scenario consists of 24

18. These are not the only tables used to define a training scenario, but they suffice in giving the reader an overview for this example.

courses and 10 locations.[19] Before calculating the training delivery costs, we need to make sure the user-defined VTT network can accommodate all the training that is to be delivered by VTT. Table 15 shows the VTT classroom utilization at each site. Because all the rates are less than 100 percent, meaning all the VTT-delivered training can be accommodated, we can proceed with the cost calculations.

Table 16 shows the individual training delivery costs and the total costs by course for both methods. (Note that in this example there are travel and per diem costs in a VTT scenario.) Table 17 summarizes the total costs (including the VTT infrastructure costs) and table 18 summarizes the QOL benefits. For this scenario, delivering training the traditional way costs $5.8 million per year, whereas delivering it by VTT costs $2.5 million per year—a reduction of $3.3 million per year. Using VTT also reduces the time sailors spend away from home by 22,190 days per year, thus improving their quality of life.

19. The courses and locations in this scenario represent actual courses delivered by VTT and actual locations with VTT capability, but the training requirements (i.e., students requiring this training by location) are fictitious. We were unable to obtain either documented training requirements (by unit) or historic throughput data (by student location) for these courses. As discussed earlier, the lack of well-defined requirements for these courses precludes a detailed analysis of the cost-effectiveness of the Navy's current VTT program.

Table 11. Course requirements by location (students per year)

CIN	Total	Nor	DamN	Newp	KBay	May	GL	Ingl	SD	PH	Ban
Total	11,862	3,357	953	345	457	917	319	349	3,435	826	904
A-493-0071	275	150	0	15	0	0	0	10	100	0	0
A-493-2099	455	165	0	20	15	45	0	25	105	35	45
A-4A-0051	545	190	0	0	25	35	0	0	185	45	65
B-322-1075	575	307	0	0	10	0	0	15	205	38	0
B-322-2120	241	95	0	0	0	0	0	0	104	42	0
B-322-2220	178	50	0	0	15	0	0	25	48	20	20
B-322-2241	76	12	0	0	0	10	0	15	21	18	0
B-322-2320	665	300	0	0	0	10	0	15	255	70	15
B-322-2365	498	0	0	10	25	50	45	30	251	67	20
B-61-2307	75	40	0	0	0	0	0	0	35	0	0
J-041-0103	679	0	299	0	35	36	0	0	238	40	31
J-101-2708	145	0	0	20	0	15	0	0	55	35	20
J-221-0025	399	0	110	0	0	45	0	30	174	20	20
J-2G-0210	299	75	44	0	20	55	0	0	65	25	15
J-2G-0603	580	160	0	50	40	65	0	20	150	45	50
J-2G-0966	226	0	84	0	10	20	0	10	42	20	40
J-551-0050	397	119	3	0	0	46	0	25	150	15	39
J-651-0451	686	419	0	0	0	80	0	15	172	0	0
K-070-9045	292	125	0	0	15	40	15	9	67	8	13
K-221-2155	555	0	229	45	0	0	0	0	252	29	0
K-2G-0908	915	350	0	0	45	95	0	40	300	50	35
K-8A-0913	173	38	0	35	0	0	0	0	63	0	37
P-500-0012	1,912	536	50	150	162	190	259	65	130	97	273
P-501-0060	1,021	226	134	0	40	80	0	0	268	107	166

Table 12. Delivery plan for VTT scenario[a]

CIN	Nor	DamN	Port	Newp	KBay	May	Ingl	GL	SD	PH	Ban
A-493-0071	VTT-O	Travel	Travel	VTT-R	VTT-R	VTT-R	VTT-R	VTT-R	VTT-O	VTT-R	VTT-R
A-493-2099	VTT-O	Travel	Travel	VTT-R	VTT-R	VTT-R	VTT-R	VTT-R	VTT-O	VTT-R	VTT-R
A-4A-0051	VTT-O	Travel	Travel	VTT-R	VTT-R	VTT-R	VTT-R	VTT-R	VTT-O	VTT-R	VTT-R
B-322-1075	VTT-O	Travel	Travel	VTT-R	VTT-R	VTT-R	VTT-R	VTT-R	VTT-O	VTT-R	VTT-R
B-322-2120	VTT-O	Travel	Travel	VTT-R	VTT-R	VTT-R	VTT-R	VTT-R	VTT-O	VTT-R	VTT-R
B-322-2220	VTT-O	Travel	Travel	VTT-R	VTT-R	VTT-R	VTT-R	VTT-R	VTT-O	VTT-R	VTT-R
B-322-2241	VTT-O	Travel	Travel	VTT-R	VTT-R	VTT-R	VTT-R	VTT-R	VTT-O	VTT-R	VTT-R
B-322-2320	VTT-O	Travel	Travel	VTT-R	VTT-R	VTT-R	VTT-R	VTT-R	VTT-O	VTT-R	VTT-R
B-322-2365	VTT-O	Travel	Travel	VTT-R	VTT-R	VTT-R	VTT-R	VTT-R	VTT-O	VTT-R	VTT-R
B-61-2307	VTT-O	VTT-R	VTT-R	VTT-R	VTT-R	VTT-R	VTT-R	VTT-R	VTT-R	VTT-R	VTT-R
J-041-0103	VTT-R	VTT-O	VTT-R	VTT-R	VTT-R	VTT-R	VTT-R	VTT-R	VTT-O	VTT-R	VTT-R
J-101-2708	VTT-O	Travel	Travel	Travel	Travel	Travel	Travel	Travel	VTT-R	Travel	Travel
J-221-0025	VTT-R	VTT-O	Travel	VTT-R	VTT-R	VTT-R	VTT-R	VTT-R	VTT-R	VTT-R	VTT-R
J-2G-0210	VTT-R	VTT-O	Travel	VTT-R	VTT-R	VTT-R	VTT-R	VTT-R	VTT-R	VTT-R	VTT-R
J-2G-0603	VTT-R	Travel	Travel	VTT-R	VTT-R	VTT-R	VTT-R	VTT-R	VTT-O	VTT-R	VTT-R
J-2G-0966	Travel	VTT-O	Travel	VTT-R	VTT-R	VTT-R	VTT-R	VTT-R	VTT-R	VTT-R	VTT-R
J-551-0050	VTT-O	Travel	Travel	VTT-R	VTT-R	VTT-R	VTT-R	VTT-R	VTT-O	VTT-R	VTT-R
J-651-0451	VTT-R	Travel	Travel	VTT-R	VTT-R	VTT-R	VTT-R	VTT-R	VTT-O	VTT-R	VTT-R
K-070-9045	VTT-R	Travel	Travel	VTT-R	VTT-R	VTT-R	VTT-R	VTT-R	VTT-O	VTT-R	VTT-R
K-221-2155	Travel	VTT-O	Travel	VTT-R	Travel	Travel	VTT-R	Travel	Travel	Travel	Travel
K-2G-0908	VTT-R	Travel	Travel	VTT-R	VTT-R	VTT-R	VTT-R	VTT-R	VTT-O	VTT-R	VTT-R
K-8A-0913	None	None	None	None	None	None	None	None	VTT-O	VTT-R	VTT-R
P-500-0012	VTT-R	VTT-O	Travel	VTT-R	VTT-R	VTT-R	VTT-R	VTT-R	VTT-R	VTT-R	VTT-R
P-501-0060	VTT-O	Travel	Travel	VTT-R	VTT-R	VTT-R	VTT-R	VTT-R	VTT-O	VTT-R	VTT-R

a. VTT-O means that the course is delivered by VTT and that this site is an originating site for this course.
VTT-R means that the course is delivered by VTT and that this site is a remote site for this course.
Travel means students will travel to another location to take this course.
None means students at this site will not get trained.

