Final Report
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EDUCATION ON URBAN CORRIDOR ISSUES THROUGH COMPUTER ANIMATION

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Abstract of TR-419
Education on Urban Corridor Issues through Computer Animation

This project was undertaken in coordination with the Environmental Assessment process on the Mt. Vernon Road Improvements project in Cedar Rapids, Iowa. The goal of the research was to determine the cost effectiveness of combined photo-imaging and computer animation as a presentation tool describing public road improvements. The Public Hearing, in combination with the involvement of a Citizen's Resource Group, afforded an opportunity to have an evaluation of the processes by interested citizens who were not familiar with engineering drawings or the construction industry.

After the initial viewing of a draft version of the video, the Resource Group made recommendations to the staff developing the video. Discussion of these recommendations led to the development of an animated composite section that showed a combination of situations typically encountered throughout the project corridor, as well as critical considerations. The composite section did not show specific locations and therefore, individuals were not distracted by looking for the details pertaining to their properties. Concentration on the concepts involved rather than specifics provided the opportunity for a more thorough understanding by the citizens. The development of the composite concept was the primary discovery of the research.

The composite was followed in the video by photo-imaging and computer animation of specific locations within the project area. Having the understanding of general concepts in advance from the composite explanation, the citizens focused upon the suggested appearance and impacts of the project rather than details of the animation or the applicable concept.

While the costs for the project exceeded double the $30,000 budget for film preparation provided by the Iowa Highway Research Board and the City of Cedar Rapids for the video, the personnel involved with the computer animation activities are confident that future projects could be done within or near the proposed budget for labor. The cost per mile to show critical features is projected as approximately one-quarter the $100,000 cost to animate an entire project. To ensure cost effectiveness, the computer hardware, use of computer techniques, and knowledge of the capabilities of computer animation is required before work can be started on any project and the establishment of a project budget.

The formatting of a final script and full development of the project concepts must be accomplished prior to beginning work on any animation or photo-imaging because the computer processing is still somewhat cumbersome and time consuming to make repeated revisions to prepared segments of animation. In other words, the animation should be used as a presentation tool rather than a design tool at this time.

Considering this process is in the research and development stage, and that computer hardware continues to improve at a rate that doubles capacity annually, preparation of the evaluated media for small projects appears to be economically feasible within a few years. In conclusion, the photo-imaging process is currently cost effective and very effective in displaying potential future appearances from a single perspective. The computer animation is also very effective in showing appearances and therefore is a valuable tool for showing complicated areas and long segments. To be effective, mixing or alternating of presentation methods should be done with consideration for the orientation of the viewer.

The continued development of these methods is highly recommended and the project video, Mt. Vernon Road: "A Solution Through Partnership", should be included in the "tool box" for Urban Corridor Management.

EDUCATION ON URBAN CORRIDOR ISSUES THROUGH COMPUTER ANIMATION
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Introduction: On May 21, 1998 the State of Iowa, through the Iowa Department of Transportation and Iowa Highway Research Board, sponsored a research project identified as TR-419, "Education on Urban Corridor Issues Through Computer Animation." The goal of the research was to determine the cost effectiveness of combined photo-imaging and computer animation as a presentation tool describing public road improvements.

Modern roadway improvements are needed where road sections are insufficient or pavements have deteriorated. Designs are intended to improve traffic flow and reduce accidents, and are considered a part of Urban Corridor Management. A major development component of adapting existing urban corridors with modern roadway improvements is to determine the impacts on adjacent property and their specific use. These concepts are often combined with other amenities, such as aesthetic design, which are of the utmost concern to the adjacent property owners.

When sufficient concern exists with regard to the potential impacts of a roadway project, an Environmental Assessment may be required. The purpose of an Environmental Assessment examines the appropriate categories established by federal criteria, ranging from socio-economic impacts that relate primarily to the effect on businesses and homes, to historical and archeological impacts along the corridor.

Part of the Environmental Assessment process is to obtain public input, identify property impacts, to arrive at possible solutions and/or mitigation of proposed improvements along the corridor. The public expects to travel the roadway without delays and to maintain public investments in the street system, while adjacent property owners, typically consisting of businesses and residences in an urban setting, have a right to maintain the investment in their property. Ultimately, the Environmental Assessment is a process that measures the impacts of transportation improvement alternatives and results in proposals that minimize or mitigate negative impacts. This is made possible by involving the public in the decision making process.

