DATABASE INTEROPERABILITY — THE CCTT TO AVCATT CONVERSION EXPERIENCE

Michael Fortin - L3 Link Simulation & Training
Rita Simons — STRICOM
Michael Butterworth — Northrop-Grumman

ABSTRACT

The Aviation Combined Arms Tactical Trainer — Aviation (AVCATT-A) program is the newest rotary wing aircraft simulator to be fielded to the U.S. Army. A significant requirement of AVCATT is interoperability with the Close Combat Tactical Trainer (CCTT) armor simulators. In order to facilitate interoperability the U.S. Army Simulation, Training, and Instrumentation Command (STRICOM) further required that the AVCATT databases be derived from existing CCTT databases. The CCTT databases were therefore converted to be compatible with the AVCATT image generation platform. This conversion occurred at several levels and addressed multiple issues.

- The primary conversion media was to be the SEDRIS Transmittal Format (STF).
- The basic format of the visual database had to be converted from a hybrid list priority/range buffer priority architecture to a full z-buffer priority implementation
- Correlation issues with derived databases for other simulation systems.
- The program driven performance requirements implied an order of magnitude improvement in performance for the AVCATT image generators.
- Addition of aviation related features and special effects.
- A difference in the number and types of simulated sensors had to be accounted for.
- Subtle modifications to the database texture maps and models were required so that they could be viewed from elevated eyepoints rather than ground level.

These issues combined to make the conversion of the databases a complex and demanding effort. This paper will discuss how STRICOM and L3 have cooperated to accomplish this task, the methods that have been employed, some of the challenges encountered, and the degree to which the effort has been successful. Finally there will be some discussion of how the techniques used in this conversion might be applied to other databases and other programs, as well as suggestions for future database requirements to better facilitate similar conversions.

ABOUT THE AUTHORS

Michael Fortin joined L3 Link Simulation & Training (then Rediffusion Simulation) in 1974. He has been involved in many technical areas of visual simulation including Visual Database development and production, Technical Marketing and Product Management. His experience covers a wide range of real-time computer graphics devices from the early Rediffusion Novoview systems to today s state of the art systems from various manufacturers. He is currently in Visual Systems Engineering at Link in Arlington (Texas) working on the integration of new image generation products, databases and display devices to meet current applications. Mr. Fortin received his bachelor's degree in math from Florida State University and served as a Naval Aviator prior to joining Link.

Rita Simons is currently a Visual Systems Engineer at STRICOM, responsible for the visual system requirements on the Aviation Combined Arms Tactical Trainer — Aviation (AVCATT-A) reconfigurable manned simulator. She is also the lead on three visual technology SBIRs. She earned a Bachelor of Science degree in Electrical Engineering from the University of Central Florida (UCF) in Orlando, FL and is currently pursuing a Master of Science degree in Simulation at UCF.

Michael R Butterworth is a Principal Member of the Technical Staff for Northrop Grumman Information Technology Defense Enterprise Solutions in Orlando Florida. He leads the Virtual Technology Functional Area for Simulation Technologies Department. He previously supported the CCTT and AVCATT Visual Team. He now leads the SNE Standards and Common Models Standards work for Distributed Mission Training (DMT) Operations and Integration (O&I). He holds a M.B.A. in Management from Western International University and a B.S. in Computer Science from East Tennessee State University.

DATABASE INTEROPERABILITY — THE CCTT TO AVCATT CONVERSION EXPERIENCE

Michael Fortin - L3 Link Simulation & Training
Rita Simons — STRICOM
Michael Butterworth — Northrop-Grumman

INTRODUCTION

The Aviation Combined Arms Tactical Trainer — Aviation (AVCATT-A) program is the newest rotary wing aircraft simulator to be fielded to the U.S. Army. It is also the latest member of the U.S. Army Combined Arms Tactical Training (CATT) network. It will eventually be networked to other CATT simulators and training units, including the Close Combat Team Training (CCTT) and Fire Support Combined Arms Trainer (FSCATT). In addition to state of the art networking capabilities the individual simulators also have some new innovations. Along with being transportable, each simulator (or manned module) can be reconfigured to one of five helicopter configurations (CH-47, OH-58D, UH-60A/L and AH-64A&D). The RAH-66 Comanche implementation is currently being defined and will be implemented in 2004. AVCATT is one of the first training systems to incorporate a helmet mounted display (HMD) to deliver the visual scene to the pilots. The AVCATT trailers include an extensive Battle Master Control facility and an After Action Review theater[1] (see Figure 1). The system also includes a Sensor Video Recording System (SVRS) that records all sensor video from the manned modules and makes it available during the mission and for the after action review[2].