Table 13. Delivery plan for traditional scenario[a]

CIN	Nor	Port	DamN	Newp	KBay	May	Ingl	GL	SD	PH	Ban
A-493-0071	Local	MTT	MTT	MTT	MTT	MTT	MTT	MTT	Local	MTT	MTT
A-493-2099	Local	Travel	Travel	Travel	Travel	Travel	Travel	Travel	Local	Travel	Travel
A-4A-0051	Local	Travel	Travel	Travel	Travel	Travel	Travel	Travel	Local	Travel	Travel
B-322-1075	Local	Travel	Travel	Travel	Travel	Travel	Travel	Travel	Local	Travel	Travel
B-322-2120	Local	Travel	Travel	Travel	Travel	Travel	Travel	Travel	Local	Travel	Travel
B-322-2220	Local	Travel	Travel	Travel	Travel	Travel	Travel	Travel	Local	Travel	Travel
B-322-2241	Local	MTT	MTT	MTT	MTT	MTT	MTT	MTT	Local	MTT	MTT
B-322-2320	Travel	Travel	Local	Travel	Travel	Local	Local	Travel	Local	Travel	Travel
B-322-2365	Travel	Travel	Local	Travel	Travel	Local	Local	Travel	Local	Travel	Travel
B-61-2307	Travel	Travel	Local	Travel	Travel	Local	Local	Travel	Local	Travel	Travel
J-041-0103	Travel	Travel	Local	Travel	Travel	Travel	Travel	Travel	Local	Travel	Travel
J-101-2708	Travel	Travel	Local	Travel	Travel	Travel	Travel	Travel	Local	Travel	Travel
J-221-0025	Local	Travel	Travel	Travel	Travel	Travel	Travel	Travel	Local	Travel	Travel
J-2G-0210	Local	Travel	Travel	Travel	Travel	Travel	Travel	Travel	Local	Travel	Travel
J-2G-0603	Local	Travel	Travel	Travel	Travel	Travel	Travel	Travel	Local	Travel	Travel
J-2G-0966	Local	Travel	Travel	Travel	Travel	Travel	Travel	Travel	Local	Travel	Travel
J-551-0050	Local	Travel	Travel	Travel	Travel	Travel	Travel	Travel	Local	Travel	Travel
J-651-0451	Local	Travel	Travel	Travel	Travel	Travel	Travel	Travel	Local	Travel	Travel
K-070-9045	Local	Travel	Travel	Travel	Travel	Travel	Travel	Travel	Local	Travel	Travel
K-221-2155	Local	Travel	Travel	Travel	Travel	Travel	Travel	Travel	Local	Travel	Travel
K-2G-0908	Local	Travel	Travel	Travel	Travel	Travel	Travel	Travel	Local	Travel	Travel
K-8A-0913	None	None	None	None	None	None	None	None	Local	Travel	Travel
P-500-0012	Local	Travel	Travel	Travel	Travel	Travel	Travel	Travel	Local	Travel	Travel
P-501-0060	Local	Travel	Travel	Travel	Travel	Travel	Travel	Travel	Local	Travel	Travel

a. Local means the course is taught locally.
MTT means the course is taught locally by a mobile training team.
Travel means students will travel to another location to take this course.
None means students at this site will not get trained.

Table 14. VTT network configuration and costs

Site	Number of VTT classrooms	Available days per classroom per year	Maximum utilization rate	Available classroom days per year	Equipment cost per classroom	Total equipment costs	Type of communications[a]	Fixed comms cost per year	Variable comms cost rate[b]	Total Comms Costs	Number of facilitators	Facilitator costs	Total site costs
Nor	2	239	85%	406	$38,000	$76,000	Dedicated T1	$41,291	$0	$41,291	2.0	$50,000	$167,291
DamN	2	239	85%	406	$81,000	$162,000	Dedicated T1	$10,316	$0	$10,316	1.5	$37,500	$209,816
Newp	1	239	85%	203	$41,000	$41,000	Dedicated T1	$21,959	$0	$21,959	0.8	$20,000	$82,959
KBay	1	239	85%	203	$41,000	$41,000	Dedicated T1	$21,244	$0	$21,244	0.1	$2,500	$64,744
May	2	239	85%	406	$35,500	$71,000	Dedicated T1	$37,884	$0	$37,884	1.0	$25,000	$133,884
Ingl	1	239	85%	203	$40,000	$40,000	Dedicated T1	$27,834	$0	$27,834	1.0	$25,000	$92,834
GL	1	239	85%	203	$41,000	$41,000	ISDN	$25,496	$30	$27,056	0.1	$2,500	$70,556
SD	3	239	85%	609	$55,000	$165,000	Dedicated T1	$41,291	$0	$41,291	1.5	$37,500	$243,791
PH	1	239	85%	203	$42,000	$42,000	Dedicated T1	$62,351	$0	$62,351	1.0	$25,000	$129,351
Ban	2	239	85%	406	$38,000	$76,000	Dedicated T1	$47,222	$0	$47,222	1.0	$25,000	$148,222

a. Options include dedicated T1, ISDN, or satellite.

b. This is the cost per hour of use for pay-as-you-use-it communications.