Citizens expect to be part of a public works decision that effects their lives because of the potential impacts, however, citizens who are not involved in the construction industry have difficulty visualizing proposed improvements from typical engineering documents.

Problem Statement: While the design improvement concepts of combining driveways, spacing of intersections, addition of turn lanes, etc., are readily understood by the general public, the common person has difficulty envisioning how such improvements will look on their project of interest. Standard engineering plans and typical sections are not understood by most individuals, and therefore they are often uncomfortable with, nor do they readily accept, design proposals. This is true even if issues have been resolved per their specific request. A significant amount of public funds and valuable time is currently being spent educating the interested public in the most basic of engineering and design principals so they may understand why a certain design is proposed and be enabled to offer constructive input on design alternatives.

Current technology has made it possible to overlay proposed features onto existing photographs and with proper views many proposed designs can be shown with this "photo-imaging". While relatively affordable, $200 to $300 per view, photo-imaging is limited to the perspective of the selected photograph. Isolated issues are often acceptably viewed from a single or few angles and could adequately be presented with single photo-imaging. "Video-imaging" is also available, but with a cost similar to photo-imaging applied to each frame of a video, the use of video for any moving situation quickly becomes very expensive as a presentation tool.

Recent advances in 3-D computer animation and current processing capabilities make it possible to create realistic animation of terrain models. While this process is still relatively costly for singular applications, once a computer model is built for a landscape, multiple "3-D camera angles" can be chosen to provide a fuller understanding of the design impacts at a particular location.

Significant cost is incurred when an entire corridor is modeled, without need in areas where few or no design "issues" exist and no public controversy is expected. Conversely, locations such as intersections can be presented with important detail through the moving perspective. These are also the locations within the corridor that tend to have significant feature changes from construction improvements and therefore would be more costly to present with photo or video-imaging than computer animation. The cost for computer animation can run upwards of $15,000 to $20,000 per thousand feet of street in an urban setting or a setting with significant detail to be modeled. For a mile of street, or a number of developed views, the cost can easily exceed $100,000.

Objectives*:* The primary goal of the proposed research was to test whether a combination of photo-imaging and computer animation can be utilized in a manner which can reduce cost to approximately 1/3 that experienced for full project 3-D animation, yet effectively model critical portions of a project. The process must clearly show the corridor improvements to the general citizens, landowners, and elected officials. Existing and post construction appearances will be shown which will compare the computer animation of proposed conceptual design versus the completed improvements.

An additional goal was to develop a process and methods for the animation that will assist the Engineer in presenting tried and true reasons for proposed improvements and

criteria. A secondary benefit is to have an example that can be used in a presentation tool box. The "tool box" is being developed for use in urban corridors, using both project specific and typical application examples. One critical element in the tool box is a realistic visualization of the "before and after" corridor.

The presentation of design proposals for an entire urban corridor can not be done on a cost effective basis with any one of the traditional methods. However, a carefully scripted combination of two of the processes, photo-imaging and computer animation, applied to the proper locations, can cost-effectively help the average person understand the impacts of design proposals and potentially save public dollars.

The project selected for the demonstration, Mt. Vernon Road, is comprised of a major arterial street in the eastern portion of Cedar Rapids, Iowa. Over 5,000 feet of the roadway is proposed to be widened from a 4-lane, 42 foot wide back-of-curb to back-of-curb section to a modern standard, five-lane section. The balance of the project will include the addition of turn lanes, a traffic signal, and transition from four lanes back to the existing two-lane section. The area is comprised of a mix of commercial and residential use with high traffic volumes and accident rates. Affected citizens are concerned about all elements of the design and how they will effect them personally. The federally funded project (STP-U-1187(22)—70-57) includes the traditional Environmental Assessment, but has no allowance for advanced presentation tools.

Cost Considerations: A stated goal of the research was to determine the cost effectiveness of the proposed presentation media. The computer time and resources required to prepare a version of computer animation is extensive. While possible with current equipment and software, the resources have only been available for the past couple of years and the software is still considered specialized. The learning curve was great on this project, considering the individuals involved with the computer animation for this project had not been involved with engineering design prior to this project. The creation of a new library of animated features was necessary and contributed to cost overruns. Costs associated with the learning curve for the engineering design issues can be considered to be approximately one-half of the approximately $60,000 spent on the project.