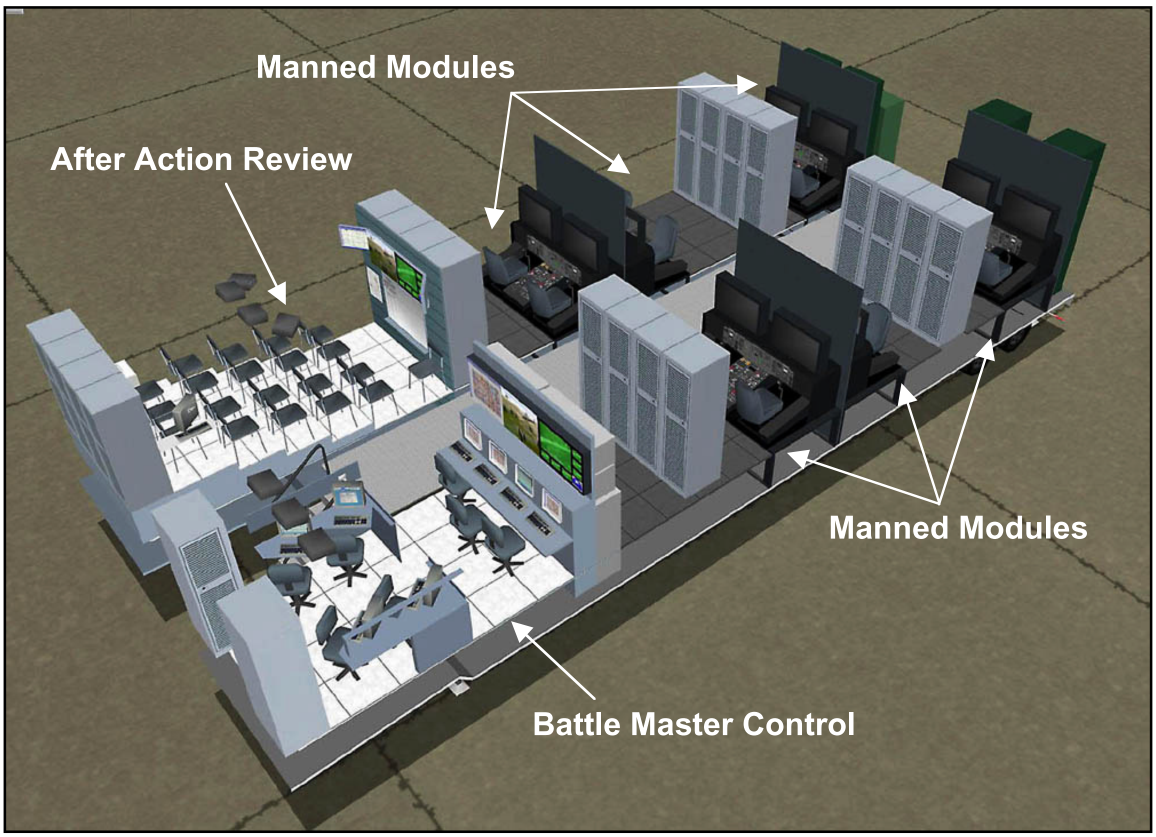


Figure 1 - AVCATT-A Trailers Showing the Mobile Configuration

Interoperability Requirements

It was determined that the optimum method of facilitating interoperability between CCTT and AVCATT was to convert the CCTT visual database to run on the AVCATT image generators (IG).

This conversion was one of the initial requirements for the AVCATT program. AVCATT was further determined to require Level 3 Interoperability as defined for CATT programs[3]. The intent is to allow the CCTT and AVCATT simulators to operate together and to provide the conditions for a "fair fight" between them. Terms like interoperability and fair fight are difficult to define and quantify. It is significant that two key definitions of fair fight (from SEDRIS[4] and DMSO[5]) refer to the degree that the differences between systems are compensated for rather than the degree to which things are made to match. One of the basic difficulties with fair fight is in determining the real-world condition. It is not clear, for example, how to quantify fair fight between helicopters (elevated, longer range sensors) and armored vehicles (on the ground, behind cover, limited sensors). The fair fight environment provided by interoperable training devices must eventually be measured against real-world conditions for the same combatants. It was with these factors in mind that the conversion of the CCTT database was undertaken. It was clear from the start that the resulting databases would not, in fact could not, be exactly the same.

BRIEF HISTORY OF CCTT DATABASE ACTIVITIES

CCTT database history began with the development of the Primary 1 (P1) Forest database and the Primary 2 (P2) Desert database. The P1 database is a 100 km x 150 km area of central Germany. The P2 database is a 100 km x 150 km of the National Training Center (NTC) in southern California. The construction of these two databases evolved a process that the other CCTT databases have refined. CCTT is constructing four additional databases; Ft. Hood (P3), Kosovo (P4), Korea (P5), and Grafenfels (P6).

The Evans and Sutherland (E&S) EaSIEST database development toolset was used to develop the master database from the various data sources. The internal format of EaSIEST is called the General Database Format (GDF). From the GDF database, the visual runtime database was compiled. This is used by the E&S ESIG IGs to create the 3-D visual training scene. Data was extracted from the GDF database to develop the proof plots and color masters for the generation of the paper maps. The GDF database was processed to extract data in the Standard Simulator Data Base (SSDB) Interchange Format (SIF) as specified in MIL-STD-1821. The SIF data was created to allow for archiving the fundamental polygonal database as well as for interchange of the CCTT terrain database with other training systems. The GDF database was also processed to extract data in the CCTT-unique SIF++ format, which was then reduced by the CCTT API pre-process to prepare the data for compiling into the derived Correlated Databases (CDB). The CDB required different formats and data content depending on their utilization within CCTT to ensure their associated simulations could support the system s real time requirements. Dedicated compilers to produce the Plan View Display (PVD) Database, Communications Database, Model Reference Terrain Database (MrTDB), and Multi-level Routing Support Terrain Database (MrsTDB) generated the derived databases. The MrTDB and MrsTDB are sometimes referred to as the Semi-Automated Forces / Computer Generated Forces (SAF/CGF) database.