Table 15. Number of required VTT classroom days

Course	Total	Nor	DamN	Newp	KBay	May	GL	Ingl	SD	PH	Ban
Total Required Classroom Days	2037	404	375	63	100	199	61	73	460	123	181
Available Classroom Days	3047	406	406	203	203	203	203	203	609	203	406
Available Days - Required Days	1010	3	31	141	104	4	142	130	149	80	226
VTT Classroom Utilization	67%	99%	92%	31%	49%	98%	30%	36%	75%	61%	44%
A-493-0071	6	2	0	2	0	0	0	2	0	0	0
A-493-2099	80	15	0	5	5	10	0	5	20	10	10
A-4A-0051	15	2	0	0	1	2	0	0	5	2	3
B-322-1075	3	0.5	0	0	0.5	0	0	0.5	0.5	1	0
B-322-2120	1.5	0	0	0	0	0	0	0	0.5	1	0
B-322-2220	3	0.5	0	0	0.5	0	0	0.5	0.5	0.5	0.5
B-322-2241	2.5	0.5	0	0	0	0.5	0	0.5	0.5	0.5	0
B-322-2320	4.5	0.5	0	0	0	0.5	0	0.5	1	1.5	0.5
B-322-2365	8.5	1.5	0	0.5	0.5	1	1	1	1	1.5	0.5
B-61-2307	20	10	0	0	0	0	0	0	10	0	0
J-041-0103	70	0	10	0	10	10	0	0	20	10	10
J-101-2708	21	6	0	0	0	0	0	0	15	0	0
J-221-0025	210	0	70	0	0	20	0	20	80	10	10
J-2G-0210	180	30	60	0	10	30	0	0	30	10	10
J-2G-0603	145	35	0	10	10	15	0	5	50	10	10
J-2G-0966	26	0	10	0	2	2	0	2	4	2	4
J-551-0050	33	6	0	0	0	6	0	3	9	3	6
J-651-0451	96	54	0	0	0	12	0	3	27	0	0
K-070-9045	95	30	0	0	5	10	5	5	30	5	5
K-221-2155	15	0	5	10	0	0	0	0	0	0	0
K-2G-0908	200	75	0	0	10	20	0	10	65	10	10
K-8A-0913	12	0	0	0	0	0	0	0	6	0	6
P-500-0012	625	115	220	35	35	40	55	15	30	20	60
P-501-0060	165	20	0	0	10	20	0	0	55	25	35

Table 16. Cost comparison at the course level (VTT system costs not included)

	TAD costs ($)		Instructors		Instructor costs ($)		Wasted travel days		Travel time costs ($)		Travel processing costs ($)		Conversion costs ($)	Total cost ($)		Time away	
Course	Trad.	VTT	Trad.	VTT	Trad.	VTT	Trad.	VTT	Trad.	VTT	Trad.	VTT	VTT	Trad.	VTT	Trad.	VTT
Total	3,376,212	404,781	23.85	16.62	1,020,786	672,685	6,857	725	1,221,885	101,430	195,450	18,550	4,314	5,814,333	1,197,446	24,590	2,400
A-493-0071	1,126	0	2.00	2.00	70,000	70,000	0	0	0	0	0	0	90	71,126	70,000	0	0
A-493-2099	144,128	0	2.00	2.00	70,000	70,000	330	0	46,200	0	9,250	0	20	269,578	70,000	1,255	0
A-4A-0051	110,529	0	2.00	2.00	70,000	70,000	310	0	43,400	0	8,500	0	90	232,429	70,000	480	0
B-322-1075	48,850	0	2.00	2.00	70,000	70,000	121	0	16,940	0	3,150	0	90	138,940	70,000	184	0
B-322-2120	38,351	0	2.00	2.00	70,000	70,000	84	0	11,760	0	2,100	0	48	122,211	70,000	126	0
B-322-2220	53,537	0	2.00	0.00	70,000	0	153	0	21,350	0	4,000	0	20	148,887	0	233	0
B-322-2241	2,057	0	0.00	0.00	0	0	0	0	0	0	0	0	20	2,057	0	0	0
B-322-2320	84,064	0	0.09	0.07	2,990	2,574	170	0	23,800	0	4,250	0	20	115,105	2,574	255	0
B-322-2365	107,354	0	0.06	0.04	2,268	1,501	292	0	40,810	0	8,350	0	720	158,782	1,501	459	0
B-61-2307	1,440	0	0.12	0.06	7,070	3,676	0	0	0	0	0	0	20	8,510	3,676	0	0
J-041-0103	114,632	0	0.85	0.70	29,901	24,663	249	0	34,790	0	7,100	0	220	186,422	24,663	959	0
J-101-2708	67,915	67,606	0.12	0.04	4,330	1,287	163	163	22,750	22,750	4,500	4,500	20	99,496	96,142	433	433
J-221-0025	128,602	0	1.00	0.43	35,056	15,012	208	0	29,050	0	5,750	0	200	198,458	15,012	1,588	0
J-2G-0210	156,285	0	0.77	0.37	45,956	22,059	193	0	46,200	0	5,750	0	380	254,191	22,059	1,573	0
J-2G-0603	237,725	0	2.00	1.00	120,000	60,000	463	0	111,000	0	13,500	0	1,940	482,225	60,000	1,813	0
J-2G-0966	78,183	0	0.12	0.06	7,070	3,676	185	0	44,400	0	5,000	0	52	134,653	3,676	385	0
J-551-0050	87,148	108	0.30	0.22	10,517	7,721	227	0	31,780	0	6,250	0	48	135,695	7,829	602	0
J-651-0451	67,942	0	0.51	0.17	30,755	9,927	150	0	28,500	0	4,750	0	52	131,947	9,927	435	0
K-070-9045	86,550	0	0.38	0.18	22,978	11,029	165	0	39,600	0	5,000	0	52	154,128	11,029	665	0
K-221-2155	65,718	332,243	0.71	0.67	24,746	23,591	126	562	17,570	78,680	3,700	14,050	28	111,734	448,564	496	1,967
K-2G-0908	240,655	0	1.12	0.40	67,167	23,897	460	0	110,400	0	13,250	0	52	431,472	23,897	1,785	0
K-8A-0913	29,551	0	0.07	0.06	4,242	3,309	74	0	17,760	0	1,850	0	28	53,403	3,309	185	0
P-500-0012	1,094,932	0	2.36	1.35	141,403	80,883	2,012	0	382,185	0	59,800	0	56	1,678,321	80,883	7,992	0
P-501-0060	328,937	4,824	1.27	0.80	44,336	27,880	726	0	101,640	0	19,650	0	48	494,563	32,704	2,691	0

Table 17. Total cost comparison (includes VTT system costs)

Costs	Traditional training ($)	VTT training (S)	Trad. - VTT ($)
TAD	3,376,212	404,781	2,971,431
Instructor	1,020,786	672,685	348,101
Travel time	1,221,885	101,430	1,120,455
Travel processing	195,450	18,550	176,900
VTT course implementation	N/A	4,314	(4,314)
VTT equipment	N/A	500,000	(500,000)
VTT communication	N/A	395,520	(395,520)
VTT facilitators	N/A	262,500	(262,500)
VTT managers	N/A	160,000	(160,000)
Total:	5,814,333	2,519,780	3,294,553

Table 18. Comparison of quality-of-life (QOL) benefits

QOL benefits	Traditional training	VTT training	Trad - VTT
Student time away from home (days)	24,590	2,400	22,190

Size and configure VTT network

The VTT analysis tool can be used to size and configure the VTT network. Specifically, it can be used to answer such questions as:

- Should the Navy expand its VTT network and, if so, to where?
- Should the Navy add more VTT classrooms and, if so, where and how many?
- What type of telecommunication service is most economical (i.e., dedicated full-time service vs. pay-as-you-use-it service)?

The best way to determine whether it's cost-effective to add another VTT site is to compute the costs and benefits for two scenarios, one of which represents the baseline network configuration (i.e., the site in question is not a VTT site) and the other represents the expanded network.[20] You then compare the estimated cost savings for both scenarios. If the savings increase, adding this site to the VTT network is cost-effective; otherwise it's not.

