

# TRAC PAC 2 – A Hands-On Educational Program

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### **DISCLAIMER**

The opinion and conclusions expressed or implied in the report are those of the research agency. They are not necessarily those of the TRB, the National Research Council, AASHTO, or the U.S. Government. This report has not been edited by TRB.

### The TRAC PAC Team

Development of the TRAC PAC was a team effort. All members participated in frequent team meetings that were held on average every other week and commented on each other's work.

In addition, members had specific contributions. R.L. Bell, G. Swan, and R.L. McNall developed the Environmental module, the Technology module, and a Maglev track that actually worked. D.C. Wyant contributed photographs and ideas for the Environmental module. F.M. Brittingham designed the Maglev and SIMCITY modules and diligently pursued perfection in the reproduction instructions for the track. A.E. Wayne created the Motion module, the Interactive Physics component of the Highway Safety module, the layout of the CDs for each of the modules, and, during the coffee break between his second and third period physics courses, conceptualized, designed and built a half scale fully functional nuclear powered reactor that provided electricity for the project. P.J. Massarelli created the Bridge Builder module and provided FTP advice. J. Labrie, K. Mossman, and V. Page wrote the Production Document (AASHTO's guide for reproducing the prototypes) and assembled PAC materials; V. Page also produced several Quick Time videos. C. W. Lynn developed the Highway Safety Module and served as project co-P.I. J.S. Miller can be blamed for creating the "Design and Construction Module," serving as P.I., and holding some of the longest meetings on record.

## ABSTRACT

The original TRAC PAC was introduced in 1994 by the American Association of State Highway and Transportation Officials (AASHTO) as a set of hands-on educational activities designed to interest high school students in transportation and be suitable for classroom use. The goal of this project was to develop a “next generation” TRAC PAC or “TRAC PAC 2.”<sup>1</sup> This new TRAC PAC contains eight modules (Bridge Builder, Design and Construction, Environmental, Maglev, Motion, Safety, SIMCITY, and Technology) with a total of 36 discrete educational activities. Approximately half of the activities might fall into the “high tech” category in the sense that they use computer hardware, software, or a calculator based lab (CBL), and the other half might be characterized as “low tech” in that they use a magnetic levitation track, trucks, paper-based templates, and other materials that don’t require a computer. The TRAC PAC activities include a teacher’s manual (with lesson plans, questions to assess student achievement, educational standards, and hints for the volunteer), equipment (such as calculator based labs, a Maglev track, and impulse pendulum, etc.), and software (data files, bridge design package, Flash animations, and QuickTime movies.)

A team of educators and transportation professionals designed and built prototypes of the next generation TRAC PACs and sent them to ten different schools throughout the U.S. for testing. Subsequent interviews of the teachers who had tested the PACs provided suggestions for making additional improvements. The process used for designing these activities, the types of feedback received, and the subsequent revisions are highlighted in this report. In addition to the eight-module TRAC PAC, a production document has been written to assist AASHTO in deploying the TRAC PAC on a wider scale.

At the request of the Panel, the report highlights administrative/policy options that AASHTO may wish to consider in order to enhance the TRAC program as the new TRAC PACs are distributed. Training highlights are also noted.

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<sup>1</sup> This new TRAC PAC is known as the “next generation TRAC PAC” or “TRAC PAC 2.” In the interest of simplicity, however, we have simply used the term “TRAC PAC” throughout this report.

## INTRODUCTION AND OVERVIEW

The TRAC PAC is a set of hands on educational activities designed to interest students and teachers in transportation. NCHRP Project 20-52 entailed the development of a next generation TRAC PAC by a team comprised of staff from the Virginia Transportation Research Council, the University of Virginia Curry School of Education, Albemarle High School, and Western Albemarle High School. This report *summarizes the approach* followed by the team in order to develop the next generation TRAC PAC. This report is not the main product of the research (the main product is the TRAC PAC itself and the associated production document).

## PURPOSE AND SCOPE

This project entailed the development of eight educational modules, where each module is a set of hands-on educational activities that pertain to transportation. The eight modules are

- Bridge Builder
- Design and Construction
- Environment
- Maglev
- Motion
- Safety
- SIMCITY and Planning
- Technology

Appendix A shows that each module is divided into three or more hands-on lessons, or activities that teachers and students can do in the classroom. Furthermore, each module contains the following items:

- *A loose leaf teacher's manual*, which includes lesson plans (e.g. how to do the activities), links to national science, math, social studies or technology education standards, suggested questions and answers, troubleshooting ideas, drawings, photographs, and suggestions for the TRAC PAC volunteer. Abstracts summarizing the activities in each module are the first page of the teacher's manual. The manuals also contain reproducible worksheets and questions for the students.
- *Hardware*. The supplies for each activity are included. As summarized in Appendix A, these range from paper map-based templates to custom-built magnetic levitation (Maglev) tracks.
- *Software and associated data files*. Some software has been custom made, such as the Flash-based animations for Bridge Builder, and other software is "off the shelf." For example, the TRAC PAC team has created custom data files for use with SIMCITY in the classroom. Simple Quick Time movies are also included in this category.

- *A CD for each module* which houses all electronic material plus photographs that the teacher can use for classroom lectures.

In addition to the eight modules, a “production document” was created for AASHTO. The production document simply describes how AASHTO can reproduce and deliver the eight TRAC PAC modules. A ninth CD contains the production document, electronic permissions to reproduce the pictures that have been provided by others, and other administrative items for AASHTO.

Five prototypes of each of the 8 modules – and the production document – were delivered to AASHTO in February 2002.

## METHODS

Five broad, iterative steps were used to design, build, test, and revise the TRAC PAC modules.

1. *Conduct interviews with transportation professionals to develop possible ideas for the TRAC PAC.* Potential interviewees were identified in different organizations known to be active in the transportation arena, such as the Insurance Institute for Highway Safety, the Federal Highway Administration, the American Planning Association, and the American Trucking Association. A complete list is shown in Exhibit 1.
2. *Design and build draft TRAC PAC modules.* For some modules, ideas from the interviews conducted in step 1 were quite helpful; in other cases, team members contributed their own ideas as topics for module development. Periodic team meetings allowed members to share information and solicit feedback from each other. This feedback included transportation topics (e.g., giving an educator the equations used to eliminate the dilemma zone at a traffic signal) and classroom realism (e.g., what materials are commonly available in the classroom and the time constraints teachers face.)
3. *Obtain feedback from schools and Panel members.* The modules were shipped to classroom teachers who had volunteered to field test different modules. These “testing teachers” had not been involved in the TRAC PAC development and thus could evaluate the module itself without bias. A significant amount of effort was expended at this step to solicit potential teachers who could test the PAC, ship them the materials and teacher’s manuals, follow up and ensure they had received everything they needed, and then interview them with respect to their suggestions for improvement. The interviews were conducted by telephone; then, the interviewer sent the interviewee a printed copy of the interview for clarification. Complete interview responses are included in Appendix C. Some panel members also reviewed the manuals and offered either specific comments and/or general policy suggestions.
4. *Revise the modules in light of feedback received.* The team made changes to the manuals in response to comments received. These ranged from very simple additions (e.g., adding

a glossary as requested by one teacher) to more detailed modifications (e.g., significantly expanding the length of an activity) to wholesale changes (e.g., removing an insurance-based activity altogether.)

5. *Determine how the modules can be reproduced more easily.* Once a module had experienced some success (even though modifications were always necessary) the team looked for ways that AASHTO could reproduce these modules. Towards the latter half of the project, difficulties experienced with producing some of the materials made team members realize that the process for reproducing the TRAC PAC should be documented so that AASHTO could avoid mistakes the team had made. Accordingly, a detailed “production document” was created for AASHTO. Unlike the eight module manuals, the audience for the production document is not the teacher but rather AASHTO, who can use this to reproduce the TRAC PAC prototypes.

## RESULTS

Because the five steps in the methods were interrelated, various types of feedback the team received from different sources (such as the transportation professionals interviewed at the inception of the project, the NCHRP 20-52 Panel members who offered policy suggestions, and the teachers who tested the modules) had implications for the duration of the project.

### Interviews with Transportation Professionals

There is no single all-encompassing definition of the “transportation professional.” However, transportation-oriented organizations, such as the Institute of Transportation Engineers, can articulate what this “transportation professional” does, what skills this person needs, and suggestions for activities that may be undertaken within the next generation TRAC PAC. Interviews with representatives from public and private sector transportation organizations resulted in suggestions for activities in the areas of transportation planning, construction, environmental analysis, safety, and design. For example, the *Institute of Transportation Engineers (ITE)* points out the breadth of transportation careers, listing examples such as teachers, environmentalists, and researchers, in addition to the more traditional examples of designers, builders, engineers, and planners.<sup>1</sup> Accordingly, a wide range of professionals were interviewed as shown in Exhibit 1.

**Exhibit 1. List of Transportation Professionals Who Were Interviewed by Telephone**

Organization	Interviewees or Contacts	Module Topics and Key Findings
American Planning Association (APA)	Peter Hawley and David Carrier	Community-oriented concepts for the <u>SIMCITY/Planning</u> Modules
American Public Transportation Association (APTA)	Karen Glendening and David Phelps	Karen gave concepts for the <u>Planning</u> module and David Phelps urged that multimodal concepts be included in the planning activities.
American Road and Transportation Builders Association (ARTBA)	Bill Buechner; Brad Sant may send barrier information; Stan Lanford,	Ideas for the <u>Construction</u> module (Mr. Sant contacted an ARTBA member, Energy Absorption Systems, who has

Organization	Interviewees or Contacts	Module Topics and Key Findings
	Steve Wright	provided some materials relating to Highway Safety.)
American Society of Civil Engineers (ASCE)	Tom Lenox	Overview of the West Point Bridge Design software for the <u>Bridge</u> module
Association of American Railroads (AAR)	Tom White, Betsy White	Gave another contact and recommended viewing the Federal Railroad Administration (FRA's) Website.
Federal Highway Administration (FHWA)	Nick Artimovich and Richard Powers	Crash barriers and guardrail design for the <u>Highway Safety Module</u> and the <u>Motion</u> module.
Institute of Transportation Engineers (ITE)	Steven Gayle	Play money, role play, and decision making activities for the <u>SIMCITY Planning</u> module.
Insurance Institutes for Highway Safety (IIHS)	Adrian Lund	IIHS Crash Video and ideas for the <u>Safety Module</u>
Intelligent Transportation Systems (ITS) America	John Collura	ITS Signal concepts for the <u>Technology</u> module; simulation suggestions as well.
J.B. Hunt Trucking Company	George Brooks	Optimization Concepts for the <u>Highway Safety Module</u>
National Highway Transportation Safety Association (NHTSA)	Sean McLaurin	CD-ROM and highway safety program concepts for the <u>Safety Module</u>
Society of Automotive Engineers (SAE)	Kathleen O'Connor-Bynres	Implementation of "A World in Motion" 6-8 week kits used by 4 <sup>th</sup> -8 <sup>th</sup> graders
Texas Transportation Institute, Center for Professional Development	Beverly Kuhn	Design of traffic signs and other courses for 3 <sup>rd</sup> -6 <sup>th</sup> graders, transportation awareness course for teachers
U.S. Department of Transportation (USDOT)	Jeff Lindley	Signal timing/CORSIM concepts for use in the <u>Technology Module</u> .
Virginia Transportation Research Council	Mike Fitch	Environmental activities that relate to highway runoff.

### **Designing and Building the Draft TRAC PAC Modules**

It is tempting to say that "Several factors influenced the design of TRAC PAC modules," and to an extent, this is the case: the policy constraints set by Panel members, individual team members' own ideas regarding key transportation components, the relevant national standards, and the general desire to have a broad set of hands-on transportation related activities all affected which activities were selected and how those activities were structured. The ultimate decision as to whether an activity will be used, however, rests with the teacher – thus, the activities were constantly designed and assessed with the teacher (and by extension, the students) in mind. Every activity aimed to fulfill five objectives:

1. *The activity is hands-on.* A key lesson from an evaluation of the previous TRAC PAC was that when teachers were asked whether it was more important for an activity to be hands-on or high-tech, teachers almost always responded "hands-on!" Software, for example needed to be cheap enough that 15 copies (e.g. two students per PC) could be purchased for a classroom. Hardware needs to be cheap enough that TRAC can supply it easily or teachers can acquire it locally. This philosophy means that it is better for students to do an activity where they create a simple animation (e.g. a computer program

that moves cars across the screen at a rate inversely proportional to traffic volume) than it is for students to do an activity where they only watch a complex animation that has been produced by someone else. In short, the goal is for students to do as much as possible rather than simply watching a demonstration.

2. *The manuals are visually appealing.* Diagrams, photographs, and tables were used as much as possible in the manuals: even if words could convey a meaning quite clearly, pictures often stand a better chance of being reviewed than does text. The team used graphics as much as possible, as suggested in Exhibit 2.