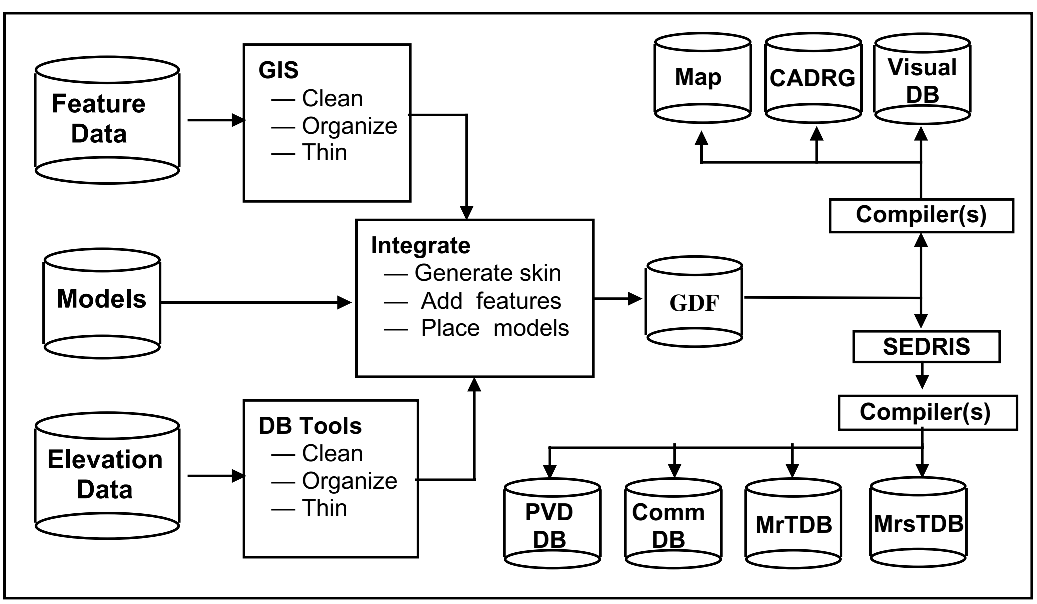


Figure 2 - CCTT Database Production Process

The original CCTT process began by consuming the NIMA source data, DTED elevation data, Interim Terrain Data (ITD) feature data and Digital Feature Analysis Data (DFAD) feature data. The source data was merged, cleaned, and thinned to create the GDF database. The SIF database was replaced with a SEDRIS Transmittal Format (STF) database beginning with the Ft. Hood database. The STF database completely replaced the SIF++ database in the Korea database effort. The current CCTT process is shown in Figure 2.

Resulting SEDRIS Data

The CCTT SEDRIS process evolved over the space of 2_ years. The SIF++ had been a constant source of confusion and errors since the beginning of CCTT. It was decided early that since the SEDRIS STF was going to replace the SIF++, and that the SEDRIS data model better supported feature type data elements, that it would be a good time to re-evaluate the data content exported from the GDF. The CDB engineers (consumer side) sat down with the Visual DB engineers (producer side) to work out a Transmittal Content Specification Requirement (TCRS). This has been documented into the CCTT SEDRIS TCRS. This specification defines the data needed for the CCTT CDB process.

This newly defined process allowed for a more consistent method of building the CDB's and provided for a better environment for test tools to check the quality of the transmittal. Some of these test tools were created just for CCTT and some were the existing SEDRIS test tools. This has led to more errors being found and corrected.
There were several difficulties with SEDRIS that were resolved by improvements and fixes with subsequent SEDRIS versions. CCTT started to implement a SEDRIS process with version 2.0. This quickly changed to version 2.0.2 and then 2.5.2. During the early stages, SEDRIS was evolving from a Read API structure to a Write API structure. The first full P2 STF and P3 STF were created with the Read API process. The Korea STF was created with the Write API process. All future CCTT DB STFs will be created with the Write API process.

There has been an effort this past year to standardize the STF of each database. The CCTT database STF s needed to be standardized because as CCTT was trying to use SEDRIS, SEDRIS was still maturing and the CCTT database versions were changing. At the beginning of 2002, the CCTT database STF versions are defined in Table 1.

The CCTT SEDRIS efforts in 2002 planned to standardize each database with a common tool set version, construction method, and standardize upon a single SEDRIS version. The planned SEDRIS version is 3.0.4. Each DB STF would also comply with the CCTT SEDRIS TCRS. Standardizing the CCTT databases and their associated SEDRIS STF s would reduce or eliminate confusion and errors in reusing the CCTT STF s both internally and externally. This is also intended to eliminate the problem with the STF being a version or two behind the fielded CCTT database as noted in Table 1.