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20. To make a fair comparison, the rest of the scenario (with the exception of the training delivery plans) should be the same.

We prefer this approach over simply comparing the difference in training delivery costs (i.e., traditional costs - VTT costs) at this site against the VTT setup and operating costs. This is because you can have situations in which the savings at a particular site are less than the site costs, but the site is still cost-effective because it increases cost savings at other sites. A common example would be a site that serves as an originating site for a lot of training (e.g., because of the availability of instructors) but does not have a large local requirement for this training. The cost to deliver training to this site may be small, but the combined savings at other sites (where students no longer have to travel) can more than offset the VTT setup and operating costs.

The tool can also help determine whether it is cost-effective to add additional classrooms to existing sites. As a quick check, the VTT classroom utilization worksheet tells you if there are enough VTT classrooms to support all the VTT-delivered training in the scenario.

For example, suppose we decide to add ten more courses to the scenario in our previous example. Can that network support this training or are additional VTT classrooms required? Table 19 shows the new VTT classroom utilization. The data show that the VTT facilities at Norfolk and Mayport can't support all this additional training; both sites would need another classroom.

Help determine which courses to deliver by VTT

Because our analysis tool works at the individual course level, it can identify which courses offer the greatest savings if delivered by VTT. In identifying these courses, two measures are of interest: the total savings and the savings rate (or the savings per VTT-classroom-day-used). Total savings represents the difference in delivery costs for that course (i.e., the difference in TAD costs, instructor costs, travel time costs, travel processing costs, and course conversion costs). It does not include the VTT infrastructure costs.

The savings rate, on the other hand, accounts for system use (even though it still does not directly include VTT system costs). It equals the total costs divided by the total number of VTT classroom days used at all sites.

Table 19. VTT classroom requirements and utilization (after adding 10 more courses)

CIN	Total	Nor	DamN	Newp	KBay	May	GL	Ingl	SD	PH	Ban
Total Required	2261	443	395	70	111	223	71	89	515	149	197
Available	3047	406	406	203	203	203	203	203	609	203	406
Available - Required	786	-36	11	134	93	-20	132	114	94	54	210
Utilization	74%	109%	97%	34%	54%	110%	35%	44%	85%	73%	48%
A-493-0071	6	2	0	2	0	0	0	2	0	0	0
A-493-2099	80	15	0	5	5	10	0	5	20	10	10
A-4A-0051	15	2	0	0	1	2	0	0	5	2	3
B-322-1075	3	1	0	0	1	0	0	1	1	1	0
B-322-2120	2	0	0	0	0	0	0	0	1	1	0
B-322-2220	3	1	0	0	1	0	0	1	1	1	1
B-322-2241	3	1	0	0	0	1	0	1	1	1	0
B-322-2320	5	1	0	0	0	1	0	1	1	2	1
B-322-2365	9	2	0	1	1	1	1	1	1	2	1
B-61-2307	20	10	0	0	0	0	0	0	10	0	0
J-041-0103	70	0	10	0	10	10	0	0	20	10	10
J-101-2708	21	6	0	0	0	0	0	0	15	0	0
J-221-0025	210	0	70	0	0	20	0	20	80	10	10
J-2G-0210	180	30	60	0	10	30	0	0	30	10	10
J-2G-0603	145	35	0	10	10	15	0	5	50	10	10
J-2G-0966	26	0	10	0	2	2	0	2	4	2	4
J-551-0050	33	6	0	0	0	6	0	3	9	3	6
J-651-0451	96	54	0	0	0	12	0	3	27	0	0
K-070-9045	95	30	0	0	5	10	5	5	30	5	5
K-221-2155	15	0	5	10	0	0	0	0	0	0	0
K-2G-0908	200	75	0	0	10	20	0	10	65	10	10
K-8A-0913	12	0	0	0	0	0	0	0	6	0	6
P-500-0012	625	115	220	35	35	40	55	15	30	20	60
P-501-0060	165	20	0	0	10	20	0	0	55	25	35
CIN-1	10	1	0	0	0	1	0	1	3	3	1
CIN-2	95	20	0	5	5	10	10	10	15	15	5
CIN-3	12	6	0	0	0	0	0	0	6	0	0
CIN-4	14	0	2	0	2	2	0	0	4	2	2
CIN-5	1	0	0	0	0	0	0	0	1	0	0
CIN-6	21	0	7	0	0	2	0	2	8	1	1
CIN-7	18	3	6	0	1	3	0	0	3	1	1
CIN-8	29	7	0	2	2	3	0	1	10	2	2
CIN-9	13	0	5	0	1	1	0	1	2	1	2
CIN-10	11	2	0	0	0	2	0	1	3	1	2

As discussed earlier, deciding on which courses to deliver by VTT also depends on overall system use. If the system is utilized at or near capacity, then delivering courses with the highest savings rate will result in the greatest savings. If, however, the system is significantly underutilized, delivering courses with the greatest total savings may be warranted.

Assist VTT schedulers and network managers

By enabling the user to examine how changes to the training scenario delivery plan affect capacity utilization and training delivery costs, the VTT analysis tool can help VTT network managers/schedulers put together a schedule (i.e., a training delivery plan) that maximizes overall cost-effectiveness.[21] The following are examples of the types of issues that can be addressed.

For new VTT courses, the tool can help determine where the originating site (or sites) should be. For courses that have more than one originating site, it can help determine which remote sites each originating site should serve. (Changing the number of remote sites that an originating site serves will most likely change the VTT classroom utilization at that site. In fact, this is one way to more evenly distribute classroom utilization across sites, acknowledging that other issues (such as time zone differences) come into play.)

For VTT sites that cannot accommodate all the scenario-defined VTT training, this tool can help determine the most cost-effective way to resolve this situation. If the only option is to send students for some courses to other sites for training, this tool can assist in determining which courses to choose.

This tool can also help determine the most cost-effective traditional training delivery plan. For example, it allows you to estimate and compare the costs of exporting training (i.e., sending instructors to student locations) to the costs of having students travel to the training

21. When we say schedule, we mean how (i.e., by which method) each course is delivered to each locations, not the exact dates of each course convening.

sites. It also allows you to do a first-cut determination as to whether it would be more cost-effective to stand up a course at a particular location (say, where the demand is high) or to have students at that location travel elsewhere for training.

Other VTT issues

Our methodology looks at the costs and QOL aspects of using VTT technology to deliver schoolhouse training to active-duty Navy personnel. Although these are usually considered the most important issues when assessing the overall value of VTT to the Navy, there are other issues to consider. They include the effectiveness of VTT-delivered training, other types of training benefits (besides monetary), and the benefits of other potential uses of VTT technology besides training. In this section, we briefly discuss these other issues.

Effectiveness of VTT-delivered training

Our methodology does not directly address training effectiveness (i.e., whether students learn as much in a VTT environment). As stated earlier, we assume that for the courses listed in the user-defined scenario, the effectiveness of VTT training is on par with the effectiveness of traditional training.