### Exhibit 2. Using Graphics Rather than Words in SIMCITY



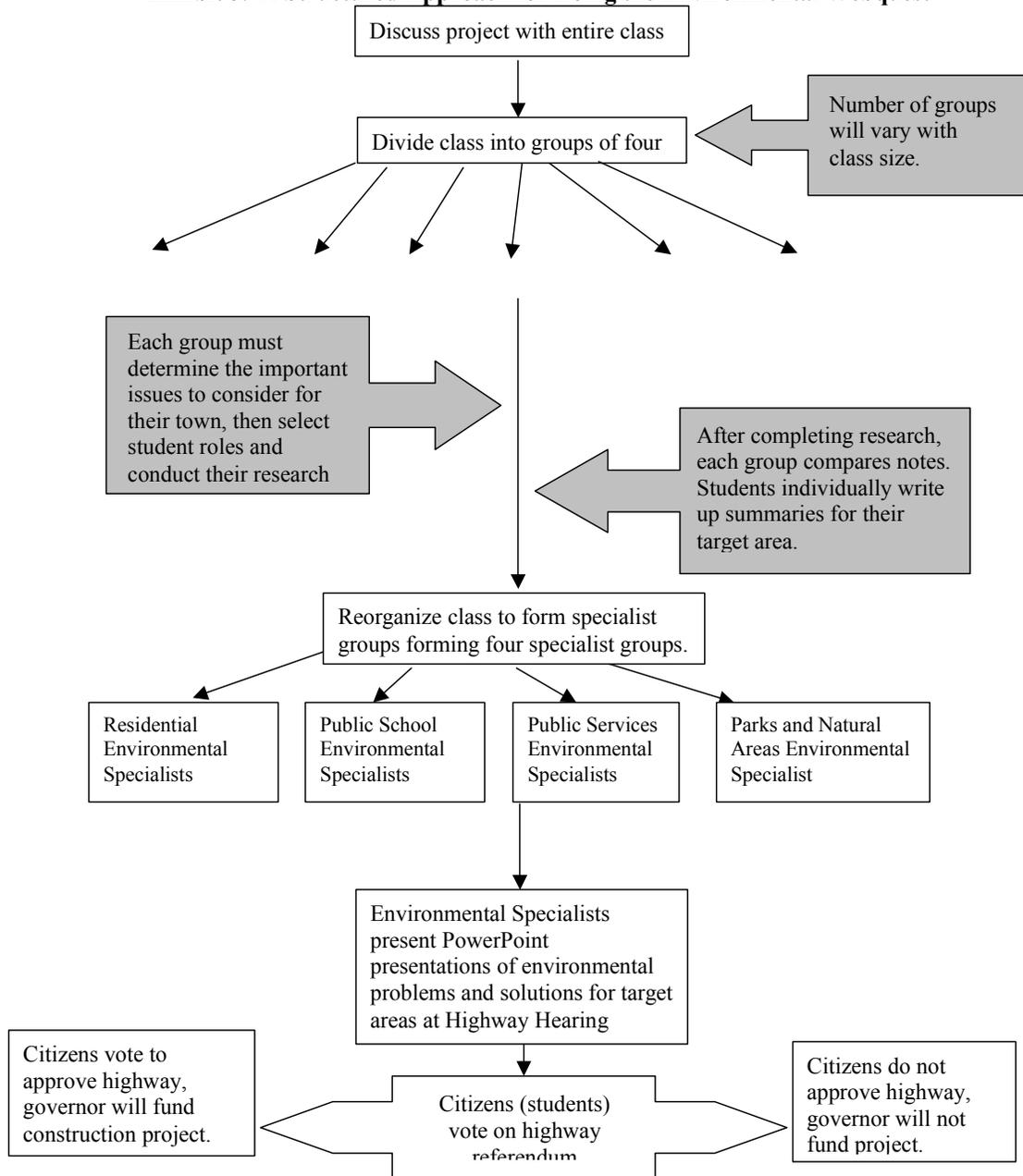
Before: School at Intersection Contributes to Congestion



After: Relocated School, Wider Roads, Mass Transit Reduce Congestion

3. *The activities fit in the classroom curricula rather than being an “extra.”* The team initially brainstormed several potentially appealing activities, such as board games, that were eventually discarded when it became apparent that these activities risked being viewed by teachers as toys rather than learning tools. Simply giving a teacher a copy of the SIMCITY package will not guarantee that this activity can be used productively in the classroom. Instead, it is necessary to suggest a structured approach that moves the use of SIMCITY beyond that of being a video game: the response was to create a “bad” city, illustrate how students can use transportation and/or zoning principles to improve the city, and to offer questions that teachers can assign to students for homework. Further, the questions need to be sufficiently focused such that teachers can evaluate students’ understanding based on their responses. Another example is highlighted with the Environmental Webquest activity: rather than only asking students to “surf the Web to learn out environmental factors in roadway design,” a structured approach comparable to that shown in Exhibit 3 is appropriate.

**Exhibit 3. A Structured Approach for Doing the Environmental Webquest**



4. *The activities “work.”* When materials or software does not perform as intended, the activity can become quite frustrating for teachers and students. In their initial construction of the prototypes, team members experienced these failings firsthand. As shown in Exhibit 4, solutions to these problems included providing better directions, using different materials, and revising the activity altogether. The classroom testing was essential for addressing these problems. Ultimately, the team aimed to retain only those activities that had the potential to work properly over the long term.

5. The *amount of classroom time* required for an activity is reasonable, with most activities being done in 1 to 2 classroom periods. In concert with this requirement is that the activities be independent: even within a single module, the team expected that not all teachers would want to do all activities. Thus, teachers can elect to do all or only some of the activities within a particular module. By extension, to the extent possible, the burden of preparing students for an activity should be relieved by material that comes with the module rather than be the responsibility of the teacher. For example, for the Safety role play, it is the responsibility of the team to devise comprehensive, concise, practical scenarios that can be used in the classroom to accomplish an educational objective rather than relying on the teacher to spend his or her own time preparing roadway drawings and writing mock debates.

**Exhibit 4. Making the Activities Work**

Problem	Solution
The Maglev track warped, causing cars not to levitate	(a) Use chocks (spacers) for the track when not in use (b) Use Silicone spray to reduce friction
The Maglev cars were not balanced	(a) Redo the magnetic tape for the cars (b) Use consistent dimensions for the cars and track
Students have trouble finding the Graphical Analysis data files in Design and Construction	Change the subdirectory names such that they are no longer than 8 characters
Students have trouble installing some of the Design and Construction software	(a) Provide step-by-step diagrams and instructions (b) Redesign Activity 5 to automatically find key files (c) Write a subroutine to remove the read-only property
The SIMCITY lab packs (which contain 5 licensed copies) only work on one CD	Contact the SIMCITY distributor to correct the error Burn extra CDs as necessary (and with permission)
It might not be clear how to connect the CBL equipment.	(a) Provide step by step diagrams showing connections (b) Install software on the graphing calculator before shipping
The Tri-fold board for the Safety posters tends to fall over	Use hanging posters (with holes or pins)
It takes teachers a while to gather two liter bottles for Environmental Activity 1	In the initial cover letter, specify that teachers will need to supply these
It is difficult to launch two cars with the same amount of force as recommended in a Motion activity	Build, and then redesign a simple rubber band launcher for the Maglev track
The crash cushions in the Motion crash barrier activity sometimes give inconsistent results	(After several modifications to the ramp, barrier, and filling material) eliminate the activity from the PAC

**Feedback Received from Schools and Panel Members**

*Activity Feedback Received from Schools*

As shown in Exhibit 5, ten schools were involved with evaluating the TRAC PAC activities, culminating in 15 detailed interviews.

**Exhibit 5. Module Testing Schedule**

Module	Schools (teacher), and date module was sent for initial testing. (Schools where a module was sent but no testing resulted are not shown)	Interview Dates
Bridge Builder	Madison HS, Texas (Joseph Weithers--all activities except Flash) July 13	Sept 28
Design and Construction	Thomas Dale HS, Virginia (Cathy Epps--activities 1,2,3) March 2001 Albuquerque HS, New Mexico (Les Peterson--activity 5) May 2001 Lincoln HS, Texas (Darren Carollo--all activities) June, 2001	May 16 June 14 August 16, Oct. 5
Environmental	Paseo HS, Missouri (Paul Kehmeier on behalf of Jackie Brown) May 2001 St. Anne's Belfield MS, Virginia (Becky McNall--student evaluation only)	July 30 August 1-31
Maglev	Thomas Dale HS, Virginia (Cathy Epps) Nov 2000 Phoenix Center, Maryland (Lynn Shine) Nov 2000	May 1,4 May 1,4
Motion	Thomas Dale HS, Virginia (Cathy Epps) Nov 2000 Phoenix Center, Maryland (Lynn Shine) Nov 2000	May 16 May 16
Safety	Perry Hall HS, Maryland (Mike McIntyre--activity 1) April 2001 McDonald County HS, Missouri (Julia Kay Eichman) April 2001	May 21 May 24
SIMCITY /Planning	Perry Hall HS, Maryland (Mike McIntyre) May 2001 McDonald County HS, Missouri (Julia Kay Eichman) May 2001	May 21, Aug. 17 May 24, July 11
Technology	Northfield HS, Vermont (Jerry Carruba) May 2001	Aug. 31

The complete teacher interview results are shown in Appendix C, and these results were instrumental for determining what modifications were necessary. The teachers generally “liked” the activities but did recommend several changes, which have subsequently been made. Generally, these changes can be summarized across five areas:

- *the initial presentation of the module.* Upon opening the box, teachers need to know what are the materials contained in the module; for example, one teacher who was new to the Maglev module thought the blue Styrofoam included inside the track was simply packing material rather than cars that accompany the module. For each module, the solution was to include a diagram of the supplies (see Exhibit 6) as well as a cover letter articulating which easily accessible materials teachers needed to supply themselves (such as empty two liter soda bottles.) Teachers also requested guidance for how to progress through the module (e.g., is it necessary to do all of the activities?) and suggestions on how to manage the class to do the activity (e.g. recommended group sizes). Simple aesthetic changes, such as a plastic container rather than a cardboard box for storing the materials as well as colored tab dividers for the notebooks, were also made at the teachers’ suggestion.

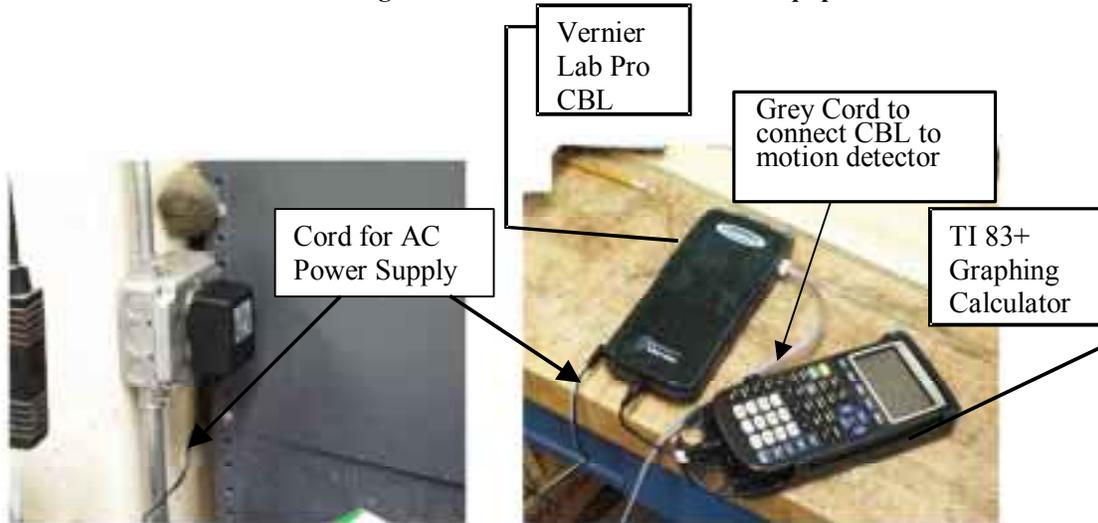
## Exhibit 6. Example Diagram of Supplies in a Module (Bridge Builder)



- the content of the activities.* Within the specific activities, teachers made specific suggestions. For example, one teacher noted that Design and Construction Activity 1 could be expanded to have the students doing more with measuring flow rates; in SIMCITY, a budgeting piece was added as requested, and in Maglev, the car contest was brought back after several teachers mentioned its potential. Teachers also noted technical enhancements, such as adding “silt” as a material and to collect field samples within the Environmental module. Finally, some feedback resulted in changes to the activity materials: in Maglev, wooden spacers or chocks were inserted during storage because one teacher noted that the tracks could warp over time without the chocks. In the Motion module, one teacher’s frustration with \$2 stopwatches led the team to use more expensive but more reliable \$6 stopwatches.

- *the directions in the manuals.* Teachers, students, and Panel members caught errors and noted areas that needed additional explanation. These included word changes (such as using “before” instead of “prior” for eighth grade students), safety explanations (e.g. requiring goggles for Bridge Builder where students cut materials with an Exacto knife), and corrections to worksheets and graphs. In some cases additional instructions were added, such as how to install software or how to connect different components of the calculator based labs (Exhibit 7).

**Exhibit 7. Diagram of How to Connect the CBL Equipment**



**Figure A: Power Supply**

**Figure B: CBL and Graphing Calculator**

- *the formatting of the manuals.* There had been concerns that the manuals would be too long, but when asked, teachers did not note length as a problem—in fact, several teachers noted that additional explanation could be helpful. Teachers felt strongly, however, that organization was critical, and initially there was confusion as to which portion of the manual was for the teacher and which portion was for the student. Dividers in the three ring binders and clarifying information in the introduction were the response to this request. Some teachers also asked for more background information as was the case of a biology teacher was covering Newton’s Laws within the Maglev module. Finally, suggested answers are supplied as requested: interviewees pointed out that even open-ended questions could still have a “suggested” answer that a new teacher could use as a resource.

### *Policy Feedback Received from Panel Members*

The Panel members provided comments throughout the project, and their initial comments influenced the direction the activities took. In addition to specific activity comments, five general guidelines were followed by the team:

1. The TRAC PAC should be a *mixture of activities* that use the computer, specialty software, or equivalent (e.g., “high tech”) and activities that can be done with locally

available materials (e.g., “low tech.”) It was emphasized that these delineations should not replace the overall TRAC PAC goal, which was to provide transportation activities that would interest students and teachers alike. Accordingly, of the 36 activities that have been designed, the split between “low tech” and “high tech” is approximately 50/50.