Database	SEDRIS Version	Comments
P1 (all versions)	**N/A**	**Fielded database P1 AH**
P2 AF	**2.5.2**	**Fielded database P2 AG**
P3 J	**2.5.2**	
P4 H	**N/A**	
P5 C	**3.0.2b**	
P6 C	**3.0.3**	

Table 1 - Current CCTT Database STF Versions

CCTT and AVCATT

While the above evolution of the CCTT database process represents progress and needed improvements, it also complicates the ongoing conversion process. This is primarily because the source data has changed several times over the course of the program, and has continued to do so. In general these improvements tend to make the conversion process both easier and better. The AVCATT team has contributed to these improvements by making suggestions as to the content of the TCRS. They do, however, make it difficult to settle on conversion techniques and tools that can be considered a production process.

IG PERFORMANCE DIFFERENCES

Perhaps the most significant consideration in any database conversion is reconciling differences in the performance of the target IGs. This was definitely a factor in running the converted databases on the AVCATT IGs due to the major differences in performance expectations between the two systems. Some of these issues are discussed below:

Update Rate

In any real-time visual simulation the amount of time the IG has to process and calculate the visual and/or sensor scenes is a key performance factor. In general, the longer the frame time, the more scene features (polygons, lights, texture, etc.) can be processed and displayed. The down side being that the longer the frame time the greater possibility of transport delay issues and image artifacts (e.g. double imaging). These are not only distracting to the user but may also lead to simulation sickness and/or difficulty flying the aircraft (e.g. pilot induced oscillations).

The CCTT IGs are designed to update 15 times per second (i.e. 15 hz.). This rate was found to be adequate for the relatively slowly moving armored vehicles. There were some display artifacts due to the 60 hz. refresh rate of the displays. Each image is drawn four times which will sometimes result in multiple versions appearing to the observer. This is minimized with an IG feature called Multi Image Suppression.

The requirement for AVCATT was for the image to be updated at 30 hz. or better. A full system engineering analysis early in the program determined that the imagery in the HMD would be much more stable and acceptable to the flight crew if the image could be updated at 60 hz. (to match the HMD refresh rate). After considerable discussion with all of the involved parties it was determined to tradeoff the database content in the interest of improved image stability. The AVCATT database would be designed to update at 60 hz. This implies that the AVCATT IG would have to calculate its image in 25% of the frame time that the CCTT IG takes.

Field of View

The largest field of view of a CCTT out the window viewport (Commander's popped hatch) is 36° horizontal by 27.4° vertically. For the AVCATT HMD the view in each eye would be 65° horizontally by 50° vertically. The eyes are overlapped by 30° to give a total field of view for the HMD of 100° x 50°. This means that the AVCATT field of view is more than three times the size of the CCTT viewport. All other things being equal this implies that the AVCATT channel must display three times the scene content. This comparison is not as straight forward due to differences in the detailed system architecture of the two IGs, but it is clear that AVCATT will be displaying a larger scene.

Visibility Requirements

Maximum visibility range is another key design parameter in determining the content of a database. If the field of view frustum is thought of as a pyramid with the peak located at the eye, the maximum visibility determines how far away the base of the pyramid must be and the resulting volume that will contain database features that must be processed.

Because the CCTT is primarily a ground based application the visibility requirement was set at four kilometers. Some large landmarks (e.g. mountains) are visible at longer ranges for navigation purposes. For AVCATT the required visibility range is 10 kilometers. Just considering the horizontal aspect of the two fields of view for CCTT and AVCATT a simple area calculation indicates that the AVCATT IG will be required to fill an area not quite ten times larger than the CCTT. In addition to the larger area to fill, the longer visibility range also impacts the way in which the database and the IG must deal with level of detail for the scene features. This is further aggravated by some of the operational differences discussed below.

While it is difficult to exactly quantify the throughput differences, it is clear that the combined increases in update rate, field of view and visibility range would demand at least an order of magnitude increase in IG performance in order to run an exact copy of the CCTT database. While there have been increases in computer graphics performance in the years since the CCTT systems were designed, the AVCATT IGs will not provide that degree of performance enhancement. It was clear from the start that the AVCATT database would require careful thinning and redistribution of polygons assets in order to satisfy the program s requirements (actual and derived).

Priority Implementation

Perhaps the most fundamental difference between the CCTT and AVCATT IGs was in their priority mechanisms. This is the function in any IG that determines whether one polygon is in front or behind another. The IG on the CCTT system uses a hybrid range buffer approach. The fixed objects in the database (terrain, trees, buildings) are fix listed so that the IG knows which should be drawn first for any eyepoint. This implementation requires specific IG hardware and software as well as special database structures so that the correct ordering of objects can be accomplished. The benefit is that less pixel processing hardware and less frame time is required to assemble each image. This approach also has major impacts on the way the database is designed. One of these is that polygons are often layered on top of each other (to add levels of detail for example). The system only processes the pixels on top so there is little or no penalty for hidden pixels.

The IGs used for AVCATT have a traditional z-buffer priority mechanism. In this implementation the content of each pixel must be evaluated for every polygon that occupies that portion of the image. In a traditional application this may become a problem when the eyepoint is close to the ground (e.g. helicopter hovering) and a large number of features are filling the screen. This can be further aggravated by special effects such as smoke or dust clouds. Configurations that tend to layer polygons are rigorously avoided wherever possible in the design and construction of a typical z-buffer database. It was clear that a number of changes in polygon geometry would be required in order to remove the multiple polygon layers included in the CCTT databases. In some cases this was a simple deletion because the polygons were entirely hidden and in others polygons were generated to fill gaps between higher priority polygons.