Past research indicates that VTT-delivered training is effective. CNA analyzed the effectiveness of VTT training during the first 2 years of CESN operations, finding only a slight degradation in mean test scores between students at remote and originating sites and no statistically significant difference in failure rates [10, 11]. NPRDC examined the effectiveness of several different types of VTT systems. Based on both student performance and student and instructor acceptance, it found that 1) several forms of VTT systems were effective, and 2) students who received training through higher end systems (such as CESN) performed slightly better [12, 13].

But what if, for some courses, there is a degradation in effectiveness? In these cases, the Navy needs to compare the cost savings against the level of degradation. If the degradation is small and the savings large, VTT may be the way to go. On the other hand, if the degradation is significant (e.g., a large increase in the course failure rate), VTT might not be warranted even if the overall TAD savings were high. (Our methodology does not consider the additional costs of higher failure rates, such as the need to put more people through training to compensate for those who fail.) The key issue here, and one that probably can be answered only by educational experts, is what level of degradation is acceptable given the potential savings. If TAD funds continue to decrease, it may become a question of providing degraded training to providing no training at all.

What types of training can be delivered using VTT?

The obvious question that stems from the above discussion is what types of training can be effectively delivered using VTT. To date, nearly all the training delivered using VTT has been lecture-based instruction. But is this the only type of training that can be delivered? Or can other types (e.g., courses with hands-on laboratory sessions or learning environments that are highly interactive) also be effectively delivered by VTT? The answer seems to be that although the nature of VTT training may make it more difficult to conduct these types of training, it does not preclude them.

NPRDC studied the feasibility of delivering courses other than traditional lecture-based courses using VTT [2–7]. In its study, NPRDC evaluated the following four courses:

- *Celestial Navigation*, which contains hands-on laboratories involving difficult computations and plotting
- *Navy Leadership*, which involves high levels of instructor-student and student-student interaction
- *Fiber Optic Cable Repair*, which includes instructor demonstrations and several challenging student laboratory sessions
- *Quality Assurance*, which includes a hands-on laboratory session.

NPRDC concluded that, from an instructional effectiveness perceptive, it is feasible to deliver some laboratory courses by VTT, although in some cases, it may require changing the way the course is taught.

This is an important finding because it greatly expands the number of courses that should, at least, be considered for delivery by VTT. In its report, NPRDC referenced a survey in the mid-1980s that showed that training administrators identified some form of laboratory work in as many as three-fourths of their courses. Thus, if a requirement for any laboratory training were used as a discriminator for identifying candidate courses for VTT delivery, the list of courses for consideration would be greatly reduced and some opportunities missed.

Other training benefits

In an earlier section, we discussed training benefits other than cost savings that could result from using VTT. Aside from the QOL measure, we did not include these in our methodology, primarily because we could not identify quantitative measures or obtain the necessary data. These benefits, however, should be considered.

Amount of training conducted

Instead of focusing on the dollars saved or avoided, one could argue that the real benefit of VTT is that it allows the Navy to provide more training. For example, if TAD funds to provide all required training the traditional way are not available (which most people would agree), the Navy may never see actual savings from using VTT. However, it would be able to provide a lot more training at no extra costs. Unfortunately, it is difficult to compute how much more because of the way TAD funds are allocated and the fact that these funds support travel other than for training. VTT also increases training throughput simply because more people are likely to go through training if it is offered locally, even if TAD funds are not a constraint.

Just-in-time training

We mentioned that VTT, particularly the ability to deliver VTT training to ships at sea, enables the Navy to conduct more just-in-time training. Most people would consider this a benefit—one that should improve readiness. Unfortunately, it's difficult to measure readiness. It is even more difficult to relate individual components of training (of which VTT is one) to readiness.

Other uses of VTT technology

Although training is the principal function of the Navy's VTT system, this technology can support other functions—most notably video teleconferencing, education, and telemedicine. Although we do not consider the cost benefits of these uses in our methodology, they are important to consider.

Video teleconferencing

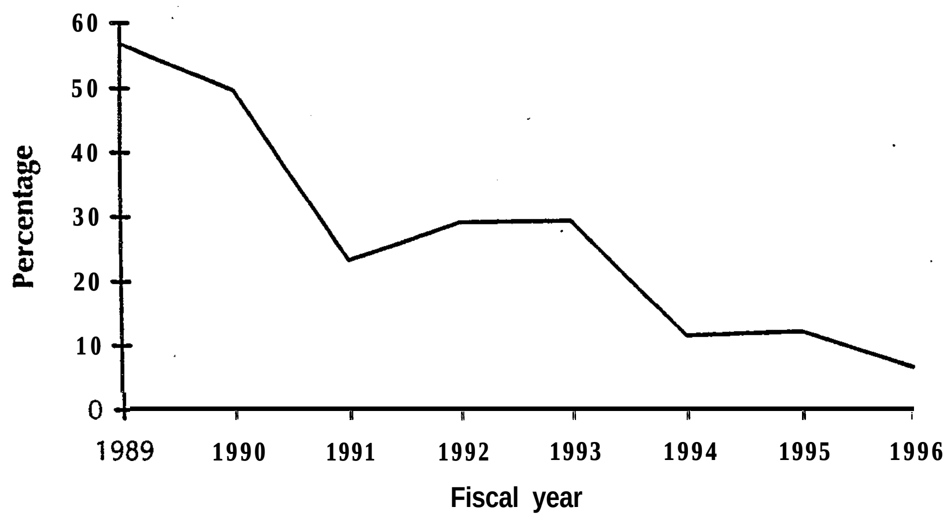
The Navy's VTT system has and will continue to support video teleconferencing (VTC) on a not-to-interfere basis with training. The CESN system can be used for VTC during lunch hours, after hours, or during days when the classroom is not scheduled for training.

The VTT program office has compiled cost avoidance data by fiscal year for CESN operations. They break out the cost avoidance due to VTT (based on student participation) and due to VTC (based on conference attendees). Figure 4 shows the percentage of the total cost avoidance due to VTC by fiscal year. The data show that in the beginning, the majority of savings came from VTC. Since then, however, the percentage has declined significantly and, during FY 1996, accounted for only about 10 percent. Presumably, the reason for this is a greater focus on using VTT for training and more courses being taught using VTT.

Education

VTT can make it easier for fleet sailors to further their education by providing local access to various military and civilian educational institutions. For example, CESN can communicate with the Naval War College and the Naval Post Graduate School, as well as with civilian institutions and industry. This should improve the quality of life, especially at sites where access to quality educational institutions is limited, and should increase the quality of Navy personnel.

Figure 4. Percentage of the total CESN cost avoidance due to video teleconferencing



Telemedicine

One aspect of telemedicine is to transfer. **information** using full motion video between ships at sea and medical facilities ashore. This technology gives medical personnel at sea the ability to send data, such as a digitized x-ray, to a specialist ashore and then to consult, in real time, with that specialist. The ability to perform consultations in this manner has the potential to avoid costly medical evacuations, as well as improve the health of deployed sailors and Marines.