2. The modules should have both *metric and English units*. In some cases, it was most practical to have units side by side within the activity. For example, in the case of the Design and Construction module, curve design tools are provided that students can use to connect two tangent sections at a specified design speed. The design speeds are printed directly on the curve tools in both English and metric units—e.g. “50 mph” and “82 km/h. In other areas, such as the Environmental module where the scholastic standard is to use only metric units, a connection between English and metric units has been provided for the volunteer as mentioned in item 3.
3. The manual should have *one page for the volunteer*. The rationale was that the volunteer’s role is to provide a connection between the educational activity and the real world; thus, the one-page section enables the volunteer to quickly digest the main topic of the module without having to read the activity details. For example, consider the Motion module, which covers experiments with a runaway truck ramp, an impulse pendulum, the Maglev track, and calculator-based labs. The volunteer does not need to know all the details of these activities; instead, the volunteer might discuss technical issues (such as how safety affects transportation in terms of designing work zones or vehicles) or policy issues (such as the selection process for safety improvement projects or the tradeoff between throughput and safety with respect to signal phasing.) Thus, the one page volunteer’s section is meant to appeal to a wide range of volunteers and to give them tips for linking their diverse experiences to the classroom, without spending an inordinate amount of time learning the classroom activities.
4. The manual should have *enhancements for those teachers* who wants to spend extra time with the class going beyond the given activities. Thus, an “enhancements” section has been included; for example, in the Maglev manual, teachers have the option of doing a car contest (which frankly is a lot of fun for the students!) but this activity requires an additional time investment.
5. The activities should be linked to the *appropriate national education standards* in the areas of science, math, social studies, and technology. Exhibit 8 shows that there are two sets of technology standards, one sponsored by the International Society for Technology in Education (ISTE) and one sponsored by the International Technology Education Association (ITEA). The two technology sets fill different niches in the classroom. For example, consider Design and Construction Activity 5 (Take the Short Way Home!). That activity relates to the ISTE standard titled “apply simulations in real world situations” as the algorithm students implement using the computer simulates decreases in traffic speed that will result from an increase in traffic volume. That same activity also pertains to an ITEA standard entitled “intelligent transportation systems”, since students are introduced to a fundamental ITS component: the communication of real time travel information (such as upstream vehicle speeds via changeable message signs).

### Exhibit 8. National Education Standards

1. *National Science Education standards*. National Research Council, National Academy Press, Washington, D.C., 1996, chapter 6. Available online at <http://www.nap.edu/readingroom/books/nses/>
2. *Principles and Standards for School Mathematics*, National Council of Teachers of Mathematics, Reston, Virginia, 2000. The online document is located at <http://standards.nctm.org/> . The most relevant portions are shown, however, at <http://standards.nctm.org/document/chapter7/data.htm> (standards for grades 9-12) and to a lesser extent, <http://standards.nctm.org/document/chapter6/index.htm> (standards for grades 6-8). See also <http://standards.nctm.org/document/chapter7/geom.htm> and <http://standards.nctm.org/document/chapter7/alg.htm>
3. *Curriculum Standards for Social Studies: Expectations of Excellence*, National Council for the Social Studies, Washington, DC, 1994. The online document is located at: <http://www.socialstudies.org/standards/toc.html>
4. *National Educational Technology Standards for Students: Connecting Curriculum and Technology*, International Society for Technology in Education. 2000. The online document is located at <http://cnets.iste.org/> (One clicks the “NETS for Students: Connecting Curriculum and Technology” button to download a PDF version of the standards. Pages 14-20 list the technology standards by grade level). Also see <http://cnets.iste.org/index2.html>.
5. *Standards for Technological Literacy: Content for the Study of Technology*, International Technology Education Association. The online document may now be viewed at <http://www.iteawww.org/TAA/STLstds.htm> (introduction), <http://www.iteawww.org/TAA/STLxesum.htm> (executive summary), and <http://www.iteawww.org/TAA/PDF/xstnd.pdf> (full standards).

### Revisions Made to the Modules Based on Teacher and Panel Feedback

As explained previously, several types of changes were helpful toward improving the modules – picking different materials, using different activities altogether, and altering the wording of the teacher and student sections in the manuals. Two types of changes, not yet described, merit inclusion here. *First*, the team looked for ways to reduce the expense of materials, balancing the PAC’s functionality and cost. In hindsight the proper tradeoffs are blatantly obvious, but at the project’s inception – before one knew what specific hardware and software could accomplish – the proper balance between materials and cost was muddy at best. *Second*, the team made changes to the scope of work outlined in the proposal (with the Panel’s concurrence) as technology and the needs of the TRAC PAC 2 became clear. An example of these two types of changes – reducing cost and changing the project scope – illustrate the kind of thinking the team had to do for the eight modules.

#### *An Example of Reducing Cost*

As an example of how activities were chosen and developed in light of balancing cost with functionality, consider Activity 4, entitled “Keep Me on the Road!” from the Design and Construction module. The idea for the activity arose in November 2000 when Panel members pointed out they wanted an activity that encompassed some interesting visualization of design, so

that students could see some of the animations produced by software such as AutoCAD, Geopak, and 3D Studio Viz. In response, the team searched for software that could meet at least five criteria to support a feasible classroom activity. In short, the software (or at least the activity) needed to be

- *interactive*. Excellent animations are available in a wide variety of formats from television, movies, and games, but for classroom use, the students needed to be involved with creating an animation rather than simply watching a movie another person had created.
- *inexpensive*. Splitting an estimated TRAC PAC cost of \$2,000 among eight modules suggests, as a ballpark figure, about \$250 for the Design and Construction module which needed to be allocated among the multiple activities within that module. When one considers that a typical classroom might have as many as 30 students, then even presuming students can share software, one needs to be able to purchase up to 15 copies within that cost amount.
- *multi-platform* so that it runs on the Macintosh and IBM computers.
- *user friendly* so that teachers and students can quickly get started. Generally TRAC PAC activities are designed to last no more than a few classroom periods unless otherwise desired by the teacher. A package that might require several weeks to “get up to speed” would likely not be used in the classroom.
- *matched to the school curriculum*. Roadway design by itself (and learning an associated software package) does not necessarily fit into a high school or intermediate school classroom, and thus will likely not be used unless there is a clear link between the activity and a subject students are required to learn. For example, knowing the minimum radius of curvature is probably not going to be of much value in the classroom unless it can be linked to a legitimate educational topic, such as physics (e.g. centrifugal acceleration), math (e.g.. through the algebra and geometry used to derive the relevant equations), technology (the use of information technology to implement solutions from the basic sciences) or social studies (e.g. through a debate of the pros and cons of different kinds of solutions, such as low speed roads that require less right of way).

In December of 2000, a software search revealed several possibilities, and one product in particular – High Road manufactured by Creative Engineering – seemed promising, given that High Road was a Mac and IBM design package expressly created for road design. At the time, the price was \$1,500 per copy (industrial version) and \$95 per copy (individual version), although the manufacturer had indicated that copies might be available within the team’s budget. The team purchased this software (one full copy at \$1,500 plus 20 individual copies at \$95 apiece) and designed an activity based on an introductory road suggested by High Road. By June 2001 Activity 4 was completed and was sent to a high school for testing and in July 2001 Creative Engineering asked if the activity could be given to Polytechnic University in Malaysia (who had requested a demonstration of High Road’s capabilities.) After getting feedback from the high school for testing Activity 4, the team asked Creative Engineering if now a lower price –

in the \$100 to \$200 range for a classroom, not just an individual PC, was feasible, and after some negotiating with its suppliers, Creative Engineering noted that a classroom site license could be given to AASHTO for \$195 (up to 20 computers, which can accommodate a class of up to 40 students). Thus, a high tech roadway design activity became available for inclusion within the TRAC PAC at a low cost.

Activity 5 of the same module illustrates another tradeoff. That activity has two components: a Visual Basic for Applications (VBA) exercise within Microsoft Excel, where students write a computer program that makes cars move across the screen relative to traffic congestion, and a demonstration of a commercial simulation package, where students can see animations of traffic congestion under two different signal timing scenarios. The cost of purchasing the full commercial simulation package was prohibitive, however, the demonstration is available free of charge. Thus, most of Activity 5 focuses on the VBA portion (which is interactive), enabling students to create animations themselves; then, at the conclusion of Activity 5, students can watch a quick example of professional animations.

### *Changes to the Project Scope*

There were three main changes to the modules that the team did not envision at the time the initial proposal was submitted. (The team believes all of these changes are for the better and all have been made with the Panel's consent.)

- Eight, rather than nine modules were produced, due to transportation and SIMCITY being merged into one module. (However, the expected number of activities rose from "between 9 and 18" to 36.) Initially, the transportation module was going to have a role play; however, elements of this role play are incorporated in the Safety Module (Activity 1) and the Environmental Webquest, thus the core idea of a debate has been preserved.
- Simple Quick Time movies were produced. The Panel noted that a promotional video was not necessary since that would be part of a separate project, and as this effort progressed the team realized that simple Quick Time silent movies could supplement the manuals and quite frankly be entertaining as well! Thus, the team produced approximately one quick time video per module that illustrates the "how to" of a challenging activity: for example, a Maglev video illustrates how to design cars for the car contest, the two Motion videos illustrate the truck ramp activity and the egg toss contest, the Safety video illustrates the role play, and so forth. (Including these videos may encourage students to produce their own homemade movies, but at this point that hope is just speculation.)
- In addition to "how-to" diagrams and photographs created by the team, additional pictures created by other sources have been included within the modules to give a better feel for real world applications, such as Exhibit 9. Permission to use these pictures has been obtained and the permission letters are included on the AASHTO administrative CD.



**Exhibit 9. Courtesy of the Railway Technical Research Institute**

### **Create a Production Document for Reproducing the PAC**

A detailed production document for AASHTO has been created that illustrates how AASHTO or a third party supplier can create these modules from scratch. In some cases, the main benefit of the production document is to identify who currently is an inexpensive supplier of key materials (including a listing for how bulk pricing can reduce costs.) Other parts of the production document point out how to physically create the materials where this instruction is critical. For example, the Maglev track works quite well only if one uses the correct measurements for the Styrofoam car width, the track width, and the magnetic tape offset!

### **RECOMMENDATIONS FOR DELIVERY OF TRAC PAC 2**

At the Activity Demonstration meeting on December 19, 2001, Panel members asked two questions of the team that pertain to the delivery of the next generation TRAC PAC. First, it was suggested that the team include a list of possible highlights that would be covered in a one day training course for new TRAC PAC teachers and volunteers. Second, the team was asked whether they had any thoughts regarding institutional or administrative obstacles to a successful TRAC PAC deployment.

#### **Training Suggestions for the Specific Modules**

In the revised TRAC PAC, it is expected that teachers would be the ones who need to do the activity, whereas volunteers would need to be able to describe real world applications as suggested in the Volunteer's page within each module. Suggested highlights for TRAC PAC training *for teachers* are recommended as follows presuming a one day training course.

**Exhibit 10. Suggested High Points of a One Day TRAC Training Course**

<b>Module</b>	<b>Recommended Training for Teachers</b>	<b>Time (mins)</b>
Bridge Builder	How to get started with Model Smart software	20
	How to join individual pieces of balsa wood	15
	Breaking the basic box	15
Design and Construction	Choosing the road layout for the different scenarios in Activity 2	15

Module	Recommended Training for Teachers	Time (mins)
	Overview of Visual Basic for Applications (VBA) within Excel	30
	How to get started with the High Road Design software	30
Environment	Mixing the floccing agent within the solution	20
	Pursuing the environmental Webquest	30
Maglev	Balancing and racing the cars	15
	How the charting reflects Newton's first and second laws	15
	How to quickly use the graphing capability of Graphing Analysis	20
Motion	Connecting and using the CBL and the Motion detector	15
	Doing the impulse pendulum demonstration	05
Safety	Using money for the Posters role play	10
	Using Interactive Physics	30
SIMCITY and Planning	The basic rules of SIMCITY	30
	The concept of the "bad city in trouble"	05
	Making improvements with transportation only vs. zoning only	10
Technology	Using the Vernier magnetic field sensor	15
	Using the CBL photogates	15
	Boolean logic	15
	Building a solenoid from scratch	15

Certainly volunteers could benefit from the training as well, but such volunteer training should focus on how the volunteers can relate their diverse experiences to a particular module. For example, consider the "Technology" module. While the "Technology" activities appeal directly to signal timing experts, there are a wide variety of other transportation professionals who can make a classroom contribution to this activity.

For that module suppose a volunteer works in an administrative purchasing department and has no experience whatsoever in traffic signals. That volunteer can still relate his or her experiences by describing the importance of making equipment purchases based on a variety of factors such as cost, performance, warranties, reliability, training availability, and user friendliness. The volunteer can then explain that signals, like any technology that must be purchased, have capital, maintenance, and life cycle costs that must be considered. By contrast, suppose the volunteer works in a non-technical management capacity. That volunteer can then describe how interjurisdictional coordination is critical to having signals work effectively, even relating (unfortunate but true) stories of how signals might not be coordinated simply because they cross jurisdictional boundaries. In both cases, these two different volunteers can explain that their backgrounds (purchasing and coordination) are as important as any of the technical timing issues addressed in the Technology module.

In sum, the volunteer training should focus on encouraging volunteers to be able to relate their experiences to the module at hand, regardless of the volunteer's specific educational or work background. The teacher training should probably be more technical, since it is usually the teacher who must make the activity work in the classroom.