An additional artifact of a list priority system is that terrain meshes are typically created as a regular grid. This arrangement is particularly efficient in a list system because separating planes can be defined along the linear boundaries. In most z-buffer systems the terrain is arranged in a triangular irregular grid (TIN). A TIN will generally provide a better representation of the terrain with few polygons, particularly if the terrain source data is significantly filtered. This was another area where the CCTT database geometry would need to be changed in order to optimize the fidelity and performance of the AVCATT database.

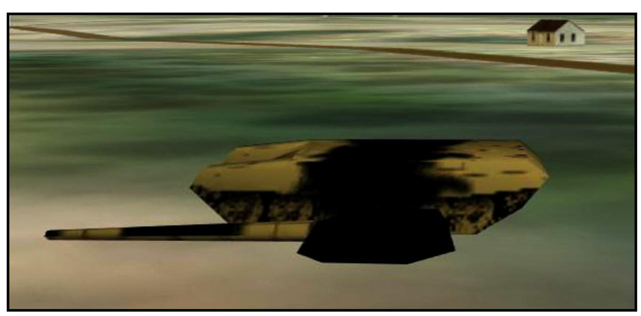
OPERATIONAL DIFFERENCES

There are also operational differences between helicopters and armored vehicles. The most obvious of these being that tanks spend all of their time on the ground and helicopters spend most of their time in the air. It was conceivable that the CCTT database components may have been modeled to take maximum advantage of this characteristic and things like roofs of buildings left off to save polygons. In actuality there was little or none of these types of short cuts, probably due to the CCTT requirement for a stealth viewer that has a bird s eye view of the database. There were legitimate cases of optimization for ground operations. These included texture maps that were designed and sized to provide cues for moving on the ground In some areas the maps had to be resized or replaced with texture that better supported low altitude flight and hover maneuvers.

Another difference in this area was the sensors that the vehicles use. Those in the helicopters tend to be used at much longer range than the ground based systems (hence the need for 10 km. visibility). During the Database Working Group meetings the comments from the subject matter experts (SME s) indicated that the FLIR versions of some of the models exhibited characteristics that they did not see in their sensors. Hot exhaust plumes had been included in the helicopter models and some ground vehicles, for example. The SME s asked that these be removed. The IR hot spots (e.g. exhaust, engine locations) were also relocated and/or adjusted on several models. This was in part due to better IR data on some of the vehicles having become available since the CCTT models were developed.

The longer range capabilities of the helicopter sensors also led to the destroyed versions of some of the models being modified. The CCTT representation for a destroyed tank was typically to show the turret leaning to one side with the cannon barrel pointed down to the ground. At extreme sensor range, even at high magnification, it was difficult to see the difference between normal and destroyed because the tank tended to be a bright spot in the IR image. These models were changed so that in the destroyed version the turret was removed and put on the ground beside the tank hull (see Figure 3). This alleviated the problem without any compromise to interoperability.The AVCATT program also required the addition of several aviation features to the database. These included multiple Forward Arming/Refueling Point (FARP) sites (see Figure 4). These consist of fuel trucks, fuel bladders, fuel pipes or hoses, and ammunition boxes used for rearming the

Normal T-72



Destroyed T-72

Figure 3 - Pictures of T-72 Showing Increased Representation Of Destroyed Version

