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Calspan

A PROPOSAL TO DEVELOP MOTORCYCLE RIDER TRAINING FILMS

Calspan Proposal No. 4426

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Prepared For:

MOTORCYCLE SAFETY FOUNDATION
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WASHINGTON, D.C. 20036

On November 17, 1972 Cornell Aeronautical Laboratory (CAL) changed its name to Calspan Corporation and converted to for-profit operations. Calspan is dedicated to carrying on CAL's long-standing tradition of advanced research and development from an independent viewpoint. All of CAL's diverse scientific and engineering programs for government and industry are being continued in the aerosciences, electronics and avionics, computer sciences, transportation and vehicle research, and the environmental sciences. Calspan is composed of the same staff, management, and facilities as CAL, which operated since 1946 under federal income tax exemption.

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SUMMARY

This proposal describes a research program aimed at developing training films utilizing computer graphics techniques for use in motorcycle rider education. The approach is based on applying computer simulations and graphics methods already developed at Calspan to special motorcycle rider training problems. Emphasis has been placed on the off-tracking steering technique for cornering (i. e. the initiation of a turn by first steering out of it) but several other potential applications are identified.

1.0 INTRODUCTION

For some twenty years, Calspan Corporation (formerly, Cornell Aeronautical Laboratory) has been deeply involved in research on wheeled-vehicle performance. This background spans a broad range of disciplines (response characteristics, handling qualities, crashworthiness design, accident statistics, etc.) and has produced some of the principal sources of information on many of these aspects which are currently available.

More recently, emphasis has been placed on the development of highly detailed nonlinear mathematical models and digital computer simulations of vehicles which have permitted the investigation of aspects of performance which could not previously be performed with confidence. In conjunction with these developments, computer graphics techniques have been adapted to provide an integrated conception of the overall motion behavior of the vehicle. The work of this nature with single track vehicles is of special interest to the program which is outlined in this proposal.

2.0 STATEMENT OF WORK

Calspan Corporation will provide all necessary qualified personnel, facilities, materials, and equipment to conduct a three month program to produce a motorcycle rider training film of approximately ten minutes duration. The film, in a 16mm color format, will be voice narrated and will concentrate on the demonstration of the off-tracking steering techniques. At least two maneuvers will be used in scenes showing a rider performing in real life. These scenes will be juxtaposed with computer graphics scenes in which the same maneuvers are replicated on the computer.

Calspan expects to have a motorcycle that can be made available to the proposed program but in the event that this turns out not to be the case it is expected that the MSF will provide a motorcycle for use on the program.

The primary output of the program will be a duplicate master of the finished film. However, in addition Calspan will publish a brief letter-type report describing the methodology of the program.

3.0 DISCUSSION

Recent discussions between personnel of the Motorcycle Safety Foundation and Calspan Corporation* identified mutual interests in the development of rider training films. The use of computer graphics to demonstrate proper control techniques was a point of special interest. It was agreed that graphic representations, generated from carefully selected "camera" locations and combined with film of equivalent real life operations, would be effective training aids.

Details of the computer simulation of the motorcycle and rider and of the computer graphics generation methods will not be described here. The main features of these are covered in a number of Calspan reports (Reference 1 through 6). Two of these, Computer Simulation of Bicycle Dynamics and Computer Animation of a Bicycle Simulation are attached for convenience. The important point is that the complete capability for generating the required graphics is currently available and operational at Calspan. The two-wheel vehicle dynamics simulation has been adapted for and is being used in motorcycle design and performance studies; a rider model which is compatible with motorcycle control requirements is operational; and a graphics representation of a motorcycle has been devised.

The rider model is highly adaptable. Although we have not as yet identified all the characteristics distinquishing the experienced rider from the novice, we believe that the utilization of certain motorcycle motion cues (or their failure to be utilized) is the key to this differentiation. To this extent, it is possible to demonstrate the results of improper control as well as the benefits of correct inputs with the simulation and to depict these effects with the computer graphics.

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* Meeting at Calspan in Buffalo, New York between Messrs. Bloomquist and Johnson of MSF and Messrs. McHenry, Milliken, Rice and Roland of Calspan on 6 February 1974.

Calspan capabilities also include an excellent photographic department. Technical personnel are very familiar with techniques and requirements for photographing full-scale vehicle test operations. A full complement of photographic equipment and facilities are available. A brief description of some of these capabilities is attached. It is suggested that the computer graphics be supplemented with film of the actual riding situation to produce complete coverage of the training situation. Experienced motorcycle riders are available and we expect that a suitable unit will be in operation at Calspan and can be made available for this purpose.

