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Engineering Animation: A Corporate Case Study

William A. Ross and Nathan Hartman
Purdue University

ABSTRACT

The use of engineering and architectural CAD models in 3D animation and simulation is rapidly becoming a widespread activity in American business and industry. Paralleling this, the ease of interchanging digital and video formats allows engineers and architects the opportunity to merge proposed 3D digital designs directly with existing conditions captured on video. Commercial application of this process impacts areas ranging from preliminary design and analysis through marketing and training. The primary objective of this article is to provide a first-hand account of a corporate project in which 3D engineering models and construction data were used as a basis for producing an engineering marketing animation for the Caterpillar Corporation. The secondary objective of this paper is to describe the role of graphics students involved in this project. The article includes an overview of how CAD models furnished by Caterpillar were used in the production process.

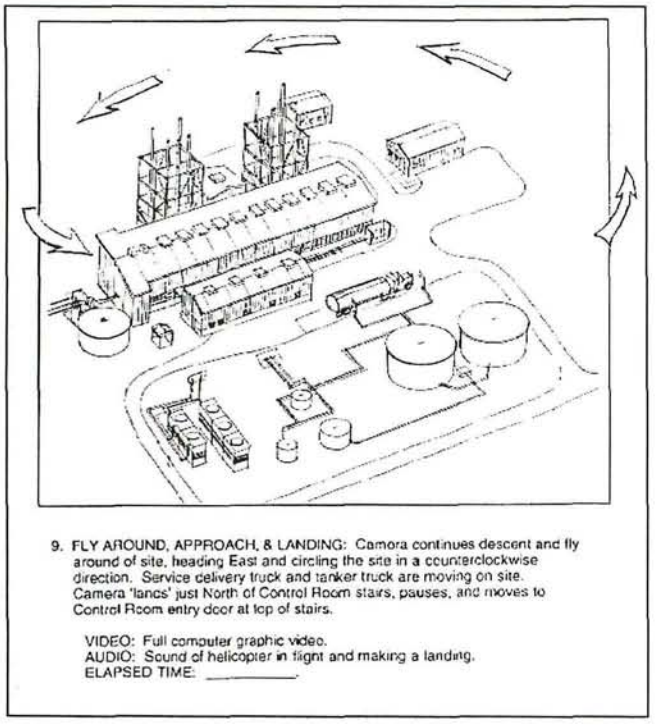
Background

The Caterpillar fly-through animation project came about as a result of several converging factors. First, the Caterpillar Large Engine manufacturing facility located in Lafayette, Indiana, was geographically close to and closely allied with Purdue University. Second, Caterpillar employed Purdue's Technical Graphics students and graduates in a variety of engineering support, marketing, manufacturing, and training capacities. Third, Caterpillar had a specific need to develop and market their recent corporate move into remote electrical power generation solutions for the international mining industry. Finally, Purdue's Centers for Excellence Program allowed the University to contract with Caterpillar to assist in developing this animation project.

Project Description

The Department of Technical Graphics, through the University's Centers for Excellence Program, met with marketing and engineering personnel at Caterpillar during February 1996 and developed a contractual agreement to produce an engineering animation and video product. The origin of this project was the result of the initiative of a Technical Graphics graduate student working as a Caterpillar intern. The result was an engineering marketing video tape combining live video and 3D computer graphic animation designed to visually show potential customers an alternative solution to electrical power generation. The initial use of the video product was as a marketing tool for Caterpillar shown at MINExpo 96, a multinational trade show for international mining companies held in Las Vegas in September 1996.

Specifically, the 3D animation phase of the story consisted of graphically depicting the layout, construction, and function of a remote power generation plant built during 1995-96 by Caterpillar in Guatemala. Functional plant systems including generator sets, cooling system, fuel system, electrical generation & control system, structural