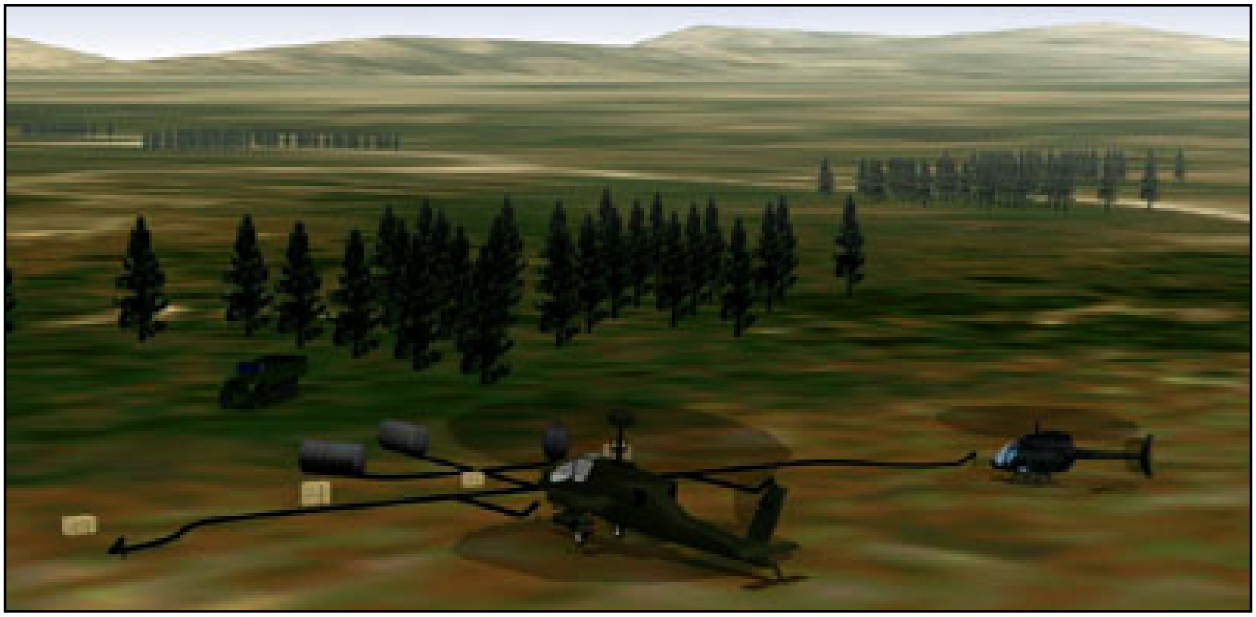


Figure 4 - Forward Arming/Refueling Point Added to the AVCATT Database

helicopters. These are positioned within the database by the SAF functions. One interoperability issue that has yet to be resolved is the addition of these features into the CCTT databases to close the interoperability loop. Approximately 20 new models were also added to AVCATT. These were primarily air defense type vehicles (e.g. mobile surface to air missiles) that had not played a part in typical CCTT armor engagements. These will also need to be added to CCTT.

INTERNAL CORRELATION

While not directly a part of the database conversion, there are requirements for the database to correlate with other functions and systems within AVCATT. As shown in Figure 5 the associated databases are derived from the converted and tuned visual database. The FLIR and Electro Optical (EO) functionalities utilize the same database as the visual out the window scenes. The polygons are material coded so that their response to changing weather and time of day conditions can be represented in the FLIR sensors. Some of the models will have sensor only polygons that are not displayed in the visual channels. These include the vehicle hot spots mentioned above.

The radar database to support the AH-64D Longbow is derived from the visual database by back-transforming the final database terrain and feature model content into NIMA like data formats. This data is then processed by the radar database tools set to produce the run-time radar database. A similar process is used to generate

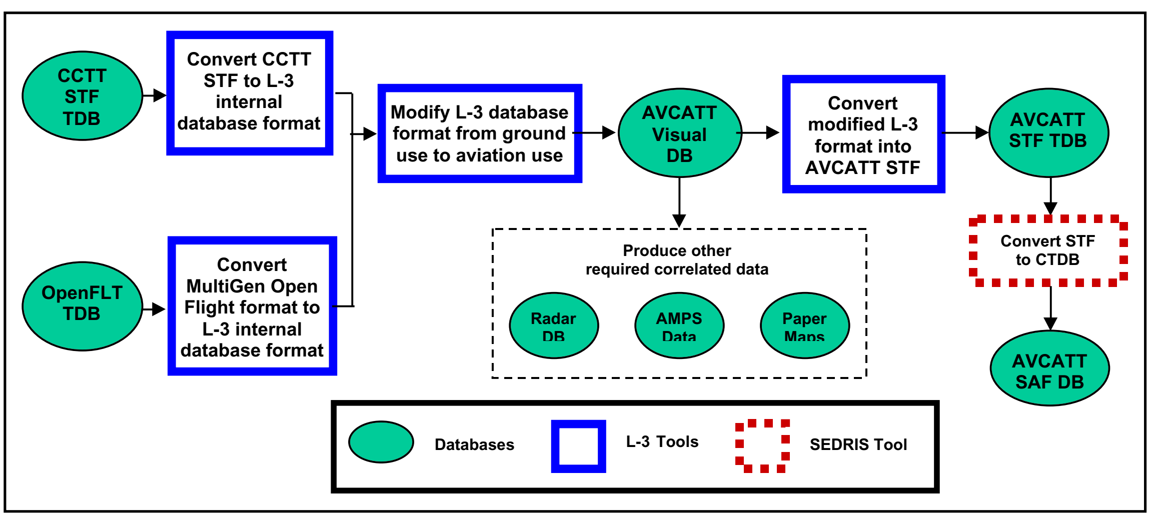


Figure 5 - Database Conversion Process

1:50,000 and 1:250,000 maps of the database. These maps can be printed to provide correlated charts or put on CD s in CADRG format for use with computer based planning tools (e.g. AMPS).

Perhaps the most important correlation is with the CGF. Since most of the participants in the simulated battles will be provided synthetically it is necessary that their movements be determined from a correlated Compact Terrain Database (CTDB). It was determined early in the program that the SEDRIS to CTDB tool developed by the SEDRIS program would be used to generate the CTDB database. L3 has worked closely with the SEDRIS supplier to ensure that the resulting database will correlate and satisfy interoperability requirements. The CTDB is also being used as the database for the Environmental Interrogator (EI). The EI is a separate processor function that acts as a line of sight server for AVCATT. The locations of two scene entities (real or CGF) are sent to the EI where their line of sight is tested against the CTDB. The results are sent back to the AVCATT host for distribution to the interested process (e.g. CGF, avionics, weapons).