The Navy has demonstrated the use of the technology through various initiatives involving USS George ***Washington (CVN-73),*** USS Carl *Vinson* (CVN-70), McMurdo Station, Antarctica, and Naval Hospitals at Bethesda, Portsmouth, and San Diego. The Navy is planning to install telemedicine capability on 350 ships, in selected Fleet Marine Force units, and at 25 shore facilities. CNA is currently conducting a study for the Surgeon General that will look at the extent to which the use of this technology might offset some of the costs.

Maintenance and logistics support

VTT technology can also support maintenance and logistics functions. One way is by allowing subject matter experts ashore (or perhaps on other ships) to support maintenance functions at sea. This technology can, in some instances, allow these experts to view and help diagnose the problem, then assist the crew in the proper maintenance procedures.

Appendix A: Description of VTT analysis tool

This appendix describes the computer-based analysis tool we developed to analyze the costs and benefits of delivering Navy training by VTT. We start with a brief overview and then describe, in detail, how to use the tool.

Overview

The analysis tool is an Excel spreadsheet model. It comprises the following five Excel files (or workbooks).

- **TRNGREQ.XLS**, which is used to define part of the training scenario and compute training requirements for each course by location
- **SUPDATA.XLS,** which contains data used in calculating training delivery costs and QOL measures
- **VTTCOST.XLS**, which is used to define the delivery plan, to analyze VTT classroom capacity, and to compute delivery costs and QOL measures for VTT training
- **TRADCOST.XLS**, which is used to define the delivery plan and to compute delivery costs and QOL measures for traditional training
- **COMPCOST.XLS**, which is used to aggregate, compare, and summarize delivery costs and QOL measures for traditional training and VTT training.

Each of these files contains a set of worksheets (i.e., spreadsheets) and macro programs. There are two types of worksheets.[1] One contains data sets that are used to define the training scenario or support the

1. There are actually three types of worksheets. The third type is a combination of the first two; it contains both data and results.

cost calculations. The user is responsible for making sure these data sets are complete and reflect the desired scenario. The other type of worksheet contains output from the model's computations. In these worksheets, the user executes a macro program by clicking on a button, and the program outputs its results into a pre-formatted table with labels and header information. To help distinguish between the two types of worksheets, we color-coded the cells in each spreadsheet according to the following scheme:

- **Yellow** indicates user-defined data. The user can enter or edit data in any yellow cell.
- **Blue** indicates model output. Light blue indicates output at the course-location level, whereas dark blue indicates aggregated (i.e., summed) output at the course or location level. The user should not directly change the contents of blue-colored cells. This should be done only by running the macro programs.
- **Gray** indicates labels and header information. Course identification numbers and location names are automatically updated when the training scenario is changed.

To update a computation worksheet, click on the button at the top of the worksheet. The program will clear the current output, and Excel will display an hourglass while the program is executing. Upon completion, the model will update the date and time of this computation in the upper left portion of the spreadsheet. Use this to keep track of which worksheets have been or need to be updated.

Some worksheets contain other useful information. Warning notices (colored red) warn the user that other worksheets should be updated before performing the calculations on this sheet. Worksheets used to define the training delivery plan contain information keys (colored light green) that define the permissible data entry options.

Using the analysis tool

To use this tool, follow these five steps:

- *Step 1*. Use **TRNGREQ.XLS** to define the VTT courses and locations to include in the training scenario and to enter or compute training requirements for each course at each location.

- *Step 2*. Review the data sets in **SUPDATA.XLS.** Make sure each one is complete, up to date, and reflects the desired scenario.
- *Step 3*. Use **VTTCOST.XLS** to (a) define the VTT training delivery plan, (b) define the VTT network and compute VTT classroom utilization, and (c) compute delivery costs and QOL measures for VTT training.
- *Step 4*. Use **TRADCOST.XLS** to define the delivery plan and compute delivery costs and QOL measures for traditional training.
- *Step 5*. Use **COMPCOST.XLS** to compare, by course, the delivery costs and QOL measures for traditional training and VTT training, and to calculate the overall costs or savings of using VTT for this particular scenario.

We now describe each of these steps (i.e., how to use each file) in more detail.

TRNGREQ.XLS

TRNGREQ.XLS consists of seven worksheets. Use the first two to define the training scenario and the remaining five to enter or compute the training requirements for each course by location.

Define the training scenario

Descriptions of worksheets 1 and 2 follow:

1. ***VTT Courses:*** Use this worksheet to list the courses and training events to be delivered by VTT. Define a course or training event by its Course Identification Number (CIN) and its title. Each course or training event must have a unique CIN.[2] If a formal CIN does not exist, make one up (i.e., use something like “CIN1” or “CINA,” as long as it’s unique). After listing the courses, enter the row numbers of the first and last course in the list where requested.

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2. Each course / training event must have a unique CIN because the model uses the CIN as an index in retrieving course data from other worksheets.

2. ***Locations:*** Select the locations to include in your scenario. Including a location means the model will calculate the costs to train people at that location. Deciding on which locations to include depends on the analysis objective. If the objective is to estimate the costs and benefits of a specific VTT network, you might only need to include locations where VTT classrooms exist.[3] If, on the other hand, the objective is to identify candidate sites for expanding the network, you probably want to include all potential VTT locations (i.e., all locations with a significant number of naval personnel). The model currently contains a list of 48 locations, with the locations that already have VTT facilities listed first. After entering the desired locations (specified by name and abbreviation), enter the row numbers of the first and last location where requested.

Compute training requirements

Our methodology requires that we define for each course the number of people who need to take that course at each location. In appendix B, we describe a procedure for projecting these requirements.

To compute course-location requirements from unit-level requirements, follow these steps:

1. ***Unit Trng Req:*** Use this worksheet to define the unit-level course requirements for each ship and submarine class and each type of aviation squadron. These requirements represent the average number of people from a single ship, submarine, or squadron who need to take the course each year. This worksheet contains 47 unit types: 27 ship classes, 3 submarine classes, and 17 aviation squadrons.

2. ***Force Laydown:*** Use this worksheet to define the force structure and its laydown (i.e., where the units are stationed). Specify by class the number of ships, submarines, and aviation squadrons

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3. This is not entirely true because VTT can still produce benefits at locations where no VTT facilities exist. For example, VTT can reduce travel costs by providing training to a remote site that is closer to the student's home location than where the course is taught live.

that are stationed at each location. The spreadsheet automatically totals the number of units by type and by location.

3. ***Force Structure Trng Req:*** This worksheet computes, for each location, the number of people from operational units (i.e., ships, subs, squadrons) who need to take each course. Simply click on the button at the top of the worksheet.

4. ***Shore Trng Req:*** Use this worksheet to define, by course and location, the training requirements for shore-based personnel (i.e., those people not assigned to operational units). Alternatively, if you choose to define *total* training requirements directly (e.g., using historic data), enter the data in this worksheet.