It was indicated in the discussions that the technique of off-tracking was of special interest. This technique, which calls for setting up a turn by initially steering away from it, appears to be well-suited to the application of the proposed approach. A typical maneuver of this type is shown in Figure 1. This figure, which is a typical data output from the two-wheel vehicle simulation, shows time traces for primary control inputs and motion outputs in turning from a straight path into a circular path (lateral acceleration of about .3g). The initial steering input in the opposite direction from that of the steady state is clearly shown. Just such an example as this could be used to generate compute graphics which would demonstrate the technique. Other possibilities would be a 90 degree turn and a lane change.

For this purpose, the computer graphics program package has a most desirable feature in that the event can be viewed from any selected point. The "camera" may be panned or zoomed as desired to emphasize any features of interest. In this application, emphasis on the steering activities (closeup of hand motion, for example) would seem particularly appropriate.

Several additional possibilities for training films of similar content and makeup appear to lend themselves to this approach. A partial list would include:

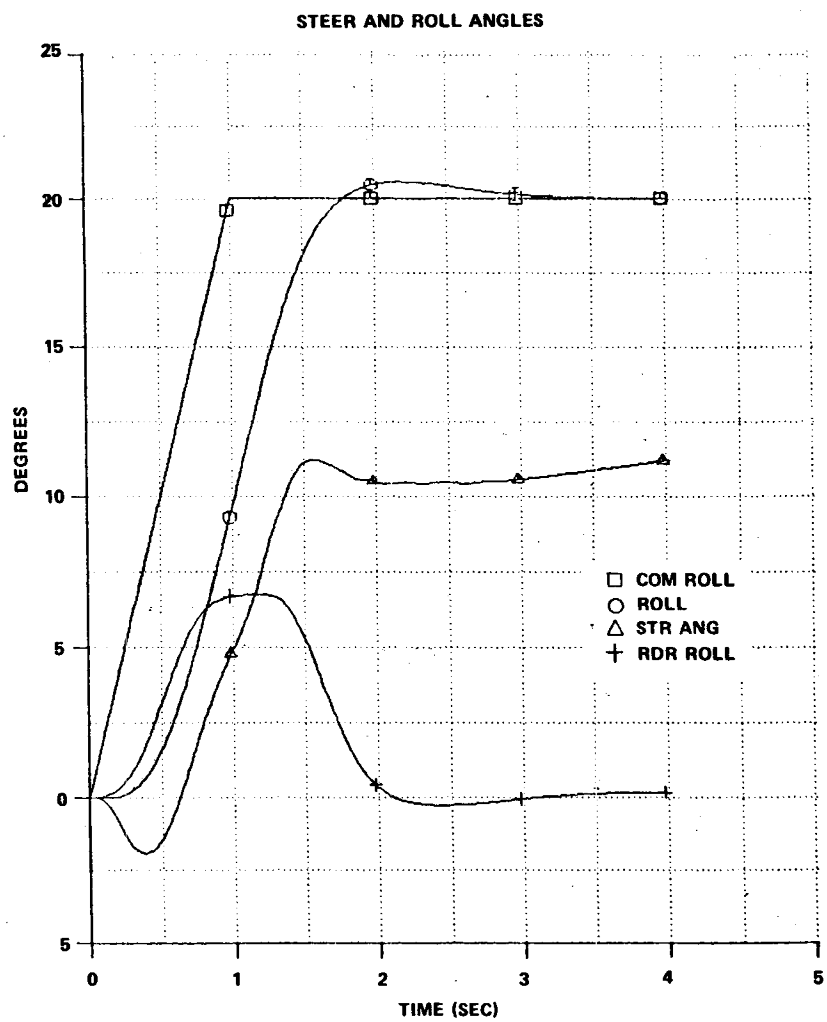

Fig. 1 Steer and Lean Control Response

1. brake application sequence
2. combined braking and cornering
3. wet pavement operations (especially, braking)
4. pitchover avoidance
5. effects of longitudinal pavement grooving on stability
6. off-road operations
7. special problems with "chopper" designs

Some of these would require further development of the simulation program but all are amenable to analysis and treatment similar to that described for off-tracking.

4.0 APPROACH

Although our discussion of the potentialities of applying computer graphics techniques to the problem of motorcycle training films has been given in general terms we propose that this first effort at the production of a film concentrate on the demonstration of the off-tracking steering technique in the context of two different maneuvers - steering into a steady turn from an initial straight-ahead condition and an avoidance maneuver (i.e. a rapid lane change followed by a return to initial path).

We expect that a 16 mm color film of approximately ten minutes duration would cover the above topic quite amply; the film would be voice narrated.

The first step in such a program would be to put together a scenario or script and review this with MSF personnel. Without going into great detail at this point the scenario would contain the following elements:

- Opening scenes of open highway riding with accompanying remarks that touch upon the relationship between riding skill and safety. The notion of off-tracking would be introduced at the end of these scenes.