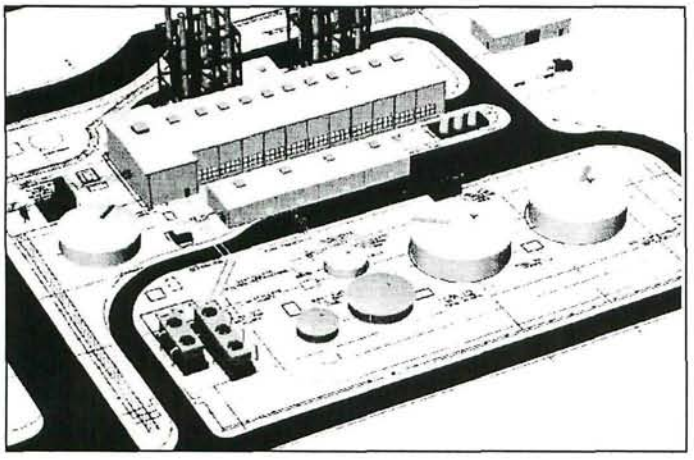


Figure 1 *- Site storyboard and rendered scene*

building systems, and other major features on the site were shown in a 3D color keyed manner as they emerged from a digital site plan. Subsequently, a site fly-around, shown in *Figure 1*, followed by a fly-through of the main control and engine generator room were created to be as accurately descriptive as possible based on engineering drawings and photographs.

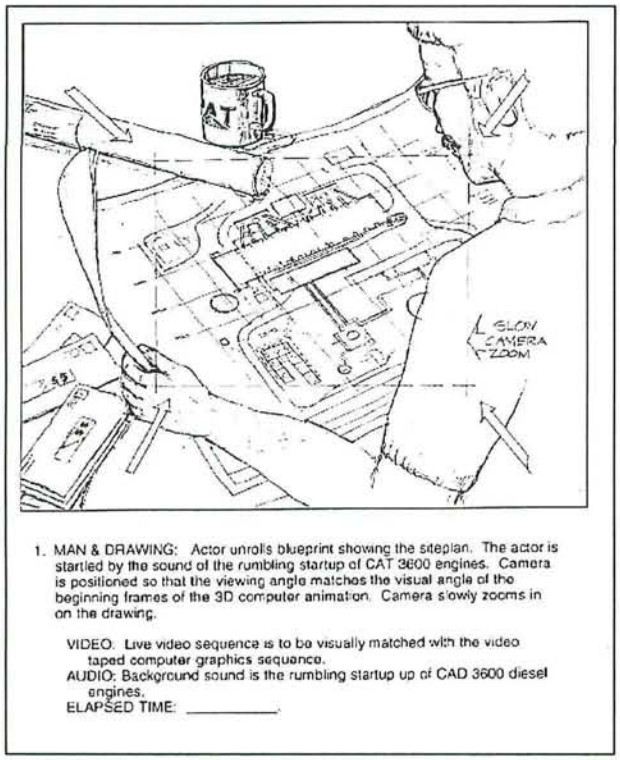
Contractually, the project was completed in two phases. The first phase - design - occurred during March 1996 and consisted of a series of meetings with CAT engineering and marketing personnel to develop and approve the concept for the animation. The deliverable portion of this phase of the project consisted of writing a preliminary script, developing a series of storyboards visually describing Caterpillar's story, and getting approval from CAT corporate to proceed with production. *Figure 2* shows storyboard number one. The second phase - production - took place between May 15 and July 31, 1996. Production was divided into three major categories: live video, computer animation, final compositing and editing.

Live Video

Live video for this project was shot in two locations. The introductory live video of CAT equipment, earth moving activities, and construction site personnel was shot at the Caterpillar plant in Mossville, Illinois in May 1996, by Caterpillar staff. The remaining live video was created at a newly completed electrical power generation facility in Guatemala in late June and early July 1996. Filming in Guatemala was produced by Video Specialists in Seattle, Washington. The two video segments were composited and edited to blend with 3D computer animation.

Computer Animation

All 3D computer animation was created at Purdue University by students employed as summer interns on the project under the supervision of a Technical Graphics faculty member serving as Project Director. This phase of the project lasted from May 15 to July 31, 1996 and required the services of



1. MAN & DRAWING: Actor unrolls blueprint showing the siteplan. The actor is startled by the sound of the rumbling startup of CAT 3600 engines. Camera is positioned so that the viewing angle matches the visual angle of the beginning frames of the 3D computer animation. Camera slowly zooms in on the drawing.