5. ***Total Trng Req:*** This worksheet computes the total training requirements for each course at each location by summing the operational unit requirement and the shore-based requirement. Simply click on the button at the top of the worksheet. The results serve as the training requirements input for the cost-benefit analysis.

SUPDATA.XLS

This file contains data sets used in calculating training delivery cost and QOL measures. Make sure the following five worksheets are complete.

1. ***Course Data:*** This worksheet contains course-specific information, such as the length of training, maximum class size, student-to-instructor ratio, type of instructor (officer or enlisted), maximum number of remote sites that can be taught at one time, and an instructor cross-utilization factor (i.e., whether instructors who teach this course can also teach other courses). Make sure this data set contains each course listed in your scenario and that all the data fields are filled in. It's all right if this data set contains courses that are not in the training scenario, as they will not be part of the calculations.

2. ***Travel Fares:*** This worksheet contains the two-way transportation costs between any two Navy locations. If you add a new location to the list, you will need to enter the transportation costs between this and every other location.

3. ***Travel Days:*** This worksheet contains the two-way travel time (in days) between any two locations. As before, if you add a new location, you will need to enter the travel time between this and every other location.

4. ***Per-Diem Rates:*** This worksheet contains per-diem and lodging rates at each location. It includes on-base meal and lodging rates for officers and enlisted personnel, off-base meal and lodging rates, and the percentage of students who stay on- and off-base. If you add a new location, you will need to enter these data.

5. ***Other Parameters:*** This worksheet contains user-defined values for eight parameters used in the cost calculations. They include the average costs of an officer and an enlisted person, the instructor preparation and related duties (IPRD) factor for teaching a traditional course and a VTT course, and the percentage of students, as defined by the training requirements, that actual get trained (i.e., quota utilization).

VTTCOST.XLS

Use this workbook to define the training delivery plan, analyze VTT-classroom capacity, and compute the costs and benefits of delivering the training by VTT. ***TRNGREQ.XLS*** and ***SUPDATA.XLS*** must be open to execute the programs in this file.

Define the training delivery plan

Define the training delivery plan for VTT training using the following four worksheets:

1. ***Trng Plan:*** Use this worksheet to define, for each course and training event, how the Navy will train people at each location under a VTT scenario. Six permissible options exist: (1) teach the course by VTT with that location serving at a VTT originating site (enter “VTT-O”), (2) teach the course by VTT with that location serving at a VTT remote site (“VTT-R”), (3) teach the course traditionally in-house at a local training activity (“Local”), (4) export the training by sending instructors to that site (“MTT”), (5) send people to a location where the course is

offered ("Travel"), or (6) do not train people at that location ("None"). You must define an option for every course-location combination.

2. ***Travel Loc:*** Use this worksheet to define, for those course-location combinations where students must travel, the location to which they will travel. Define the location by its abbreviation. It's critical that you use the same abbreviations that are in the header.

3. ***MTT Loc:*** Use this worksheet to define, for those course-location combinations where the training is exported (designated "MTT" in "Trng Plan"), the location where the instructor comes from (i.e., the instructor's home location). Again, use the exact location abbreviations as listed in the header.

4. ***Orig Site:*** Use this worksheet to define, for those locations where the course is delivered at a remote VTT site, the originating VTT site for that course and location. If a course has only one originating site, enter that location for all remote sites. If more than one originating site exists, determine which site will feed each remote site. As before, be sure to use the correct location abbreviations.

Define the VTT network and compute classroom utilization

Use the following five worksheets to define the VTT network and compute VTT classroom utilization.

1. ***Crs-Loc Throughput:*** This worksheet computes, for each course, the number of students who will be trained at each location where the course is offered.

2. ***VTT Course Convenings:*** This worksheet computes, for each course and location, the number of times the course must convene in a VTT classroom to accommodate all the students who will be trained at that location.

3. ***Non-VTT Course Convenings:*** This worksheet computes, for each course and location, the number of times the course will convene in a regular (i.e., traditional) classroom.

4. ***VTT Network Config & Costs:*** This worksheet serves two functions. First, use it to define the VTT network. Define, for each location, the number of VTT classrooms, the number of days each classroom is available per year, and the scheduling inefficiency factor (i.e., a realistic utilization rate that accounts for inefficiencies due to scheduling). Also use this worksheet to define the equipment costs for each classroom, the type of communications at each site, the fixed and variable communications costs, and the number of facilitators needed. The worksheet computes the total equipment costs, communications costs, and facilitator costs for each site.

5. ***VTT Classroom Days:*** This worksheet computes the number of VTT classroom days required at each site to support the VTT training scenario. It also compares these requirements to the number of available classroom days to determine if the VTT network can support the VTT training. Sites where the requirement exceeds the capacity are color-coded red.

If the VTT classroom requirement exceeds the network capacity at any site, you must either reduce the number of VTT courses (in file TRNGREQ.XLS) or change the training delivery plan (e.g., teach some courses the traditional way or change the originating site). After making these changes, repeat the above process to make sure the new scenario can be accommodated.

Calculate training costs and QOL measures

Use the remaining worksheets in VTTCOST.XLS to compute the costs and QOL measures for delivering training by VTT. You can compute these measures in any order with two exceptions: (1) you must compute transportation costs and per-diem costs before computing total TAD costs, and (2) you must compute total course costs last.

6. ***Transportation Costs*:** This worksheet computes the transportation costs in sending students to other locations for training and in sending instructors to export training. The worksheet assigns the costs to the students' (or instructors') home locations (e.g., the cost to send 50 sailors from Mayport to Norfolk for training gets assigned to Mayport).

7. ***Per-Diem Costs*:** This worksheet computes the per-diem costs (i.e., meals & incidental expenses and lodging costs) in sending students to other locations for training and in sending instructors to export training. As with transportation costs, the worksheet assigns the costs to the students' home locations.

8. ***Total TAD Costs*:** This worksheet computes the total TAD costs for each course-location pair by summing the transportation and per-diem costs.

9. ***Instructor Costs*:** This worksheet computes the number of instructors (in fractions) required to support the training conducted at each location. The worksheet assigns the instructor requirement for exported training to the instructor's home location (as designated in "***MTT Loc***").

10. ***Travel Time Costs:*** This worksheet computes the time students spend traveling to and from their training locations. The worksheet assigns this time to the students' home locations.

11. ***Travel Processing Costs:*** This worksheet computes the number of travel claims that need to be processed. The worksheet assigns this measure to the students' home locations.

12. ***Time Away Costs*:** This worksheet computes the number of days students are away from home because of training. This includes the time at the training location and the time traveling to and from that location.

13. ***Course Implementation Costs***: The worksheet computes the cost to convert and equip a course for delivery using VTT. The user needs to enter the conversion costs and the costs of the material at each remote site. The program determines the number of remote sites based on the training delivery plan and calculates the total costs.