## Recommendations for Implementing the TRAC Program en Masse

At the December 19, 2001 review meeting the Panel also asked if there were any recommendations that the team had for AASHTO as it seeks to increase TRAC participation on a larger scale. Although this 20-52 NCHRP research effort had focused on simply developing the TRAC PACs themselves, some of the experiences of the team can be examined in light of the policy recommendations from an earlier 20-07 NCHRP report that evaluated the original TRAC PAC and touched on policy options as well.<sup>2</sup> That report contained some 35 recommendations, and the first 22 referred directly to creating the TRAC PAC itself, which the team believes are now reflected in the current TRAC PAC design. Recommendations 23 through 35, however, addressed the educational standards and the TRAC PAC administration – and the team believes that many of the points highlighted therein are still relevant. The following tips may prove helpful in future efforts:

- *Consider relating the national standards to the appropriate state standards on a pilot basis with a few states and a sample of the modules.* Linking all of the national standards to all of the state standards for the TRAC PAC is a cumbersome process, so logically one would not want to undertake that effort unless AASHTO could be assured there would be some benefit. Accordingly, a sample mapping of state educational standards to modules could suggest whether such an approach has merit. The audience for such a mapping would in many cases not be the teacher, as teachers who were interviewed for this project often indicated they were not influenced by the standards. Such a mapping, however, could be a way for AASHTO to open dialog with principals, state Departments of Education, and others who manage the high school curricula.
- *Market the TRAC PAC at the appropriate educational conferences.* Several of the activities in the TRAC PAC address skills that interviewees had cited as important during the original 20-07 project, such as problem solving, designing an experiment, and integrating two or more disciplines (e.g., understanding how history and technology have influenced land development, or discerning the technical and policy implications of designing narrower roads with lower speed limits.) Examples of educational conferences include the National Science Teachers Association (NSTA) meeting as well as state-based conferences.
- *Consider making elements of the TRAC PAC available to 7<sup>th</sup> and 8<sup>th</sup> grade students.* Certain activities within the modules (for example, the first activity under Newton's First Law and the first activity under Newton's Second Law) are geared specifically to younger students. The value of introducing the TRAC PAC early is that by late high school (e.g. 11<sup>th</sup> grade), many students are already locked into a specific course tracking (college preparation, math/science emphasis, and so forth.)
- *Use the TRAC Website to stimulate discussion between educators, volunteers, and the TRAC National Headquarters.* The team incorporated real world linkages into the manuals as well as troubleshooting tips. Undoubtedly, however, teachers will develop additional suggestions. (For example, one interviewee found that when her students failed to bring in beans and other materials from home for the runaway truck ramp

activity, they were able to use other things in the classroom – even their sweaters! – as a substitute for the aggregate.) The Website can highlight such solutions. Recommendation 30 of the 20-07 report detailed several ways in which the Website could be used to reward educators and volunteers for sharing their ideas as well as eliciting feedback from students. Periodically, such feedback can be used to update the PAC, with revisions to the manuals, software updates, and troubleshooting tips being posted to the TRAC Website.

- *Continue conversations between AASHTO and TRAC users.* Realistically, the team does not foresee that the new TRAC PAC will eliminate the need for face to face interaction. Through testing and revising the activities, it is hoped that more of the activities will be usable by teachers without having to have quite as much technical training. No activity, however, can substitute for some of the face-to-face interaction suggested in recommendations 33, 34, and 35 of the 20-7 report. Coordination between AASHTO, the TRAC Regional Centers, the state Department of Education, and teachers is thus still relevant. As an illustration, consider that during the 20-07 project, at least eight different objectives for the TRAC program were mentioned:

- (a) to recruit engineers for the state DOT,
- (b) to stimulate interest in transportation from a civil engineering perspective,
- (c) to increase student interest in math and science,
- (d) to increase minority and female recruitment (either in engineering or within a state DOT),
- (e) to teach that transportation is an interdisciplinary field (e.g., bridges, planning, environmental studies, etc.)
- (f) to improve local education,
- (g) to portray engineering as a creative blend of humanity and science, and
- (h) to make students better “consumers” of transportation services, even if they do not enter the field.

It is reasonable that TRAC’s emphasis might vary from state to state or even within states: in one setting, TRAC might focus on simply improving local education, whereas in another setting, as suggested by a Panel member, TRAC is an optional weekend program geared specifically toward female students. When deciding these objectives for a specific state or location, however, it will probably be helpful for the AASHTO director (or his representative) to have some conversations with the TRAC users or equivalent regarding how the program can be implemented and what types of support are needed from the volunteers and the national headquarters.

- Find a TRAC “champion” at the state or local level. The most effective programs seem to have a person who interacts with all of the players and coordinates their activities. Although it probably help matters if the champion is at a high level of government, the champion can make a difference if she or he can overcome obstacles to active TRAC participation, with tactics such as
  - enabling volunteers to visit schools (and prepare lessons) while at work rather than on their own time,

- ensuring that volunteers have the support of their supervisors,
- opening the lines of communication between the education and transportation departments,
- creatively pursuing avenues for the TRAC program inside and outside of regular school hours, and
- aggressively looking for volunteers within the state DOT, consulting firms, and other transportation organizations. (It is easy to think of ideas that can spark an interest in the TRAC program, such as a poster display of TRAC activities, but it is harder to actually take the time to implement these ideas.) There is no substitute for a TRAC champion at the local level.

### **CONCLUDING REMARKS: HOW CAN TRAC COMPETE IN THE CLASSROOM?**

The earlier 20-07 project showed that getting a program into schools is difficult: teachers have many demands on their classroom time, and there is no shortage of educational resources, many of which are available over the Internet. Although one can argue that the TRAC program is multidimensional, we suggest that the TRAC PAC can be a useful resource that enables the TRAC program to gain a competitive advantage on two fronts:

1. *The TRAC PAC is a set of hands-on, educator-designed activities.* Despite the team's attempt to include lots of neat gadgets, TRAC cannot compete with other programs, video games, and other stimuli on the basis of technology alone. TRAC can compete, however, by adopting the attitude of "we have some cool stuff but more importantly, it is ready for educational use in the classroom". *The Washington Post* drew a line between having high tech resources and being able to use them effectively, noting that only "one-third of public school teachers who have access to computers or the Internet at school feel well prepared or very well prepared to use them in teaching..."<sup>3</sup> The implication is that for the new TRAC PAC, additional emphasis is placed on teacher familiarization lest the TRAC PAC fall into the same category as existing computer resources.
2. *The TRAC program is supported by a set of real volunteers who come to the classroom.* There is no substitute for having a practitioner come and be able to talk to students about how the existing activity relates to real world applications. This volunteer need not be familiar with the details of the activities themselves (that's the teacher's job)—instead, the volunteer simply needs to understand the gist of the activity, as summarized in the one page volunteer's section, and then be able to describe how transportation work relates to that activity.

The team hopes that the prototype next generation TRAC PACs delivered to AASHTO in February 2002 will help address the first objective. The second objective, however – active involvement of the volunteers – remains critical.

## APPENDIX A. TRAC PAC MODULES, ACTIVITIES, AND CONTENTS AT A GLANCE

An *activity* denotes a discrete lesson that a teacher can do with students, and a *module* is a set of activities organized around a particular topic area. For example, the “Bridge Builder” module has five separate activities – a Flash-based animation explaining structural concepts, a series of very short demonstrations regarding bridge beam strength, an introduction to bridge design software called ModelSmart, a hands on activity with a “basic box” bridge structure, and a competition where students design and test their own bridge improvements.

**Exhibit 11. TRAC PAC Modules and Activities**

<b>Bridge Builder</b>	Structural Concepts Beam Me Up Computer Based-Bridge Modeling Basic Box Bridge Structure Improved Box Bridge Structure
<b>Design and Construction</b>	How Much Traffic Can the Road Handle? Not In My Backyard!! How Much Does it Cost? Keep Me on the Road! Take the Short Way Home
<b>Environment</b>	Settling Out Filtering the Silt The Connector Highway Project: An Environmental Webquest
<b>Maglev</b>	Timing Newton’s Apple: How Accurate is Your Measurement? Running the Gauntlet (Newton’s First Law) Graphing the Gauntlet (Newton’s First Law) Caution: 6% Grade Ahead (Newton’s Second Law) Graphing the Grade (Newton’s Second Law) Wrap-up and Racing
<b>Motion</b>	Bump-N-Run Calculated Collisions Design Your Own TMS Egg Catch Impulse Pendulum Run Away Truck!
<b>Safety</b>	Quick Fixes for High Crash Highways Collision Calamity Barrier Bumping
<b>SIMCITY and Planning</b>	Transportation Zoning* Transportation and Zoning
<b>Technology</b>	Calculating Reaction Time Calculating Braking Distance Setting Yellow Light Period Traffic System Logic Reactive Traffic Technology

\*Zoning covers elements of land use planning –e.g. deciding where homes, offices, and schools should be built.

The TRAC PAC materials are detailed in the Production document and are summarized in Exhibits 12 and 13 below.

**Exhibit 12. TRAC PAC Hardware Summary**

<b>Module</b>	<b>Hardware</b>
Bridge Builder	Balsa wood, Exacto knives, cutting supplies
Design and Construction	Popcorn, funnels, maps
Environment	Calgon, flumes, sieves, soils, gravel, burlap
Maglev	Styrofoam cars, maglev track, silicon spray Cutting tools & materials for creating cars
Motion	Trucks, impulse pendulum, motion detector
Safety	Posters, play money, money boxes
SIMCITY and Planning	None
Technology	Hot Wheels Cars, road track, Magnetic field sensor and solenoid CBLs, graphing calculator, photogates,

**Exhibit 13. TRAC PAC Software Summary**

<b>Module</b>	<b>Software</b>
Bridge Builder	ModelSmart bridge design software Flash Animation for Activity 1
Design and Construction	High Road Design Software Visual Basic for Applications (free w/Excel) Synchro/SimTraffic (demonstration only) QuickTime movie <i>Popcorn.mov</i>
Environment	Environmental Webquest QuickTime movie <i>Flume.mov</i>
Maglev	Graphical Analysis (spreadsheet software) QuickTime movie <i>MaglevCarContest.mov</i>
Motion	QuickTime movie <i>EggInMotion.mov</i> QuickTime movie <i>MotionTruckRamp.mov</i>
Safety	Interactive Physics QuickTime movie <i>UnrulySafetyMeeting.mov</i>
SIMCITY and Planning	SIMCITY 3000 (not “unlimited”)
Technology	DataMate/DataGate (CBL) OR Logger Pro (PC) Excel/Graphical Analysis

Because the vision of the TRAC PAC is that each module should be independent (e.g. a school could acquire Maglev but not SIMCITY), the organization of each manual has been tailored to the particular module. In other words, there is a reason that the modules have a different style of organization, and this reason becomes apparent when one looks at the three ring binders with the tabs. *The logical dividers within each module are different.* For example, in Maglev, there is a natural division between Newton's First Law and Newton's Second Law. Each law groups together two activities. On the other hand, in another module, such as Bridge Builder, such a grouping would make no sense. Instead, in Bridge Builder, it is appropriate to have each activity have its own tab.

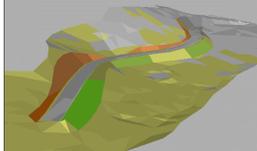
As an editorial aside, one might also ask why the tabs are not always even when looking at the table of contents. For example, in the SIMCITY module, one can see that "Activity 3: Transportation and Zoning" gets its own tab whereas "National Education Standards" does not. The reason is that even though those two headings are both second order, *they are not equivalent in importance.* One can easily see a teacher wanting to quickly turn to Activity 3 (hence it gets a tab.) It is difficult to see a teacher quickly wanting to look up the national education standards, however (hence it does not get tab). The team aimed for no more than about seven tabs per manual.

The summary sheet on the page that follows may be placed at the beginning of each module. It gives a one page overview of the TRAC PAC in a form suitable for educators and students.

# TRAC PAC

## TRAC PAC

The TRAC PAC contains eight different **modules**. Each module includes a *teacher's manual materials* to do the module in the classroom, and the appropriate software, including QuickTime movies, animations, and pictures stored on a CD.

<b>Bridge Builder</b>	Design and test your own bridge using balsa wood and computer software; then, see bridges around the world in an interactive flash-based demonstration.	
<b>Design and Construction</b>	Design a road with software, write a program to simulate traffic flow, and determine where to place a road in a rambunctious community so that you please residents, environmentalists, and motorists.	
<b>Environmental</b>	Create a filtration system using locally available materials, then embark on a guided tour of the Web to build an environmentally friendly highway.	
<b>Maglev</b>	Build magnetic levitation cars, race cars them down a track, and use Newton's First and Second Laws to analyze the results.	
<b>Motion</b>	Build a runaway truck ramp, participate in an egg toss contest, and further use the Maglev track to study motion and impulse.	
<b>Safety</b>	Select the best highway safety improvements in an interactive role play, then use the interactive physics software to study vehicle design.	
<b>SIMCITY and Planning</b>	Turn a deficit-ridden, polluted, congested city into a utopia by improving transportation and changing the zoning laws.	
<b>Traffic Technology</b>	Build a model traffic signal using calculator based labs, a hot wheels track, and spreadsheet software.	

## APPENDIX B. CITATIONS

1. Institute of Transportation Engineers. "The Transportation Profession" Viewed at <http://www.ite.org/Global/Frames3.asp> on May 4, 2000.
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3. Mathews, J. and Strauss, V. Teacher Poll: "Adjusting to the Net," *The Washington Post*, Tuesday, May 2, 2000, No. 149, pp. A11. (The post notes that this article is "compiled from reports by staff writers Jay Mathews and Valerie Strauss.")

## APPENDIX C. TEACHER INTERVIEW RESULTS

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The pages that follow highlight feedback that teachers who tested the TRAC PAC activities gave to the team. It is noted that although “Maglev” and “Motion” were two separate modules, they were both evaluated by two teachers, and given that many comments from one module applied to the other, the interview results for those two modules are sorted by teacher rather than by module.