   VIDEO: Live video sequence is to be visually matched with the video taped computer graphics sequence.
   AUDIO: Background sound is the rumbling startup up of CAD 3600 diesel engines.
   ELAPSED TIME: _____.

***Figure 2** - Animation storyboard one*

three full-time and two part-time student employees. A staff of three graduate students and two undergraduate students were employed with the following job descriptions; (2) Animators, (2) Engineering CAD Modelers, and (1) Digital Imaging Specialist. One of the graduate students also served as liaison with Caterpillar to secure engineering specifications, drawings, and digital imaging data.

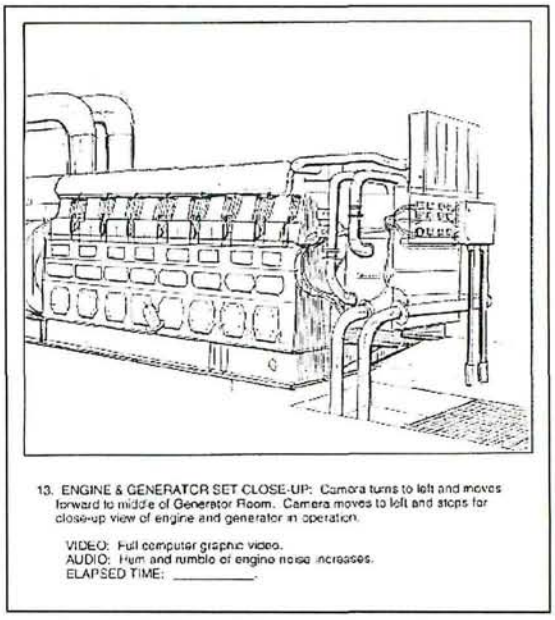
The facility used for this project consisted of two faculty offices which were temporarily vacated for the duration of the project. Equipment consisted of three Micron P5 Pentium 166 mhz computers with 64 megabytes of RAM each, one Micron P6 Pentium 200 mhz computer with 96 megabytes of RAM, one Hewlett-Packard flatbed scanner, one Apple Digital camera, and one SVHS video tape unit. The operating system was Windows NT 3.51 with a local area network for network rendering and storage. In addition to local hard drive storage, archival storage and back-up was supported through one Iomega Jazz and two Iomega Zip drives. Rendered animation sequences were converted to broadcast quality video by means of a Digital Perception board with a video capture daughter board.

The principle production software for this project was Kinetix's 3D Studio MAX. An allowance was made to give students the opportunity to ramp up their initial skills in learning 3D Studio MAX. Other support software included Autodesk's 3D Studio R4, AutoCAD R12, Adobe Photoshop 3.0, Corel Draw, and Adobe Premiere.

Initial CAD models of the Caterpillar 3600 Engine were furnished by CAT Engineering in the form of a 36 megabyte DXF file. Approximately 250 man hours were spent refining and finishing the engine model. *Figure 3* shows storyboard and finished rendered engine models. As shown in *Figure 4*, a total of ten engines were needed for the animation. Additional technical information for constructing the engine and the rest of the 3D site was gathered from engineering and construction drawings as well as site visits to the local Caterpillar Large Engine plant in Lafayette, Indiana. Approximately 750 man hours were required to build all required 3D digital models including terrain and site environment conditions.

In accordance with the storyboards and script for the project, 3D animation was divided into ten sequences: 1) Transition from blueprint of Site Plan from real to digital, 2) Fade-in of ten 3600 engine Gensets on site plan in 3D, 3) Fade-in of Cooling System, 4) Fade-in of Fuel System, 5) Fade -in and close up of Electrical Generation System, 6) Fade-in of Electrical Control

System, 7) Fade in and pull back on Building Structural System, 8) Buildings and Site Plan transform to Reality with trucks and terrain. Camera moves around site to control room entrance, 9) Control Room fly-through, and 10) Engine Generator Room fly-through. As each sequence was completed, images from the animation were attached to the Technical Graphics WEB site, reviewed by CAT personnel, and approved via fax signature on a sign-off sheet. This saved mailing time in getting corporate approval for each stage of the animation. Approximately 1850 total man hours were spent in all computer graphics tasks. Excluding digital video, the file archive storage requirements for this project, including all vector and raster image files was less the one gigabyte of data.