14. ***Total Course Costs:*** This worksheet consolidates all the training costs associated with delivering each course. It converts student travel days to manpower costs and calculates the cost to process all the travel claims. It also computes the total cost for each course, displays the number of students trained, and computes the average delivery cost per student.

TRADCOST.XLS

Use this workbook to estimate the costs of delivering the user-defined training the traditional way (i.e., sending students to where the training is offered or sending instructors to where the student are). ***TRNGREQ.XLS*** and ***SUPDATA.XLS*** must be open to execute the programs in this file.

Define the training delivery plan

Use the first three worksheets to define the training delivery plan:

1. ***Trng Plan:*** Use this worksheet to define, for each course and training event, how the Navy will train people at each location. There are four permissible options: (1) teach the course in-house at a local training activity ("Local"), (2) export the training by sending instructors to that site ("MTT"), (3) send people to a location where the course is offered ("Travel"), or (4) do not train people at that location ("None"). You must define an option for every course-location combination.
2. ***Travel Loc:*** Use this worksheet to define, for those course-location combinations where students must travel, the location they will travel to. Define a location by its abbreviation. It's critical that you use the same abbreviations that are in the header.
3. ***MTT Loc:*** Use this worksheet to define, for those course-location combinations where the training is exported (i.e., designated MTT in "Trng Plan"), the location where the instructors come from (i.e., the instructor's home location). Again, use the exact location abbreviations as listed in the header.

Calculate cost and QOL measures

Use the remaining worksheets in TRADCOST.XLS to compute the cost and QOL measures for delivery of training the traditional way. Before computing these measures, however, you must first compute two intermediate measures. The first is the number of students who will be trained at each location where the training is offered. The second is the number of course convenings at each of these locations.[4] After that, you can compute the cost and QOL measures in any order with two exceptions. You must compute the transportation costs and per diem costs before you compute the total TAD costs, and you must compute the total course costs last.

1. ***Crs-Loc Throughput***: This worksheet computes, for each course, the number of students who will be trained at each location where the course is offered.

2. ***Course Convenings***: This worksheet computes, for each course, the number of times the course must convene at each location to accommodate all the students who will be trained at that location.

3. ***Transportation Costs*****:** This worksheet computes the transportation costs in sending students to other locations for training and in sending instructors to export training. The worksheet assigns the costs to the students' (or instructors') home locations (e.g., the cost to send 50 sailors from Mayport to Norfolk for training is assigned to Mayport).

4. ***Per-Diem Costs***: This worksheet computes the per-diem costs (i.e., meals & incidental expenses and lodging costs) in sending students to other locations for training and in sending instructors to export training. As with transportation costs, the worksheet assigns the costs to the students' home locations.

5. ***Total TAD Costs***: This worksheet computes the total TAD costs for each course-location pair by summing the transportation and per-diem costs.

6. ***Instructor Costs***: This worksheet computes the number of instructors (in fractions) required to conduct the training. The worksheet assigns the instructor requirement for exported training to the instructor's home location (as designated in "***MTT Loc"***).

7. ***Travel Time Costs***: This worksheet computes the time students spend traveling to and from their training locations. The worksheet assigns this time to the students' home locations.

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4. Recall in working through the VTT workbook that we computed these measures in analyzing the capacity of the VTT network.

8. ***Travel Processing Costs***: This worksheet computes the number of travel claims that need to be processed. The worksheet assigns this measure to the students' home locations.

9. ***Time Away Costs***: This worksheet computes the number of days students are away from home due to training. This includes the time at the training location and the time traveling to and from this location.

10. ***Total Course Costs***: This worksheet consolidates all the training costs associated with delivering each course. It converts student travel days to manpower costs and calculates the cost to process all the travel claims. It also computes the total cost for each course, displays the number of students training, and computes the average cost per student.

COMPCOST.XLS

Use this workbook to compare, by course, the delivery costs and QOL measures for traditional training and VTT training and to calculate the overall costs or savings of using VTT. ***TRNGREQ.XLS, TRADCOST.XLS***, and ***VTTCOST.XLS*** must be open to execute the programs in this file.

1. ***Course Costs***: This worksheet displays, side-by-side, the costs and QOL measures to deliver a course the traditional way and by VTT. It computes the total costs for each method and the difference. It's important to understand that these costs do not include the costs to equip and operate the VTT network.

2. ***Cost Summary***: This worksheet computes the overall costs to deliver the training the traditional way and by VTT. It includes the costs to equip and operate the VTT network. In fact, it computes VTT system overhead costs based on the following user input: (1) the number of network managers and their average salary and (2) the number of multipoint control units and their annual operating (or lease) costs.

3. ***Course Savings Rate***: This worksheet computes the cost rate to deliver each course by VTT. It totals the delivery costs for each course and adds a pro-rated VTT network costs—based on the number of VTT classroom days required by that course.

Appendix B: Method to project training requirements

This appendix describes a methodology for projecting how many people at each location need to take a course each year. We've incorporated this methodology into our VTT analysis tool.

To project course requirements by location, we split the Navy into two groups: personnel assigned to operational units (i.e., ships, submarines, and aviation squadrons) and all other personnel. (We refer to this latter group as "shore" personnel, although we recognize that this group includes personnel assigned to operational units other than ships, submarines, and aviation squadrons.)

To estimate the demand for operational personnel, we first define the course requirements for each ship and submarine class and each aviation squadron type— in terms of the average number of people from a single unit who require this training each year. Table 20 shows a sample data set. In this example, each DDG-51 ship will send, on average, two people to course A and five people to course C each year.

Table 20. Sample unit requirements data set

Course	DD-963	DDG-51	CG-47	FFG-7	SSN-688
A	2	2	3	2	3
B	4	0	0	2	0
C	0	5	5	0	0
D	0	0	0	0	2

Both the surface and submarine communities define their formal fleet course requirements in this way. Appendix D of the *Surface Force Training Manual* contains course requirements for each ship class, and SUBNOTE 1500 contains course requirements for each submarine class [14, 15].

Once we've defined the unit requirements, we now need to define a force structure and a laydown of these forces by geographic location. That is, we need to specify how many of each ship and submarine class and how many of each aviation squadron type are stationed at each location. We then compute the course demand at each location by multiplying the unit requirements times the number of units and summing over all unit types, that is

$$Op\_Req(crs, loc) = \sum_{type} [Unit\_Req(crs, type) \times \#Units(type, loc)] \quad ,$$

where *Unit_Req(crs,type)* is the course requirement for each unit type and *#Units(type,loc)* is the number of units by type and location.

Some courses delivered by VTT may also have a significant training demand from "shore" personnel. To account for this, we need to define another data set that contains the shore demand for each geographic location. We can either use historical data to define these requirements or estimate the requirements by looking at the number of shore billets within an area and tying training requirements to billets—based on rating, NEC, job function, or shore activity.

To obtain the total course requirement, we simply add the shore demand and the operational forces demand, that is

$$Tot\_Req(crs, loc) = Op\_Req(crs, loc) + Shore\_Req(crs, loc) \quad .$$

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