## **BRIDGE BUILDER MODULE**

Joseph Weithers, a physics and chemistry teacher at Martin Luther King High School in Dallas, Texas, evaluated the Bridge Builder module and spoke with Peter Massarelli and John Miller on September 28, 2001. Overall, Mr. Weithers and his students enjoyed the module! Students were split up, with half the class designing the bridge on the PC and half the class designing the bridge with the balsa wood. Specific suggestions are shown below.

### **FORMATTING**

There were no real formatting problems: the students and teacher both could follow the questions, and the formatting of the manual was understood. (Students generally could work with the entire manual: it was not necessary for the teacher to first “interpret” the manual for them.)

### **PROCEDURE**

The modules themselves worked well. There are, however, some suggestions for items that are worth including either in the upcoming flash animation, as additional narrative, or possibly as an optional “enhancement.”

- The concept of expansion and contraction due to thermal fluctuations could be discussed—real world examples include the expansion areas one can see between sidewalk slabs.
- An animation should be added that allows students to see the truck that breaks the bridge. [There are two ways to address this: a screen capture of how the Model Smart software does this can be included in the teacher’s manual, or it may be appropriate to include this type of animation in the Flash activity.]
- Some additional explanation could be given as to how suspension bridges work). Mr. Weithers also mentioned that he would like his students to research famous bridges (e.g. the Verranzano Bridge) to see how they are designed.

The time for student work for building the bridges was about three hours (at one hour per day, which was doable with 90 minute periods). Some students then benefited from extra time to redesign their bridges.

The time for teacher preparation was about a day, but Mr. Weithers indicated it took him about twice as long as it would a normal teacher as he is legally blind.

When testing the bridges, there were some students who could design better bridges than others; fortunately, students were all able to learn from these differences (e.g. students whose bridges failed at lighter loads could talk to students whose bridges withstood heavier loads!) The teacher indicated they were able to hold up to 20 pounds; his goal is to get the students to design bridges that can hold up to 50 pounds.

### **EQUIPMENT AND MATERIALS**

The materials that were sent were sufficient: in fact, more materials were received than necessary (which will be helpful for future testing!!)

### **EDUCATIONAL STANDARDS**

Generally, it is beneficial for the manual to show how the activities relate to the National Science Education Standards (NSES). For this particular module, the teacher was able to determine how each activity fit

into his syllabus by looking at the physics topics covered the activities (forces, pressure, tension, thermal expansion). These can be related to the individual state's standards (in the case of Texas, these are the "knowledge and skills."

#### **NEXT STEPS**

Joseph Weithers will test the interactive flash activity (Activity 1) when it arrives.

## DESIGN AND CONSTRUCTION MODULE

On Thursday, August 16, 2001 John Miller interviewed Darren Carollo with respect to the design and construction module. Mr. Carollo received the module in July and began testing it with a group of five summer students, and he is continuing to test it with his regular Fall classes. Mr. Carollo teaches physics and biology at Lincoln High School in Dallas, Texas.

### EFFECTIVENESS

Overall Mr. Carollo liked the general approach of the module, noting that it appears to be less costly than the previous TRAC PAC yet more integrated into the disciplines of physics, engineering, and technology, noting the examples of spreadsheets and computer-based modeling.

The hands on portions were appealing: for example, the popcorn analogy (activity 1) was easy to explain and gave students a real live view they could relate to. Similarly, the financial accounting (activity 3) and the environmental impacts (activity 2) of roadway construction were also helpful and gave a real world, broader perspective to the module. From the perspective of a biology teacher, the environmental aspect is especially critical, given some real challenges that are being faced [e.g. in Texas, an issue arose where a recent construction effort wiped out a group of protected ibises.] Activities 3 and 4 have not yet been used one in class, although Activity 3 looks promising as the spreadsheet concepts shown therein are necessary for most physics courses and Activity 4 uses CADD concepts with which the instructor is familiar. Activity 5 (Visual Basic for Excel) worked out well, although it did require additional preparation time.

### PROCEDURE AND CONTENT

The following enhancements can be made to these activities:

- *Activity 1. Calculate “how big” the road has to be in order to relieve congestion.* That is, indicate how does one measure these data? Certainly data elements such as the width of the car, length of the car, and the number of cars per lane become relevant when making this determination. Going a step further, one can ask what can be done to eliminate congestion when a roadway expansion is not feasible (whether due to insufficient right of way or environmental concerns)? One might then look at adding a train [e.g., light rail for suburban movements or a subway for urban movements].
- *Activity 2: Determine the most cost effective way to get from point A to point B.* One generally has three choices to getting past a barrier (go around it, above it, or underneath) [and one can compare construction costs associated with tunneling against environmental and land use costs associated with additional land acquisition].
- *Activity 2: Add some environmental scenarios.* One can consider some different challenges where the effects of road construction extend beyond what can initially be observed. For example, suppose a road eliminates a population of insects; this elimination will affect the food chain for rodents and thus can extend beyond the simple taking of land. This conjures up the notion of considering electric vehicles and alternative modes for getting persons from point A to point B.
- *Activity 3: Consider showing how to do this with Excel* [Activity 3 uses Graphical Analysis]. The cost effectiveness of different modes (e.g. high speed rail for traveling from Dallas to Houston) may also be considered here.
- Overall, one thing that was not present that was expected is the use of probes for collisions (e.g. these work with Graphical Analysis).

## **EDUCATIONAL STANDARDS**

The activities cover each standard well and are well integrated with the standards. Overall, administrators take an interest in the national standards (e.g., the National Science Education Standards) but teachers tend not to focus too heavily on each standard per se. Instead, it is more important that each activity have meet three principles: be hands on, integrate technology into the activity where appropriate, and provide a creative element for students.

## **FORMATTING**

The writing is very good. In terms of organization, however, use a three ring binder with tabs for the final product. In fact, the following can be added to the module:

- An indication as to *how teachers should progress through* the module: start with activity 1, and then do activity 2 or 3, and so forth. (A weekly *time line* in conjunction with the table of contents would be helpful.)
- Include an *index* and a *glossary of terms* in the back for easy reference.
- Indicate *individuals who can support the module* (in addition to the spreadsheet forms on the CD).

Answers to questions may be important; however, realize that answers to many questions may vary, thus it may be better in some instances to provide an example of an answer.

When explicitly asked about the length, Mr. Carollo indicated that the module is not too long -- in fact, the length is just about right, especially if one keeps in mind that a teacher can look through a module and select what components he or she will use with the class. In fact, there are some additions that can be made to the module as indicated previously.

## **EQUIPMENT AND MATERIALS**

Thus far the equipment and materials have all worked well.

## **PREPARATION**

The preparation time requirements are not excessive. However, teachers should allow some preparation time for the new computer components [e.g. Activity 4 which uses CADD concepts] depending on their level of experience.

## **NEXT STEPS FOR EVALUATING THE ACTIVITY**

Finally, Mr. Carollo cautioned that the five students he had this summer were not necessarily his strongest students academically, but he expects to have both top students and a wider cross section with testing that is being done this fall.

## **DESIGN AND CONSTRUCTION MODULE (Continued)**

On Friday October 5, 2001 John Miller again interviewed Darren Carollo with respect to the design and construction module. Mr. Carollo had tested part of the module in July with his summer school students, and he tested the entire module with his 120 Fall High School students. Mr. Carollo teaches physics and biology at Lincoln High School in Dallas, Texas.

Mr. Carollo really liked the module overall, and he had several suggestions for how it could be improved. Suggestions are grouped by activity.

### **ACTIVITY 1**

The popcorn containers are not supplied (and do not need to be supplied) as any container will do (e.g. one can suggest that teachers could use a coffee can to hold the kernels).

Find some way of stretching activity 1 into a longer activity: is there anything that can be done with the popcorn kernels, such as additional graphing and measurement, to relate those bottleneck concepts to traffic flow? The demonstration is good, but students need to do something more in that first Activity.

### **ACTIVITY 2**

Are students allowed to cut the plastic roadway segments (the tangent sections) with scissors? If so, this should be stated in the directions. Also consider using a heavier grade plastic for the tangent sections.

### **ACTIVITY 3**

At the very beginning the kids got lost, but then with explanation and clarification as to how to use the computer files it worked well. Two suggestions result: first, clarify what is the "big picture," and second, explain how to access the computer files as it seems like Graphical Analysis has a Macintosh-like interface. One option that could help this and the other activities might be a primer indicating which CD is being used, how to copy files from the CD to the hard drive, how to save changes, and when one can start a program by double clicking on it as opposed to having to go through the menu options of Start/Programs/...followed by the file name. As an illustration, in Graphical Analysis, students tended to want to activate the file by double clicking on Constru3.dat rather than by opening up Graphical Analysis first. [The primer idea will be accomplished with one primer illustrating file operations for the five activities.]

Activity 3 works better with Graphical Analysis than with Excel, so instead of providing directions for doing the activity with both packages, eliminate the Excel option and simply have users use Graphical Analysis.

For this and other activities, groups comprised of diverse students (e.g. an artist, an organizer, and a technical person) worked well.

### **ACTIVITY 4**

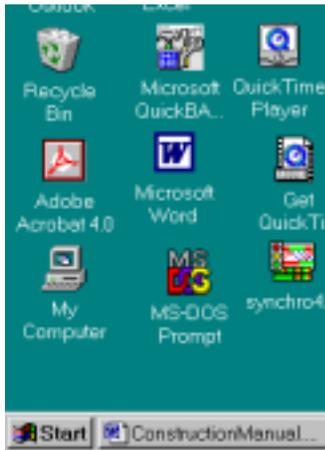
As stated for activity 3, there was some confusion about which CD to use (e.g. the High Road CD as opposed to the Graphical Analysis CD) so this needs to be clarified. Also, once students saved the *.rdd* file they had designed, it was not clear where it had been saved [so the path to get to the file needs to be clearly explained.] At one point we ended up saving files to the A drive in order to know where the file was being stored.

## ACTIVITY 5

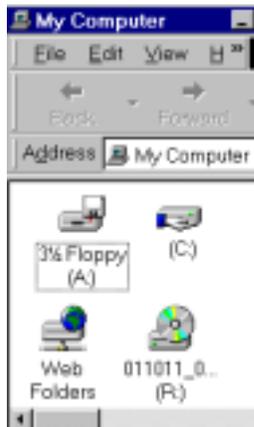
This takes three solid people and gives the students things to figure out for themselves. Three things arise: (a) the amount of memory used by the cars (even with 164 megabytes of RAM it was necessary to restart the computer a few times), (b) getting the cars to stop once the simulation is running, and (c) the necessity of the image files in order to have the cars move. [One way around this is to have the program automatically look for the image files rather than having the students place them in a particular subdirectory.]

An excerpt of the primer that is being developed is shown below.

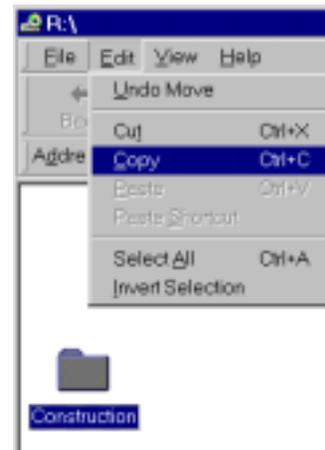
### Example of Copying the Construction CD to the Hard Drive



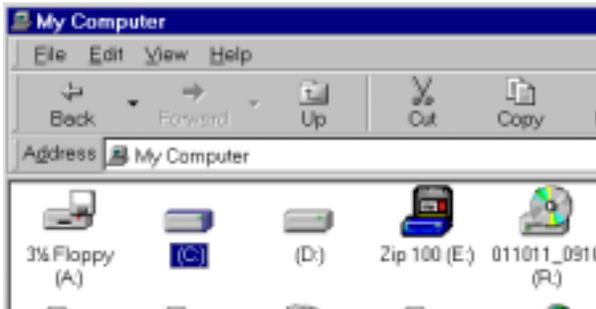
Double click on “My Computer”



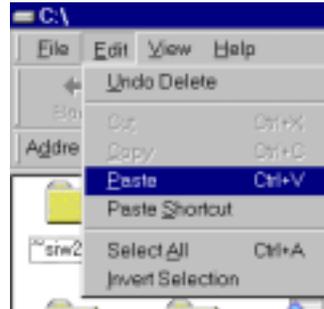
Double click on the CD drive (mine is R:)



Single click on the construction folder and select Edit/Copy



Double click on the hard drive (mine is C:)



Select Edit/Paste to paste a folder called “Construction” to the hard drive.

### Quick Addition from Friday, October 19, 2001

Mr. Carollo noted that when the students got to the programming portion of Activity 5 (where they were writing their own code), they would sometimes not follow the instructions but instead would jump ahead. This could frustrate them, because there were times when the code would not work because they had omitted a step. To alleviate them, it is advised that for that sub part (where they write the code), the individual steps should be enumerated (e.g. do this first, do that second) so that students always know where they are in the manual.

Also Office 2000 is needed for activity 5.

**Quick Addition from July 15, 2001 (Construction)**

**From:** Darren Carollo [DC9069@pigeon.dallasisd.org]

**Sent:** Sunday, July 15, 2001 1:16 PM

**To:** MillerJS@vdot.state.va.us

**Subject:** trac pack week 1

Hey John:

I wanted to touch base with you. I hope that all is well. We worked on the kit for four days last week. Everything is real smooth. Easy to understand and comprehend.

I should commend you on such an outstanding job you did setting this kit up as it is flawless.

I will meet back with these students the first week in August and at that time I will have a more detailed report for you as we will continue to finish the modules. I am training with Intel the next two weeks and will be out of town but will continue to respond to all email.