- Several shots, at the Calspan proving ground, of the performance of the first maneuver, the steady-turn, taken at different perspectives. These would, of course, consist of full-scale turns with a real rider. To the extent possible the off-tracking detail will be shown in close-up.

- At this point the techniques of computer simulation and computer graphics would be introduced to give the viewer a feel for what they involve. One or two computer graphics maneuvers - with their full-scale counterparts - will be shown side-by-side (these will not concentrate on the off-tracking detail).

- The next set of computer graphics scenes will concentrate on the first maneuver (previously seen in "real life"); shots will be shown at several different perspectives including an overhead shot that follows the vehicle through the turn. Since the amount of reverse steer normally needed to execute a turn is small the overhead computer graphics condition can be magnified - i.e. - the steering exaggerated - so that the point is brought home forcefully. Also, the computer graphics scenes will show the contrast between the fast steering response that results with off-tracking and the slow response that results when reverse steer is not used but, instead, the turn is executed by a lean plus steer input. Finally, the computer graphics can show what happens if neither reverse steer nor lean is used but a positive (i.e. monotonic) steer input is used. This last behavior is difficult to show in real life.

- These will be followed by scenes that show the second maneuver in real life. We have suggested an avoidance maneuver but this could easily be any other maneuver with a run time of several seconds.

- As before the next shots will show the same maneuver in "contrasting" computer graphics. Again, one of the points of view of the "camera" will be from directly overhead - following the rider through the maneuver.

- The final scene, undefined at this point, will be devised to close out the film on whatever note is selected as the dominant theme - i.e. safety, skill, learning, etc.

The above outline of a scenario is offered as a possibility for the first attempt at combining conventional footage with computer graphics in a motorcycle training film. It represents a relatively unsophisticated approach that is entirely compatible with Calspan's current motorcycle computer graphics capabilities. Later, if the concept proves to be a useful one, it should be possible to work up to more sophisticated "animations" - we have in mind especially the depiction of accident events in which, for example, the rider disengages from the motorcycle.

5.0 REFERENCES

1. Rice, R. S. and Roland, R. D., "An Evaluation of the Performance and Handling Qualities of Bicycles," VJ-2888-K, 1970, Calspan Corporation, Buffalo, N. Y., (prepared for the National Commission on Product Safety).

2. Rice, R. S. and Roland, R. D., "An Evaluation of the Safety Performance of Tricycles and Minibikes," ZN-5144-K-1, November 1972, Calspan Corporation, Buffalo, N. Y. (prepared for the Department of Health, Education and Welfare).

3. Roland, R. D., "Simulation Study of Motorcycle Stability at High Speed," Proceedings of the Second International Conference on Automobile Safety, July 1973.

4. Roland, R. D. and Massing, D. E., "A Digital Computer Simulation of Bicycle Dynamics," YA-3063-K-1, June 1971, Calspan Corporation Buffalo, N. Y. (prepared for the Schwinn Bicycle Company).

5. Roland, R. D. and Lynch, J. P., "Bicycle Dynamics, Tire Characteristics and Rider Modeling," YA-3063-K-2, March 1972, Calspan Corporation, Buffalo, N. Y. (prepared for the Schwinn Bicycle Company).

6. Roland, R. D. and Rice, R. S., "Bicycle Dynamics, Rider Guidance Modeling and Disturbance Response," ZS-5157-K-1, April 1973, Calspan Corporation, Buffalo, N. Y. (prepared for the Schwinn Bicycle Company).

DESCRIPTION OF PHOTOGRAPHIC CAPABILITIES

AUDIO/VISUAL GROUP

Audio/visual operations are performed by the personnel of the Photography and Presentations sections. As contrasted with the still photography for document reproduction performed by personnel of Documentation's Photomechanics/ Duplicating section, personnel of the Photography section are responsible for the original still and motion-picture photography -- as well as audio and television-video facilities/documentation -- needed by the company and by outside customers. Thus, while Photomechanics/Duplicating provides and maintains the company document-copying facilities and mans document reproduction centers, Photography provides and maintains the company projection and associated audio facilities and, as required, mans projection centers in auditoriums, technical conference rooms, and board meeting facilities. Similarly the experienced industrial artists of the Presentations section prepare primarily sophisticated graphic design, visual aids, and sales literature, as opposed to the technical documentation and proposals prepared by their counterparts in the Illustrations section.

Photography section personnel use extensive, owned color and black-and-white facilities and equipment for the exposure, automatic processing, printing, and projection of still photographs, high-speed 16mm motion pictures (rates of 200 to 22,000 frames per second), and standard 16mm sound or silent motion pictures. Although most of this photography is accomplished on location, some is done using a modern Calspan studio equipped with a Photogenic Studiomaster II studio speedlighting system and a Frontpro HCS front-projection backdrop system in addition to the more conventional studio overhead tungsten lighting system and standard white and colored backdrops.