AVCATT STF CONVERSION/PRODUCTION

The major task in the conversion of the CCTT database was the importing of the SEDRIS transmittal into the AVCATT database tools. The L3 tools suite is a combination of COTS tools and in-house developed tools. The appropriate tools are selected from this suite based on the application and the target image generation platform for which the database is designed. As mentioned above, the importing process was somewhat hampered by initially incomplete STF data and then by ongoing changes as SEDRIS itself matured. The database conversion process is shown above in Figure 5.

Among the COTS tools that L3 employs is the EaSIEST tool set used by E&S to develop the CCTT database. One possibility for resolving some early difficulties was to request the P2 database in the GDF format. This was provided but was not as helpful as anticipated. It was valuable as a check against the results of the SEDRIS conversion. Some of the issues with the conversion of discussed below:

Terrain Issues

As discussed above, the terrain skin had to be modified to compensate for the difference in performance requirements as well as the differences in operational needs. The strategy for the CCTT database had been to put the terrain fidelity in areas where the armored vehicles could be expected to go. Consequently the hills and rougher parts of the terrain were somewhat simplified. This was opposite to the fidelity requirements of the AVCATT helicopters. The approach taken was to first generate a terrain elevation grid from the CCTT terrain and then to use normal filtering techniques to create a new terrain skin that would better satisfy fidelity and operational needs while maintaining the required degree of interoperability.

This was accomplished by using the vertices of the highest level terrain polygons as grid post. This was facilitated by the regular terrain grid approach used for the CCTT terrain (see above). From these points the AVCATT terrain tool was able to generate a TIN that represents the original terrain while also redistributing the available polygons.

Another aspect of the terrain that had to be managed were the cut and fill features. These are features in CCTT that were generated algorithmically as part of the terrain process. In general they are ITD features that somehow influenced the surrounding terrain in order to achieve the required fidelity. An example is a ITD road lineal that must be cut into a hillside in order for the road to be flat enough for a ground vehicle to drive on it. Other examples in the desert areas were wadis (dry river beds) that are typically below the terrain surface. These are tactically significant in a desert environment and are important to both CCTT and AVCATT. In some cases the cut and fill features included information that allowed them to be reproduced by making adjustments to the AVCATT tools. In more difficult cases the polygon geometry had to be analyzed to determine how to proceed. This required some additions to the tools in order to automate the process as much as possible.

Basis sets were another area that required attention. These are features unique to list priority systems. In the CCTT IG, basis sets are used effectively to reduce disk bandwidth and increase system throughput. A basis set is a triangular section of terrain with associated features (e.g. trees, rocks). Because of the regular terrain grid it is possible to use a given basis set in any location where the geo-typical features are consistent with the area. The basis set, and its associated features, are maintained in system memory and instanced to the location(s) in real-time for processing. In order to replicate the feature locations in AVCATT it was necessary to examine every basis set application and apply similar features to the area. This functionality again required modifications to the AVCATT tools.

One further complication in the conversion of the terrain was the basic coordinate system. CCTT uses a flat earth coordinate system. This is acceptable for the relatively small databases employed. Displacement errors at the outer edges are well within acceptable tolerances. Future AVCATT databases that may not be interoperable with CCTT are expected to be significantly larger. For this reason it was decided that AVCATT should use a round earth coordinate system.

Models

Static feature models, moving models and special effects (i.e. animations) were all converted from SEDRIS into OpenFLT. OpenFLT is a MultiGen Paradigm format widely used for 3D models. Some aspects of the models had to be modified in order to be compatible with the run-time software for the AVCATT IGs. Texture maps had to be reformatted. The control mechanisms for animations were somewhat different requiring slight restructuring of the sequences. There were some list priority tricks that had be compensated for in order for the model to appear correctly in a z-buffer system. In general these alterations were not difficult but they did not lend themselves to batch processing like many of the terrain issues (after the tools had been modified). Most of these changes were made by hand.

In addition to developing the new AVCATT specific models mentioned above, there were several CCTT models that required improvements. In particular the helicopter models developed for CCTT were never intended to fly formation with. During the time these AVCATT models were being refined, L3 was also working with E&S on the 8th U.S. Army program to upgrade the visual systems on several helicopter simulators. Since E&S was under contract to provide high fidelity helicopter models for that program, it was decided to convert those models rather than the original CCTT models provided via the STF. Since the simulators being upgraded were both cargo helicopters there were no sensor effects included in the improved models. These were added for AVCATT.

Another operational difference between CCTT and AVCATT that precipitated changes to some of the models had to do with where on the battlefield certain vehicles might be encountered. During CCTT engagements the enemy vehicles are encountered at the front line where they are fully deployed. It is possible for the AVCATT helicopters to encounter these same vehicles behind the lines where they may be in their stowed or travel configuration. It was necessary to create new versions of some models that showed them being towed by other vehicles (e.g. anti-aircraft guns) or with their weapon launchers stowed (e.g. mobile SAM units).

LESSONS LEARNED

The requirement to convert the CCTT databases for use on AVCATT has been an enlightening experience both to AVCATT as a consumer, and to CCTT as a producer. AVCATT is the first major program to do a complete conversion in order to provide a terrain database capable of combined operational exercises. They are also the first to utilize the available SEDRIS tools to satisfy the AVCATT database requirements. While other programs may have utilized the tools to produce small patches of databases, or to test small conversions, AVCATT is required to convert the entire CCTT database and produce the visual and all correlated databases. This has not been a trivial effort, and many lessons learned were acquired from this experience.