As mentioned in your letter, I will make sure that everything you requested will be returned to you.

Again, I appreciate the opportunity to be involved in your organization and I will have more detailed data in about three weeks.

Please feel free to call or email if you have further questions.

Regards, Darren Carollo 214-729-0161

## CONSTRUCTION MODULE (Activity 4, Continued)

Les Peterson, a computer science teacher with the Career Research Center in Albuquerque, New Mexico, tested activity 4 of the Construction module with his students and gave feedback on June 12, 2001. Mr. Peterson did this in a couple of iterations, first catching bugs in the program with his students and then going through the activity.

### EQUIPMENT AND MATERIALS

Initially the program crashed (the solution was for John to change the picture button control to an image control) and consumed quite a bit of memory (the solution has been to delete the left and right leading cars, in addition to the following cars, at the end of the program). The bitmap car images (.bmp extension) work far better than the metafile and gif images (.wmf and .gif). Once these were taken care of, the program ran well, although teachers should be given an idea as to the different student skill levels required as noted below.

Two students per PC is acceptable if you cannot have student per PC.

### PROCEDURE

It worked o.k. to use this activity within a regular Visual Basic course. [This activity uses a programming language called Visual Basic for Applications (VBA) which has some differences from Visual Basic (VB), but the main reason Activity 4 was designed with VBA rather than VB is that VBA is included free with Microsoft Excel, thereby making it more accessible to schools.] However, VB students need some time to adjust to VBA; the differences are in the commands used within the coding window of VBA.

The timing and skill levels required vary by each part. In terms of *student time*, you can point out that part 1 requires about four hours and part 2 is substantially shorter; these two parts could be done by most teachers with an interest in programming. The third part is wide open: for teachers to do the third part, they need some familiarity with excel, graphic files [e.g. a bitmap image], and making these files accessible [e.g. knowing to place the car image in the c:\testing folder so that it can be accessed by the program]. In terms of *teacher preparation time*, one should allow 1-3 hours for teacher preparation time depending on familiarity.

### EDUCATIONAL STANDARDS

In this particular school teachers are expected to teach all of the standards regardless of the subject matter. However, this activity may relate to mathematics standards that involve translating knowledge into careers, using the computer to apply mathematics, and problem solving.

### FORMATTING

Make the screen shots clearer (e.g. the box of properties on page 9 and the toolbars on page 5). Give more details on the width of the column in the first portion (where the students draw the freeway and the two lane highway).

For the third section when you give this to the students, point out that as enhancement they can make modifications to the screen. This gives them a chance to be creative; in fact, Mr. Peterson's students made some enhancements on their own (e.g. adding cross intersections, using different looking cars, and so forth.) The only thing to watch out for is that one could easily spend about six weeks doing this.

**ENVIRONMENTAL MODULE**

On Monday, July 30, 2001 Becky McNall interviewed Paul Kehmeier who had tested the Environmental module activities.

1. Which of the module’s activities have you used? How many times?

*Mr. Kehmeier used Activity one: Waiting for the Dust to Settle environmental activity.*

With which classes (include the subject and grade)?

Grades 9-11 (16-18 years) during 9<sup>th</sup> grade summer school biology class.  
Most of the students taking the summer session class are enrolled because of unsatisfactory performance in biology the last school year. There are a few students enrolled in the summer session who are taking the class to get credit for the next school year.

2. Have any other teachers used activity?  Yes  No  
Do you think they would mind us contacting them?  Yes  No NA

Names and contact information: \_\_\_\_\_

3. How long did the activity take? 1 hours 30 minutes

4. How many students participated? Did they participate in groups or individually? What size groups?

20 students participated in groups of 2 or 4.

**PREPARATION**

5. How long did it take you to prepare to do the activity (reading, assembling needed materials, setting up equipment, etc.)? 2 hours \_\_\_\_\_ minutes

6. How did you parcel out this preparation time (i.e. how much for reading, assembling materials, setting up equipment, etc.)?

Reading	<u>1</u>	hours	_____	minutes
Assembling materials	_____	hours	<u>45</u>	minutes
Setting up equipment	_____	hours	<u>15</u>	minutes
Other	_____	hours	_____	minutes
Other	_____	hours	_____	minutes

7. Was the time and effort involved in preparation reasonable?

*Yes, but it took some time to gather the bottles for the activity (this activity requires teachers to supply four 2-liter bottles per group). Mr. Kehmeier pointed out that it might be easier during the school year to have students bring in the bottles for extra credit. His difficulty was that his students are often forgetful cannot be counted on to do any take home assignments. His policy is to assign no homework in science for this reason.*

**FORMATTING**

8. What did you think of the format of the Teachers’ Manual? Was there too much duplication? Not enough? How would you change the format to be more useful to teachers?

*Mr. Kehmeier found the teacher background information well chosen and helpful, explaining that it supplied sufficient information for each activity. He commented that the photos were poor and unusable since they were in black and white. The subject in the pictures often appeared as a black or gray blob, which would not attract student attention. The appendix version of the student sheets were easily accessible. He commented more on these in question 10.*

9. What do you think of the activities table at the beginning of each *module*? How about the one at the beginning of each *activity*?

The activities table at the beginning of the module was helpful in selecting an activity, getting a quick overview, and identifying the technology level. In particular Mr. Kehmeier found the descriptions and technology level very helpful. Since he does not have to identify science standards addressed in his lessons, the science standards of learning were not essential to him, but he believed it would be helpful for the many other teachers who do need to identify the standards covered in each lesson. Mr. Kehmeier was positive about having the activity table at the beginning of each activity. He explained that it helped him organize his time as he planned the lesson. Again, he mentioned that it was not necessary for him to supply standards of learning to support his lessons, so this section was not essential for him.

10. Currently, all of the student handouts and worksheets appear in both the body of the manual and the appendix, along with the possible answers to the discussion questions. How do you feel about this?

Upon initial overview of the module, Mr. Kehmeier found the student hand outs in the appendix a bit redundant, explaining that if cost was an issue, the appendix version of the student hand outs could easily be omitted. However, after using the module to teach the first activity, he decided the worksheets located in the Appendix were a great help. The sheets in the appendix are ready to use with a section for students to put their name. Having the worksheets easily accessible and ready to copy cut Mr. Kehmeier's time as he prepared the lesson. The answers were also helpful in the appendix; they defined what was expected to occur for the activity. These were also helpful in knowing whether or not the activity went as planned.

## PROCEDURE

11. Did you or your students have any difficulty with the activity or the discussion questions?  
If so, what sort of difficulties?

*Mr. Kehmeier had several minor problems with the activity mostly due to his students not following directions. They were quick to combine the water and sediment in the containers, often forgetting to time the settling rate, or they would remember to start the stopwatch after the gravel or sand had already settled. Some students were concerned they could not get an accurate time for the gravel since it settled faster than they could set the stopwatch. Many of these difficulties Mr. Kehmeier believed could easily be handled in each individual classroom. It would depend on the ability of the teacher to manage his/her class. The only difficulty Mr. Kehmeier had with the activity that was not easily explained was the addition of Calgon water softener to the clay water. The Calgon should have increased the settling rate of the clay, but in his case, just the opposite occurred. After some discussion, it was difficult to tell where his experiment had gone wrong. The activity had been conducted five or more times in the lab prior sending the materials to Mr. Kehmeier. Each time worked well. The interviewer also conducted the experiment with her class over the summer and with positive results.*

When closing the lesson, Mr. Kehmeier explained that he often has difficulty keeping his students attention at the end of the lessons. They are usually more excited about doing the activity and less so about discussing what happened. He explained that this was a weakness of his students. He found the questions on the worksheets adequate, but had limited student involvement. The writing was appropriate, although some of the text was a bit higher than his students' reading level. Words such as "prior" should be changed to "before."

12. How feasible is the implementation of the activity (including the group size)?

Mr. Kehmeier had little difficulty with the implementation. Group sizes seemed to be appropriate between 2 and 4. Again, classroom management was an issue. Some of the students threw sand at each other from across the room, but overall they enjoyed the activity.

13. Are there any special insights or tips you could offer to make this activity more “doable?”

Mr. Kehmeier had several good suggestions to add to the lesson. To practice the scientific method he teaches in his course, Mr. Kehmeier required that groups conduct each trial three times to gather sufficient data. After discussing other possible strategies to incorporate a more scientific procedure, he agreed that a teacher could count each group’s trial separately. In a class of twenty-four students divided into groups of four, this would provide six trials per sediment. He also suggested adding silt as one of the materials since silt is more representative of soil, however, since silt and clay would act in similar ways, the gravel adds a better dimension for time and road erosion. As an extension to the activity, Mr. Kehmeier had his class go outside and collect soil samples to test. After conducting this exercise, he decided it was important to gather sufficient quantities of soil for the sedimentation test; otherwise there was not enough soil in the container to observe. He also used smaller containers, which may have effected the outcome.

## EQUIPMENT AND MATERIALS

14. Was the equipment overly difficult to set up?  Yes  No  
What would you do to make it easier? \_\_\_\_\_

*Materials were easy to set up for this lesson.*

15. Was everything you needed included in what you were sent?  Yes  No  
What else did you need?

The 2-liter bottles were a hassle to gather since students cannot be counted on to bring them to class. A teacher planning to use this activity would have to plan ahead to have the bottles available for the activity.

Was this extra equipment/material difficult to find?  Yes  No  
Do you think that this should be included in the TRAC Pac?  Yes  No

16. Did the equipment work the first time?  Yes  No  
Did the equipment ever work?  Yes\*  No  
Did it just need “tweaking?”  Yes  No  
What tweaking did you do?

\*The funnels were too small for the gravel. They needed to be tapped to get the gravel to go through. The Calgon® also did not work. Mr. Kehmeier said he did not measure how much he put in, but poured a sizeable amount into the container of water mixed with clay. He did not redo the experiment to make it work.

Did it need more than tweaking?  Yes  No

17. Did the activity result in the expected data?  Yes  No  
If not, why not?

As mentioned earlier, all the sediments settled according to plan, except for the Calgon and clay bottle. There may be a possibility that too much Calgon was added to the water.

## STANDARDS OF LEARNING

18. How useful (if at all) are the national standards shown at the beginning of the *module*?  
These were not useful for Mr. Kehmeier since he is not required to identify standards covered in his lessons; however, he did see the need to include them in the module.

19. How useful are the national standards shown at the beginning of the *activity*?

*These were not useful to Mr. Kehmeier.*

20. If they are useful, should they be placed somewhere else? Should they be abbreviated? Lengthened?

Mr. Kehmeier believed the standards should be found in an unabbreviated form in the front of the manual since that is where they are most often found in other texts and manuals.

21. Did the activity satisfy the SOLs you had hoped it would?

Mr. Kehmeier conducted this lesson with his summer school biology students. The concepts taught in the lesson were not included in his biology course. In terms of his environmental science course, he found few connections with the activity and his course. He explained that he designs his course to cover topics in environmental science that interest his students. Since his students live in an urban setting, he concentrates on topics that effect the urban environment including recycling, toxic waste, pollution, etc. He thought the activities included in the module would better fit the earth science curriculum or junior high science curriculum; however several activities, such as the webquest and the filtering activity, could also be included in environmental science.

## EFFECTIVENESS

22. What was this activity's greatest strength:

The greatest strength of this activity was its ease of implementation and its simple design that was easy for students to understand. Mr. Kehmeier found the information easy to read and the background information pertinent to the topic. The students had no trouble conducting the activity except for not following directions properly.

23. Its greatest weakness?

Mr. Kehmeier's students have little interest in soil erosion. They are more concerned with toxic waste and pollution from abandoned factory sites in the urban area. They enjoyed doing the activity, but he did not feel it would be of great interest to the students.

24. How well did the activity fit into your curriculum? Was it an easy fit or did you have to stretch?

As he mentioned earlier, the material covered in this activity can be included in biology, but with Mr. Kehmeier's current curriculum, he had to make a stretch to include the topic in his class.

25. Did the activity illustrate the principles you had hoped it would? (Did the students learn what you wanted them to?)  Yes  No

26. How well did the activity *physically* fit into your classroom?

*The activity fit well using the lab stations in the classroom.*

27. Did the activity hold the students' interest?  Yes  No  
If not, why do you think it didn't? What would you change?

*The activity held the students' interest until they were expected to discuss the outcome. At this point, many lost interest and few contributed to the discussion.*

28. Overall, would you use this activity in your classes again? \_\_\_Yes X No  
If not, what would have to be changed for you to use it again?

*Mr. Kehmeier explained several times over the interview that he thought this was a good activity, but that it did not fit well into his curriculum. For this reason, he would probably not use the activity in his classroom.*

## **QUESTIONS SPECIFIC TO INDIVIDUAL MODULES**

Thank the teacher and mention that you will send his or her answers back to make sure that we've correctly summarized their thinking, and would like them to respond to that mailing as soon as possible. Be sure to ascertain the quickest and most certain way to contact the teachers.

Best Address: Mr. Paul Kehmeier:  
4928 Tracy Ave.  
Kansas City, MO 64110  
(H) 816-333-4280  
Email: Paul-Kehmeier@msn.com

Also, we are planning to refine the activities based on your comments this summer. Is there some way that we can contact you this summer if we have any questions?

Best Address: Same as above.

Finally, when we have the revised version ready this fall, would you be willing to test it out just one more time?

Mr. Kehmeier apologized for not using the activities as he had promised. For this reason, he is willing to do more of the activities in the fall.

## **ENVIRONMENTAL MODULE CONTINUED--STUDENT COMMENTS**

Becky McNall, a member of the TRAC PAC team who had designed the Environmental Module, asked her summer school students to give her some comments on two of the activities she used with her class: "Webquest" and "Filtering the Silt." Select comments are attached, and her students' PowerPoint presentations are shown in the subdirectory "BeckyMcNallStudentsPresent."