The photographers employ 22 high-speed motion-picture cameras (six Wollensak FASTAX, five Hycam, four Photosonics, six Stalex, and one Kodak type III) having film capacities of up to 400 ft and equipped with lenses having focal lengths of 5.3mm to 150mm. Nine timing-light generators (timebase calibrators), five automatic camera start/stop and timebase control units, and a number of other accessories are available for use with these cameras. Also utilized are five standard 16mm motion-picture cameras (two Arriflex, one Aurecon [sound-on-film], one Traid, and one Canon Scoopic) equipped with 12mm to 300mm focal-length lenses and with which a variety of accessories, including fluid-drive tripod heads, may be employed. Motion-picture sound equipment includes a professional sound recording booth, five Magnasync recorders with amplifiers, one Magnecorder recorder with amplifier, professional microphones, and a Magnasync microphone mixer. Automatic motion-picture development is accomplished using an Allen 16mm film processor, and duplicate films are made with a Bell & Howell 16mm printer. Footage is edited using a 16mm Moviola, a sophisticated Pic-Sync 16mm editor/viewer for sound and picture conformance, and three professional splicers. Completed 16mm films may be viewed using one of 10 projectors (three Kodak Pageant sound, four Bell & Howell sound, one Bell & Howell silent, and two L & W/Kodak analyzers).

Still photography is accomplished using nine 4 in. x 5 in. cameras (one Linhof Technika V, one Linhof Technika III, two Super speed Graphics, one Crown Graphic, one Anniversary Graphic, one Graf-Check sequence, one Arka view, and one Polaroid MP-3 studio), provided with the usual cut-film, roll-film, and Polaroid backs; one 70mm Hulcher sequence camera; two 2-1/4 in. x 3-1/4 in. Hasselblad (Superwide and 500C) cameras; seven 35mm cameras (one Nikon F-2 Photomic, one Nikon FTN, one Nikkormat, two Pentax Spotmatics, one Leica M-2 and one Robot Royal 35S); and a Fairchild oscillogram camera. A variety of lenses and accessories are available for these cameras. Additional equipment available for making 35mm slides includes a Honeywell Repronar slide copier and a Leitz Reprovit slide maker. Portable electronic flash equipment includes seven conventional units (one Brown, four Honeywell Strobonar, one Ascor, and one Vivitar) and two General Radio Strobotacs.

Development of still photographs is done automatically or semi-automatically by a Kodak Versamat black-and-white film processor, a Kodak Ektamatic black-and-white print processor, a Fairchild oscillogram processor, a Merz S2 color film or print processor (handling sizes from 35mm to 20 in. x 24 in. simultaneously), and a Nord color print processor. For special applications, photographs are processed manually in well-equipped photographic laboratories. The eight enlargers available include a Nord 4 in. x 5 in. color unit and seven black-and-white units: one Durst 5 in. x 7 in., one Beseler 4 in. x 5 in., two Omega 4 in. x 5 in. (one devoted to microfilm), one Omega 2-1/4 in. x 3-1/4 in., and one Leitz Veloy 35mm. Specialized accessories available include an EG&G sensitometer, a Macbeth Quantalog densitometer with reflected-light and transmitted-light attachments, and a Kodak photo-optical data analyzer.

Still projection equipment includes four Kodak Carousel 35mm projectors, one American Optical and two Beseler 3-1/4 in. x 4-1/4 in. transparency projectors, one American Optical opaque projector, and six overhead viewgraph projectors (four American Optical, one 3M, and one Beseler).

Presentations section artists, supported by the Composition and Photomechanics/Duplicating sections of the Documentation group, prepare all original artwork and layouts necessary for viewgraphs, slides, motion-picture titles, general and technical house organs, brochures and handouts, and wall and flip charts. Display copy is prepared within Presentations using a Visual Graphics Corporation Photo Typositor, which can utilize any of 6,200 fonts to produce headings in virtually any type face (style) directly in sizes ranging from less than 9 point to 144 point or, via Posiprint reduction or enlargement, in nearly any other size desired. An Art-o-Graph model 1000 overhead projector is available as an artist's aid for making composite illustrations or for redrawing at changed scale without the use of Posiprints.

Most color and black-and-white viewgraphs are economically made by Presentations using its Transparex color system, which utilizes direct-positive film in any of 11 colors that is exposed by a Thermofax copy machine and developed by one of two Transparex W20 processors. Alternatively, viewgraphs may be made in Presentations using Technifax color materials that are exposed and processed using a Bruning model 70 unit, or in Photomechanics/Duplicating from 3M Colorkey materials that are contact-printed from intermediate photographic negatives.