Better Definition of SEDRIS Content

A challenge for the AVCATT visual team was to understand exactly what was in the CCTT STF source provided to AVCATT. AVCATT was able to deal with the source data by reading in the CCTT STF source with existing database tools, and output database source files consisting of raw CCTT data. This data included exact terrain polygons and areal/lineal/point features. AVCATT was then able to generate an elevation grid from the CCTT terrain polygons in order to implement the AVCATT terrain design. In recognition of the potential problems with the SEDRIS content, AVCATT is investigating producing a TCRS from the consumer side, based on our experiences.

Better Definition of Database Design

The AVCATT experience also highlights the difficulty in trying to reuse a SNE built to different requirements, different software architectures, and different hardware architectures. This difficulty exists whether using a standardized interchange format like SEDRIS or other means. Part of the reuse effort is to convert the database design as noted above. This specific case was the conversion of the CCTT database design to an AVCATT database design. What makes this especially difficult is that the CCTT database design has evolved over time and is not entirely identical from database to database. The reasons for this evolution have been better tools, different engineers, and new technologies.

Common Model Libraries

Many of the ground models provided by CCTT were high fidelity and therefore made up of a large number of polygons. Utilizing multiple copies of these models on AVCATT would have overloaded the IG. Other

CCTT models did not include the detail AVCATT required and had to be enhanced. A basic set of models, at agreed upon fidelity levels should be utilized to limit such problems.

Stable Source Data Formats, Content

A challenge for AVCATT, and a nightmare for configuration control, is the version of the source data format. If CCTT releases a newer version of a produced database, and AVCATT is operating under the older version, then there is potential for a fair fight problem. A mechanism needs to be implemented to ensure that newer releases of the database will not inhibit the operational capabilities of systems utilizing the older version. In addition, AVCATT converted P2 and P3 from the STF 2.5.2 versions. CCTT is now in the process of producing and releasing their newer databases in the STF 3.0.4 versions. The disparity between source versions is another concern to the AVCATT program.

Interoperability and Fair Fight

As stated above, the concepts of interoperability and fair fight are difficult to define and quantify. AVCATT made the decision to tie the interoperability requirement to the CCTT Interface Control Document definitions. If AVCATT meets the criteria stated in that document, then AVCATT will be interoperable with CCTT with respect to the level identified. Given this, it was determined early in the conversion process that certain areas of the CCTT source database would be problematic. While the different visual performance parameters discussed above were managed for most database areas there are small complex areas that required additional consideration and tradeoffs. These tend to be city or residential areas and rock fields. In the CCTT source database these areas include a large number of 3D features that cannot be supported on a one to one basis by the AVCATT IG. It was therefore necessary to make compromises to the scene content in these areas so that IG performance can be maintained while also supporting operational and/or training requirements.

Whereas CCTT is concerned with every ditch, bump, or slope of the terrain areas where the vehicles operate, an air application simply flies those areas, with an occasional need to land. Conversely, CCTT is not concerned with hilly or rough terrain where the vehicle traffic is not possible. These tend to be the areas where the helicopters would like to operate. In order to optimize the database for the polygon capacity of the AVCATT IG it was necessary to make adjustments in both of these areas. This was accomplished by reskinning the terrain to more closely support an air application. This change also brings into question the correlation between the two databases (CCTT and AVCATT) and if there are any fair fight issues as a result of the reskinning process.

The lesson learned in this area is for all parties to come to an agreement at the beginning of the conversion process as to the level of terrain and feature fidelity that must be maintained in order to provide meaningful fair fight conditions. This should include the number of specific feature types as well as terrain accuracy for various areas of the database. Decisions of this type may be somewhat easier in the future once CCTT and AVCATT have had a chance to interoperate on different types of training exercises and the contribution of database fidelity to fair fight issues is better understood.

Simultaneous Database Adjustments

As AVCATT goes through this conversion process, the thought comes up frequently If only CCTT had done this when generating the source . These thoughts are invaluable for both the producers and consumers of the database. A mechanism needs to be in place where these thoughts can be provided directly to the producer, for possible incorporation in their next release. A simple addition may be able to delete lengthy computer compilation in order to ensure a capability will exist. Additional benefits might be derived from considering changes to the source database content in order to facilitate interoperability. Rather than expect one of the simulations (e.g. AVCATT) to make all of the required adjustments, if features could be modified or deleted from the source (e.g. CCTT) without impacting training capabilities the overall combined training would benefit. It may be practical in this context to maintain a separate version of a database that is only used for combined training exercises.

REFERENCES

1. Schaefer, J., Simons, R. "Virtual War Gaming in Aviation Combined Arms Tactical Trainer (AVCATT-A)" IMAGE 2002
2. Gazzam, G., Knight, S. "Use of Digital Video Technology for Real-Time Exercise Monitoring and Debrief of Collective Training Applications" IITSEC'01
3. CCTT Interoperability Control Document
4. SEDRIS Glossary of Terms
5. DMSO On-line M&S Glossary