### **WEBQUEST**

I liked it because it was online and technology packed and we got to use Power Point.

It was fun.

It was fun to research and make a Power Point.

### **FILTERING THE SILT ACTIVITY**

When asked if this student would suggest having others do this activity these students replied:

Yes [because it provided her with the] understanding why silt fences work.

Yes, because it teaches kids about pores that let water pass but not silt.

Yes, because it would be just as fun for them as for us.

Yes, it shows how silt fences work.

It was informative and fun.

Yeah, except make sure you have a big enough bucket so you don't spill it.

## MAGLEV AND MOTION MODULES—PART I

Ms. Lynn Shine, a biology teacher with 21 years of experience, works with students who have unique emotional needs at the Phoenix Center in Annapolis, Maryland. Ms. Shine received the first round of the Maglev and Motion modules in the Fall of 2000, tried out the activities with her students, and gave John Miller some comments on May 1 and 4, 2001.

### FORMATTING

One of the biggest comments is that a teacher needs something more structured than what is offered in terms of linking the individual activities together. The teacher needs to know more concrete ways move from one activity to another and how much is too much to give to students at once. It took a while, after receiving the manuals, to just know where to get started and how to digest the activities. In short, the individual activities are o.k. by themselves, but for a teacher receiving this for the first time, some type of progression through the module should be recommended. For example, you might consider including a progression schedule that looks like this:

Day 1: Just read about how things are done now and how they will be done in the future

Day 2: Do the prelab activity in Maglev [the one with the paper dropping]

Day 3: Do activities 1 and 2

[In the progression schedule show how each activity builds upon the others]

A second formatting issue relates to needing more background information: it was hard to explain why we are doing this activity and how this is related to school, and some additional background information, such as Newton's laws, would have been helpful. For example, as a biology teacher, how could I relate these activities to biology? A better tie in with that subject would have been helpful.

A third formatting issue relates to the organization of the material. It is good to have the answers all together in the back, but sometimes it was not clear which portion of the manual was for the teacher and which portion was for the students. Simply put, the reading did not seem to flow. A clearer delineation of the teachers and students' portions would be helpful.

A fourth formatting issue is that one should clearly indicate for teachers what the materials are. When the box arrived, it was not clear that the blue Styrofoam cars were in fact cars rather than extraneous packing material.

### PROCEDURE AND CONTENT OF THE ACTIVITIES

The students liked the hands-on aspects of the activities--they were ready to jump in and use the materials themselves.

There was not too much reading for the students -- they definitely understood the reason for the individual activities [but a stronger link for the activities is needed as noted in the formatting section above].

For the most part, the materials held up (e.g. the physical tracks and the cars) and the activities worked as expected. There were three exceptions however:

- The buttons often did not work on the stopwatches. [Editor's note: clearly we should go with the \$10 rather than \$2 stopwatches!!]
- It was hard to get the pens to stay with the Velcro strip. [This is where students watch a Maglev car move down the track and press the stopwatch button when the car is at a specific point, such as "40 cm."] Often the pens would fall down, increasing error and frustration. One suggestion might

be to have a type of lever, similar to the flag on a mailbox, that is attached at the specified points that can be raised when markers are needed and lowered when markers are not needed.

- Students did not get the same values for some of the timings that the manual suggested. [This is probably where we need to revise the manual so as not to be averaging discrepant events.]

The charting was difficult. Consider alternative methods of doing that [e.g. where the students do graphs of velocity and acceleration vs. position and time.]

When developing questions, include also some basic review type questions in order to really test the students' reading of the material, such as key definitions or questions and answers based on the background presented with the activities.

When giving the answers for the teacher, add more explanation for teachers who may not usually teach this discipline. For example, don't just say "Answer varies." Instead, while you can still say that the answer varies, give an expected range of answers and say why the variation occurs. [Perhaps we should ask ourselves "what information would a good teacher, but one who does not usually teach this field, need if all she had available was not a textbook but rather the teacher's manual we are providing?"]

## **PREPARATION**

The activities with the cars themselves in Maglev and Motion were generally shorter than the recommended time, except where students experienced difficulties with the charting. The activity with the stopwatches [the prelab for Maglev] took longer than the allotted time because the stopwatches did not work properly.

A big part of the preparation obstacle was that some way of moving between activities is needed, as noted under "Formatting" above.

## **EDUCATIONAL STANDARDS**

Ms. Shine did not need the educational standards shown in the document, however, she pointed out that some teachers are required to show to their principal their lesson plan and how such a plan relates to the "core learning goals" (terminology and standards vary by state) so in that sense the educational standards may be appropriate.

## MAGLEV AND MOTION MODULES—Part II

Cathy Epps, a physics teacher with a couple of decades of teaching experience, evaluated the Maglev, Motion, and Construction modules with students at Thomas Dale High School in Chester, Virginia and Monacan High School near Richmond, Virginia. Ms. Epps gave John Miller some comments on May 16 when they met in person at Thomas Dale High School.

[For future interviews, we (VTRC) should have the manuals in front of us as some teachers may have to answer questions from memory.]

For Maglev and Motion, Ms. Epps had one track for the class which was a disadvantage. Generally, a good lab group size is about 4 persons per track [for some reason even numbers of students works better than odd numbers of students]. Thus with a class of 24 students [which was the case for this class] one would ideally need six tracks. For the construction activity, students worked in groups of \_\_\_\_ to decide on the road placement [activity 2].

### FORMATTING

Point out in the volunteer's section that the background could be very well done by a volunteer [an example is the runaway truck ramp activity where the volunteer could comment on different types of aggregate that are used and their efficacy in reducing speeds, their durability, and their cost].

Having the table at the beginning of each activity was helpful [but one should not have too much detail there.]

There is too much duplication in terms of having three sets of questions for each activity. The questions probably only need to be shown twice: one set of questions for the students and one set of questions with the answers for the teachers is enough repetition.

In terms of deciding where to place the answers (e.g. at the back or at the front) teachers will give different opinions as this is based on personal preference, but one has to evaluate both (a) consistency among the modules and (b) spacing requirements. It may be the case that not all modules fit into the same format -- at which point one has to decide how critical the consistency issue is. It's not going to be possible to please everyone [but we should make sure we ask each teacher their opinion on this.]

Do not staple the answers to the teacher's section!! [For evaluation purposes, send a school one teachers manual with the answers and 20 or 30 student copies without the answers.]

### PROCEDURE

As discussed earlier, check the details of how some of the graphs are presented. [Ms. Epps had explained in the Fall that the vertical axes on some of the charts was in error and confused the students, such as that on page 12 for Maglev.]

For the second or third Maglev activity, make the point obvious about what the difference was between those two activities. [I believe this is in reference to the former covering Newton's first law, where without friction an object should be moving at a constant velocity, and the latter covering Newton's second law, where an unbalanced force exerted upon an object causes a change in velocity.]

The collisions of different sized cars (e.g. A-A, A-B, A-C) worked well and it was useful when the students had to develop the ratio of the movement of the collisions. Portions of this activity are appropriate for a middle school student or as a quick high school demonstration. Similarly the popcorn portion of construction activity 1 was not necessary for high school seniors.

The discussion questions were the same for a couple of labs, so revise them to avoid repetition. Ideally they should be different for each activity (there can be overlaps of concepts but one cannot expect high school and middle school students to have the same level of understanding).

Also check the calculations for the data table where momentum is computed [in the Motion module. In that same module, we also need to check some of the impulse calculations where John may have inserted an error!]

For middle school students, a free response question means you are going to get one or two words, period. Thus for middle school students you should have more concrete questions, with the open ended questions being held for high school. This balance between open and closed ended questions is critical.

The impulse worksheet questions and answers were useful.

## EQUIPMENT AND MATERIALS

For the Maglev track, make the following changes:

- the spacers [the wooden chocks] must be kept in place when the track is not in use or else the track will warp. The instructions should clearly point this out.
- One does not generally have to use Silicon spray provided the spacers are used to keep the track from warping.
- The Velcro is helpful but make sure the pictures show the middle of the pen or pencil sticking to the Velcro. [Ms. Epps pointed out that she could see how another teacher might have the pens or pencils fall over if they were stuck at the end to the Velcro; the solution is to place them in the middle.] The picture could thus show a long pencil as the measuring device.

*The most critical issue is that the cars slide freely down the track—it is frustrating if this part does not work, and if it does not work then the lab will be stopped there.* On the bright side, this track works better than previous tracks. A plus was the length of the track (it was good that the track was long enough to do individual timings) and the short timing intervals (e.g. on the order of 10 to 20 cm).

The runaway truck ramp seemed to work o.k.—the track was helpful and the instructions for building the holder [the cardboard box top that is filled with gravel or other material] were clear. The students were told to bring in materials [for the runaway truck ramp] and most did not, so those students ended up using their sweaters for the activity. It should be pointed out that this activity can be done as a “station” or a contest, since one really needs about four students maximum doing it at a time. It is not necessary to provide all of the materials [sand, gravel, etc.]—the big thing is the students’ creativity.

The students used the truck cab without the trailer for the runway truck ramp, because the trailer was not clearing the nails (which are used in other parts of Motion as rubber band launchers). For future reference, consider either (a) just using the cab or (b) finding a vehicle that has a high enough clearance that it clears the nails.

The curve tools themselves worked well, but the larger roads are way too big. A solution would be to make the largest road only as wide as the curve tools, which would enable one to place a road without destroying most of the neighborhood on the map. [Ms. Epps also noted it might be appropriate to make all roads the same size.] The middle school students don’t have the same judgment as the high school students in terms of where to place the road, so keep that in mind.

Ms. Epps noted that she has purchased watches in the same place in the past (A&N where they are \$2 apiece) and thus expected some to fail. She has noted that an advantage of them (as to more expensive \$10 watches) is that one need not become concerned when they break or are lost; thus she was comfortable using them.

## **EDUCATIONAL STANDARDS**

Ironically, with no educational standards for physics, schools need more tools like this [the Maglev track] as more students may elect to take courses such as physics without the educational standards. The standards should be available but “don’t go overboard”—they can be put in once as a reference rather than multiple times, and a minimal amount is desirable, such as “This follows SOL H3 and H4.” Although each state has its own standards, a good caveat would be to simply link each activity to the appropriate national standards but using an abbreviated form rather than taking lots of pages.

It does seem that construction [activity 3] would be suitable for a government/social studies class and social studies teachers have been given copies of the manual but have not yet responded.

## **NEXT STEPS AND OTHER COMMENTS**

For construction activity 5, consider also including the effects of a special event in the simulation (where a short green time for minor roads is usually appropriate but for a special event such as a fair one needs to adjust the green time accordingly). One could also show the effects of different timings throughout the corridor (e.g. with side streets backing up due to a very short green time but the tradeoff being smooth traffic flow on the main street).

In SIMCITY, perhaps the effects of a funeral procession could be included. [This might be an option for SimTraffic if it is not feasible for SIMCITY].

Ms. Epps will hold onto the track and motion materials and will try the revised Maglev and motion activities early next fall.

She will also try the construction activity 3 next fall (she did not get to do it this spring because it requires some customized installations) but time permitting she will try activity 5 this spring.

We should send the Webquest to Ms. Epps as well.

## **SAFETY MODULE**

Julia Eichman is a physics and chemistry teacher at McDonald High School in Anderson, Missouri. She received the Quick Fix for High Crash Highways activity [an activity from the Safety Module], along with the SIMCITY module, in late April. She used the Quick Fix activity during the week of May 7<sup>th</sup>, and talked with Cheryl Lynn about the results on May 17, 2001.

### **EFFECTIVENESS**

Ms. Eichman had planned to use the *Quick Fix* activity with only one of her freshmen classes, but it went so well with her introductory physics class that she also used it with her introductory chemistry class as well. Afterward, several of her seniors heard about the activity and requested a shot at it, so she ended up using it with all of her classes. She is sending us 30 to 40 of the best lab reports to us, along with a marked up copy of the Teachers' Manual.

According to Julia, the students really enjoyed the class and took it very seriously. She noted that, "We really had a blast. They [the students] were learning things, which is scary, and they talked intelligently, like they knew what was going on. They actually wanted to participate and to put their 2 cents in. Usually, they don't attach to projects like they did with this." There were a number of athletes in one of her blocks, and they made it a competition, putting their results in the board.

Interestingly, the students seemed convinced that the pictures were of local intersections, and even tried to figure out exactly where they were. Ms. Eichman thought that reducing crashes became a matter of pride with the students because they thought the locations were local. When questioned about effectiveness, she noted that the students understood the concepts of more vs. less reliable data and picking the most cost effective solutions. She called the unit, "one of the best things we've done."

### **PREPARATION**

Preparing for the activity took about 90 minutes, most of which involved reading all of the materials for the first time, and some of which involved setting up the posters, counting out money, etc. However, once that was done for the first class, it was ready for all the classes.

### **FORMATTING**

When asked about the format of the Teachers' Manual, Ms. Eichman said that it was "okay" and that "someone must have wanted to share everything they knew." Although she couldn't present all of the introductory material, she liked having the traffic engineering/highway safety information available so that she could answer questions as they came up. She also felt that we didn't need the redundancy in the manual, especially in terms of the student worksheets and materials. She preferred having these materials presented once, in the body of the activity, and putting the answers to questions in the appendix.

In terms of the student worksheet, she felt that it did not have enough room for all the comments the students needed to have in front of them to do their presentations well. She suggested running the worksheet in landscape format and using the extra space for comments. She also mentioned that the activities table at the beginning of the modules was lopped off and that there were typographical errors in the activity, including a discrepancy in the cost of an improvement between the printed materials and the posters (\$5,000 vs. \$500).