Considering the budgeted cost for the video production was $30,000, the cost for such a project would be in line with that budgeted, assuming an experienced project team. The personnel involved with the computer animation activities are confident that future projects could be done within or near the proposed budget for labor, however, the computer power required for the process is still too great to meet the time schedule typically required for this type of product. Upon completion of the original model, each revision to an animated segment (taking as little as fifteen minutes to revise) required eight to twenty-four hours of computer processing time, on eight, interfaced, state of the art personal computers. Many such revisions were required, often because of the lack of experience in roadway design of the computer personnel, resulting in additional time and computer processing beyond the original expectations and budgeting. Costs of this

nature are considered training or research and development and cannot be directly attributable to the individual project.

Given the adjustments for training, the budgeted cost of $30,000 for the development of a presentation film on the main project features and impacts appears to be reasonable on this project. The length of the project is approximately 6000 lineal feet, resulting in a per mile cost of $26,000. This compares with the cost of $100,000 for full animation of a mile of street.

Project Development: The original outline for the project was comprised of a work plan, or a "Story Board" of the planned views to be developed. This was later supplemented by a script, based upon the planning sessions of the engineering and computer staffs. It became apparent through the process that a script was a necessary beginning point for the development of the video, and it should be used to develop the Story Board. This requires a full understanding of the project and related concepts, as well as a final design concept prior to the initiation of the film activity. Changes in the design once computer work is begun can be costly and very time consuming.

As a part of the project development, the script can be read aloud to help determine the length of the film. While the writing of narration and formation of a script can be very time consuming, prepared statements included in a video can provide a very comprehensive and effective presentation tool.

Evaluation: The Mt. Vernon Road project afforded an opportunity to illustrate the advantages of combined photo imaging and computer simulations. The public demanded detailed information about the impacts of considered designs on the Mt. Vernon Road Project. (A situation that will become more common as aging arterial roads in established communities need rehabilitation or improvement.) This project presented an opportunity to apply the above concept to a "real life" situation and receive critical input from a focused and interested Citizen Resource Group (comprised of a representative cross section of individuals impacted by the proposed street improvements). The group provided a critical review of the design option presented by combined imaging and the presentation methods.

The Resource Group evaluated the video in regular meetings on July 9, 1998 and August 27, 1998, prior to the Environmental Assessment Public hearing of September 2, 1998. A "rough draft" of the video was presented in the July meeting. The rough draft contained examples of the photo imaging and computer simulations so that general direction on the presentation tools could be given. Comments from that forum included:

- Too high of a view point was detrimental. The "helicopter perspective" did not give a true feeling of the on ground applications. A "camera angle" of near the street light height was thought to be desirable.
- Contiguous progression from one end of the project to the other (west to east on this project) was considered essential.

- Confusion also resulted from switching from one presentation method to another. Many observers became disorientated unless the second method was observing the same location from the same perspective.
- Video of the existing conditions was used as a "Before condition" representation. This was not considered helpful, perhaps because it introduced an additional presentation method.
- The Resource Group suggested that a fade from a photo to a simulation perspective from the same viewpoint would be helpful.
- Numerous feature details were commented upon which emphasized the point that citizens would be looking for details pertaining to their own interests for the video.

It was also apparent that some narrative pertaining to the Resource Group process and the major concepts involved with the project itself would be necessary for the Public Hearing version of the video. Interviews of Resource Group members and city officials discussing the Resource Group and major project issues were added to the final video.

Consultation with the computer simulation consultant for the project, following the Resource Groups review of the draft video, gave rise to a new concept to describe typical situations. A composite view of typical existing conditions, utilities, and features was added to the video, followed by a proposed view of the same area with the typical revision for the future condition. Highlighting of the features discussed with the accompanying narration drew attention and concentration of the audience to the details as desired. This method was considered essential by all individuals reviewing the tape.

Final Product: The consultant for the Mt. Vernon Road Project, Snyder & Associates, provided photo-imaging for the above through the original scope of services. A sub-consultant, Dick Shook & Associates of Slater, Iowa, prepared the 3-D computer animation and combined the described products into a single presentation video. The computer animation was applied to approximately five portions of the corridor (which were more completely described with multiple views). The animation was incorporated into a video with photo-imaging of other critical locations throughout the project, explanations of the concepts involved, and interviews with Resource Group members and City officials.