13. ENGINE & GENERATOR SET CLOSE-UP: Camera turns to left and moves forward to middle of Generator Room. Camera moves to left and stops for close-up view of engine and generator in operation.

VIDEO: Full computer graphic video.
AUDIO: Hum and rumble of engine noise increases.
ELAPSED TIME: _____.

The final portion of the 3D animation production phase consisted of rendering out broadcast quality digital images of the animation and recording the completed animation sequences on a Beta SP master tape. This process was out-sourced to Purdue's Center for Instructional Services Video Production facility and required approximately 20 man hours at the end of the project.

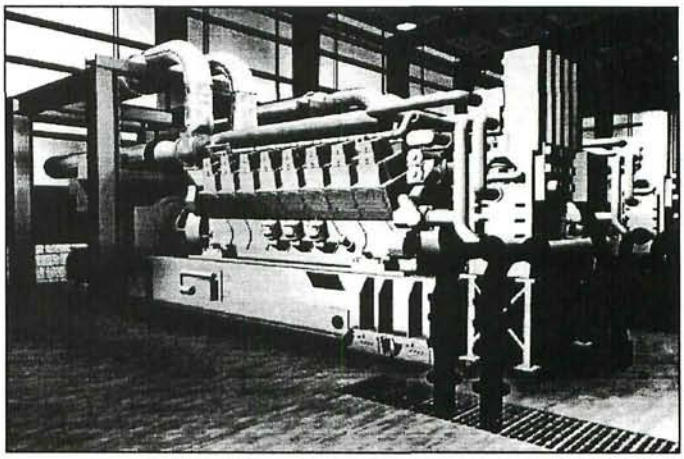


***Figure 3** - CAT 3600 storyboard and rendered engine*

Video Compositing and Editing

The Beta master tape containing the completed animation sequences was shipped to Video Specialists in Seattle, Washington on July 31, for final compositing and editing with live video and sound. The completed video product, in SVHS format was delivered to Caterpillar before August 31 for the presentation at MINExpo Trade Show in Las Vegas.

Summary

Based on letters and calls received from Caterpillar personnel, the company is pleased with the finished product. From the standpoint of Purdue faculty and students employed on this project, involvement in a real world engineering animation problem with a tight production schedule was a tremendous challenge and a marvelous learning experience. The Department of Technical Graphics gained valuable curriculum insight in the process of producing technical and engineering animation. Additionally, revenues generated through

the contractual agreement helped in purchasing valuable equipment and software for the Department. Of most importance, students employed on this project gained invaluable internship experience by working directly with engineering and marketing personnel from a major corporation while producing a complex and valuable product for the company.

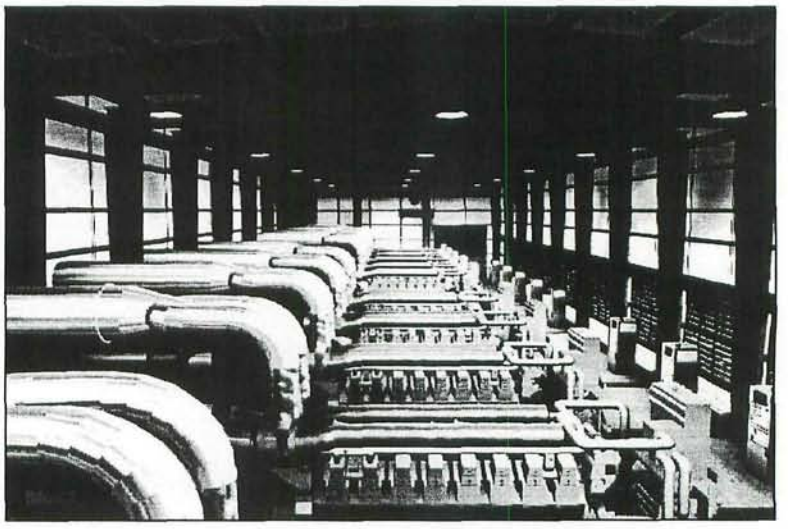


Figure 4 *- Finished generator room with ten CAT 3600 engines and generator sets.*

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