A copy of the final presentation video tape is submitted as a part of this report. The Resource Group and public were very receptive of the final product, especially the animated composite views.

Assuming a modeled view, or a version thereof, is the choice for construction, a post-construction video tape can be provided for comparative analysis. The combination of post-construction video tape with the original 3-D computer animation/photo imaging, and accompanying final report, could be submitted following construction, assuming a construction alternative is chosen by the city for the project.

Conclusions: The initial intentions of the research were to combine photo-imaging and computer animation in a presentation mode. While use of both media in a presentation is workable, alternating between the methods tends to disorientate the observer. Maintaining a consistent "direction of travel", such as west to east, was also crucial to maintaining the orientation of individuals. In summary, the methods can be used effectively in the same presentation, however, they should be separated into clearly different segments by introduction of the site, or other subject matter.

An "after construction" video has been added to the end of the original report tape which shows the successful completion of the project. Comparison of the animation to the final product does show a close correlation between accurate animation and the final construction product. Resource Group members were contacted after completion of the construction project. The general consensus was the use of the animated video with associated narration and interviews assisted the lay-person in visualizing the final anticipated improvements during the conceptual design phase and ultimately helped "sell" the project to the both the public and the directly impacted property owners and businesses.

A composite section was developed after consultation with the resource group. The composite section did not show specific locations and therefore, individuals were not distracted by looking for the details pertaining to their properties. Concentration on the concepts involved rather than specifics provided the opportunity for a more thorough understanding by the citizens. The development of the composite concept was the primary discovery of the research.

The composite was followed in the video by photo-imaging and computer animation of specific locations within the project area. Having the understanding of general concepts in advance from the composite explanation, the citizens focused upon the suggested appearance and impacts of the project rather than details of the animation or the applicable concept.

The conclusion was that with the advancement of technology, alternatives such as driveway location or retaining wall design could be visually considered by designers and project owners during project development as a design decision tool.

Angles such as an overhead "fly-by" and rotation of an intersection help to give perspective to a designer, but to the lay-person or typical citizen, a simple west-to-east progression resulted in the best understanding of the project.

Caution is also recommended regarding the use of cosmetic features such as flags or active pedestrians. While such features may add a touch of realism, they should be depicted in such a way that they can actually be implemented. Although not the case on this project, showing exaggerated improvements to the viewer, such as enhanced streetscapes, would generally be considered misleading.

The cost rate per mile for the preparation of this presentation video was approximately one-quarter the cost of animation on an entire project. The costs for the project exceeded double the

$30,000 budget for film preparation provided by the Iowa Highway Research Board and the City of Cedar Rapids for the video, however, the personnel involved with the computer animation activities are confident that future projects could be done within or near the proposed budget for labor. To ensure cost effectiveness, computer and animation expertise are necessary before work can be started on any project and the establishment of a project budget.

At the time of the original video and interim report (1998), the computer processing was still somewhat cumbersome and it was time consuming to make repeated revisions to prepared segments of animation. In other words, the animation needed to be used as a presentation tool rather than a design tool at that time. In the interim four years, computer speeds have increased several fold and animation techniques have also improved to the point that the process can be used for design purposes as needed, or to portray design options to project owners.

At the time of the interim report, preparation of the evaluated media for small projects appeared to be economically feasible within a few years. At the present time, four years later, animation tools do exist to allow the designer to quickly consider design options of skeleton plans and stick drawings for any size project. Design options can be narrowed and detailed animation then prepared for the final options.

In conclusion, the photo-imaging process is currently cost effective and very effective in displaying potential future appearances from a single perspective. The computer animation is also very effective in showing appearances and therefore a valuable tool for showing complicated areas and long segments. To be effective, mixing or alternating of presentations methods should be done with consideration for the orientation of the viewer, understanding that the target audience does not have the designer's knowledge or perspective of the project, or the appreciation for the technology of the presentation. With the continued evolution of computer technology, the animation has become a cost effective method worth considering on large and medium sized projects. With continued technology improvements, cost effective animation of any project will be possible within a few more years.

The continued development of these methods is highly recommended and the project video, Mt. Vernon Road: "A Solution Through Partnership", should be included in the "tool box" for Urban Corridor Management.