### **PROCEDURE AND CONTENT OF THE ACTIVITIES**

Ms. Eichman ran the activity for classes of about 30 students, working in groups of 3. The class had just finished the unit on motion (momentum, velocity, acceleration) which she tied into this activity ("made the material

real”) by beginning with a discussion of the physics of traffic crashes and why some crashes have more severe outcomes than others.

The *Quick Fix* activity took about 90 minutes (one block) to complete. Ms. Eichman gave them an hour for the group work, and the remainder for writing the lab report and discussing the results, allowing them to hand in the report at the beginning of the next class, so they could do some additional work (which they wanted to do). She gave one class two blocks to complete the activity (one whole block for group work), but felt that that was too long, since the students tended to lose focus. She also felt that the activity could be done in two 50-55 minute classes, one for group work and one for writing and discussion

In order to give the students a chance to use what they had learned, Ms. Eichman changed discussion question number 5, which originally asked if there were problem intersections in the local area. Ms. Eichman had each of the students identify one local intersection that they felt was dangerous. Then, the students were asked how they would improve the intersection, and how much that would cost, referring back to the posters and student materials.

Ms. Eichman stated that she gave the students minimal direction, and the students did not have difficulty understanding the assignment. During the first pass at selecting improvements, they tended to be very careful with their budgets, almost as if the money were theirs and they could keep what they had left (which was about \$300,000 per group). As an enhancement, after seeing the results of their work in terms of reduced crashes, Ms. Eichman gave them another chance at improving the crash locations. This time, they spent more money, often on more than one improvement at each location, thus increasing the crash reduction.

## **EQUIPMENT AND MATERIALS**

Ms. Eichman felt that the posters worked better than the tri-fold board, which kept falling over when the students tried to put money into the envelopes and remove the outcome cards. The posters hung straight (she used the hooks on the board, but said that they could have been push-pinned on a bulletin board or just taped to the wall). The envelope flaps did not come off the posters.

The distribution of the money was something of a problem. There were too many \$500,000 bills, which were useless, and not enough smaller bills, particularly \$100,000. Since she had ten groups of 3 students each, she needed more of the appropriate denominations.

During the interview, I mentioned that we planned to redraw the illustrations of the crash locations to make them stand out more and to replace the hand written-labeling with printed labels. Ms. Eichman noted that she would prefer to keep the current posters. Because the illustrations were not machine labeled, the students had assumed that their teacher had put the materials together for them, and they also assumed that the crash locations were local as well, an assumption that helped them take a personal interest in the activity. Ms. Eichman stated that without the hand touches, the activity was “just another program” from an educational developer.

## **EDUCATIONAL STANDARDS**

Since teachers in her school are required to use the SOLs to justify their use of activities, Ms. Eichman felt that the SOLs were useful. While she didn’t want them expanded, she liked having the SOLs where they were, because the only additional work she had to do was augment the national standards with the corresponding Missouri SOLs.

As an aside, Ms. Eichman mentioned that she plans to devote two blocks (May 18 and 21) to the SIMCITY activity. She has invited their TRAC volunteers to the class and plans to have them play the game using the same scenarios as the students, who are excited about competing with the transportation professionals!

## SAFETY MODULE (Continued)

Mike McIntyre is a technology and engineering teacher at Perry Hall High School in Perry Hall, Maryland. He received the *Quick Fix for High Crash Highways* activity in late April and the *SIMCITY* activity in May. Mr. McIntyre used the *Quick Fix* activity in late May and early June with two of his Engineering classes, primarily juniors and seniors. One of the Perry Hall social studies teachers used it three times in a government and fiscal policy unit with 9<sup>th</sup> graders. Mr. McIntyre passed on both teachers' comments, since the social studies teacher had already left school at the time of this interview on June 18, 2001.

Mr. McIntyre also agreed to retest both *SIMCITY* and the *Quick Fix* in September, when school reopens, as well as test the Interactive Physics activity, *Hidden Collision*.

### EFFECTIVENESS

Mr. McIntyre used the *Quick Fix* activity with his engineering juniors and seniors. He presented the posters as part of the activity, allowing the students to consider the five problems sequentially. One of the things he noted about the classes was that although all the students were above average, students with higher abilities got more out of the activity than did those with lesser abilities. Working in groups of three, two of the students would often prefer one option and the third another, with the group members having to work out a compromise. The higher-level students were more willing to verbalize their opinions and take chances during these deliberations, and the other students were more likely to go along with the consensus. This is when the best discussions occurred. The groups also discussed the issue of how much a human life is worth, an issue that still plagues highway economists.

According to Mike, the students initially felt that the solutions to the traffic problems were pretty cut and dried, until they were reminded that there were factors to be considered other than economics. This was when the students began to diverge in their solutions. He also had the students critique the activity afterward, and many used the words, "highly motivational" to refer to the activity. Mr. McIntyre also felt that the real world activity complemented a unit called Sudden Impact, in which the students have to design a bumper and then crash-test it (although he felt that it would fit in better in his fundamentals and intro classes). He also felt that the activity reflected the decision making process used by engineers, as well as the quick time frame in which they had to make critical decisions.

These two teachers also developed a method of conducting the activity that we had not considered. To reduce the time necessary to complete the activity, the social studies teacher used only 3 of the five scenarios. Also, Mike had the students develop a presentation on their results, but then had them hand in the presentation rather than deliver it to the class. He also had them keep a running total of their expenditures rather than hand out the TRAC money. In this way, he was able to complete the activity in a 50-minute class period.

### PREPARATION

Mr. McIntyre felt that there was a minimum of preparation time required for this activity and that the instructions were clear and largely self-explanatory. It took some time to put up the posters, since the hole spacing on one was different from the others.

### FORMATTING

Mr. McIntyre thought that the Teacher's Manual was well organized and not very lengthy (a good quality). He liked having the answers to the discussion questions and a range of possible findings. He felt that all the needed concepts were covered. He did mention that it was a bit repetitive, but he liked having the student work sheets in both the body of the lesson and the appendix, since it was likely that someone would take one of them out for reproduction and never put it back. By having two, there was a better chance of always having that material available. He also

felt that the repetition was necessary for teachers picking and choosing among activities or doing them out of sequence. He thought that the half page table in front of each activity was also useful.

## **PROCEDURE AND CONTENT OF THE ACTIVITIES**

Like Julia Eichman, Mr. McIntyre had his students working in groups of 3. The *Quick Fix* activity took one class period to complete. He felt that the times listed in the activity table were off for this activity, and that the activity would go faster for more advanced students.

The students had some trouble with one of the scenarios – the one dealing with access management. They felt they needed more information concerning traffic flow. They noted that they would have chosen one solution based on an expected increase in traffic flow, and another if flow stayed the same.

## **EQUIPMENT AND MATERIALS**

Mr. McIntyre 's classes preferred the poster versions of the scenarios compared to the tri-fold board. He also noted that he presented the posters sequentially to the class, and that the holes on the poster for scenario #2 were different from the others and made switching posters more cumbersome. When asked about the dowels at the bottom, he felt that they may not be needed. Also, he expects that most teachers will store the posters hanging up rather than rolled, since rolling adversely affects the "envelopes." Mike felt that most teachers would have room to hang the posters when not in use.

During the interview, I mentioned that we planned to redraw the illustrations of the crash locations to make them stand out more and to replace the hand written-labeling with printed labels. Mr. McIntyre had no trouble with this plan.

## **EDUCATIONAL STANDARDS**

In Maryland, as in some other states, teachers are required to provide justification as part of the lesson plan development. Mr. McIntyre said that the SOLs were used in writing the lesson plan, and that they enhanced the written background, introduction, and objectives. Having the SOLs available made planning easier for the teacher. He noted that the National Technology Standards were just adopted last month and he felt that they would also be useful as part of our activities. He also felt that the SOLs were in the right place in the manual (before the activity) and that they were sufficiently detailed.

## **SIMCITY AND PLANNING MODULE**

On August 17, 2001, Mike McIntyre of Perry Hall High School, Maryland gave an interview for the SIMCITY and Planning module. He had used it towards the end of his last school term in June. He used all three of the activities with the 80 students in his Engineering class. The students were 11th and 12th graders, with most of them being in the Honors or Gifted track. He spent about one and a half weeks with the module, with classes that met each day for 50 Minutes.

### **PREPARATION**

Mike spent about a 1/2 hour of preparation time and considered the time and effort involved very reasonable. He indicated that the teacher time presented in the Activity table was “right on target”.

### **FORMATTING**

Mike thought that the actual formatting of the document was fine, and he would make no changes. He liked the activity chart at the beginning of each activity, but thought the time predicted for students to do the activity was underestimated. There is a learning curve that the students must get through before they can effectively use the program, and he thought that this time is what takes longer than anticipated. He really liked having the student handouts in a separate section at the end, that way he could “just grab and duplicate”.

### **PROCEDURE**

He had two suggestions for the procedure used with the activities. The first was to include more emphasis on the controls that students must use to run the program, especially pointing out the speed control. I specifically asked him about whether or not the disaster option should be turned off, and he was adamant about keeping it since it made the scenarios more like real life as well as more exciting for the students. He suggested that maybe we could put some information in the student handouts for how to deal with disasters when they occur.

### **EQUIPMENT AND MATERIALS**

The installation on his IBM computers went just fine. He had a CD ROM for each computer and had no problems.

### **STANDARDS OF LEARNING**

Mike thought that the general statement of the national standards was fine. He found that Maryland’s standards fell “right in line” with the ones we had quoted.

### **EFFECTIVENESS**

The greatest strength that Mike found in the module was the motivation it provided for his students. Students came in during lunch and didn’t want to leave at the end of a class period. They fell into a natural sort of competition to see who could do the best city design the cheapest. They hated “to borrow money,” but otherwise did not have any problems with the budget feature of the program. The greatest weakness was the time students spent on the learning curve, and not anticipating it.

Mike thought the activities fit very well into his curriculum and plans to definitely use it next year and to incorporate it into his tech class perhaps as an introduction type of exercise. He was “amazed at the end,” feeling like ALL of his students had grasped the principles that he had hoped they would.

## **CONCLUSION**

When Mike was asked at the end of the interview if he would like to add anything positive or negative, he said that he thought the module “was well thought out and well organized.” He is thinking about how he might integrate some of these activities with a collision bumper design unit that he does with one of his classes. He spoke with an English teacher who seemed quite excited to try it with his/her students, but wasn’t sure that time would allow it since Maryland is now shifting to a testing process on their SOLs. He quoted one rather bright student who said “it was easy once you got started and kept reading the banner at the bottom of the screen.” His final comment was “I enjoyed it and my kids enjoyed it!”.

## **SIMCITY AND PLANNING MODULE (Continued)**

This is a follow-up interview with Julia Eichman, a physics and chemistry teacher at McDonald High School in Anderson, Missouri. She used the activity on May 18 and May 22, 2001 with three classes. The students were freshmen in her Intro to Chemistry and Physics course. She was interviewed previously by Cheryl Lynn. This interview was conducted by Michael Brittingham.

### **PREPARATION**

Preparation time on behalf of the teacher was reasonable, although she did state that she should have spent more time up front herself. She was familiar with SIMCITY 2000, and assumed that there were few differences with the 3000 version, although apparently there were.

She commented that the learning curve for the SIMCITY software was fairly high, and hence a good bit of time was spent by students just learning to use the software. As I understand, after the first block class, students were given handouts to read prior to the second block, which helped familiarize them with the intent and goals of the lesson. She then found this second class to be far more productive.

She suggested that a 'preliminary' lesson on just navigating in SIMCITY might be beneficial to students before the actual 'lesson' was attempted.<sup>1</sup>

One of her other two suggestions was to either cut off the 'disaster mode' feature of the software, or emphasize more clearly how to do that yourself.<sup>2</sup>

Finally, there was the suggestion that students might need more practice with how to set up and run a 'budget' within SIMCITY.<sup>3</sup>

### **FORMATTING**

She felt that the format of the Teacher's Manual was fine. She had no problem going through it in advance and pulling materials for student handouts, etc. As mentioned above, she did wish she had spent more time with the program before hand.

She liked the layout of the material and how it was arranged in the manual.

### **PROCEDURE**

Most procedural comments have been made above. However, it is worthy to note that students worked on individual machines, but in 'island' groups of four, which allowed them to exchange ideas and information as they proceeded. She felt this worked well.

### **EQUIPMENT AND MATERIALS**

As mentioned in the previous interview, the SIMCITY lab 5 packs need to come with five CDs, instead of the one included. Each machine must have a CD-ROM in place to run the program. Hence we need to avoid having the teacher get copies made. It is an inefficient use of teacher prep time.<sup>4</sup>

### **STANDARDS OF LEARNING**

She found the national standards placed in the Teachers Manual to work out just fine. She was able to cross-reference those with her state standards with little difficulty.

## **EFFECTIVENESS**

The activity's greatest strength was found in putting the lesson goals of planning and transportation in a real life form that could be experienced by the students. The students were completely interested, excited, quiet and attentive.

She felt the activity would fit easily into her curriculum, and plans to use it next year.

## **COMMENTS (from the interviewer)**

It should be noted that only the first of three activities in the module was tested by most of the students.

1. *We certainly could develop an additional activity to accomplish this. Although, one might also consider the first of the current activities to serve in that capacity. Ms. Eichman's timeframe for the class only allowed her to run one of the three activities.*
2. *This one is up for grabs. There would be no problem sending the working files with the disaster option cut off. However, I might suggest that this is also one of the features that makes the program more 'fun and exciting'.*
3. *We can revisit the section of the instructions devoted to the budget issue. How to get practice with setting up and running a budget without actually doing it becomes the question. This activity could be included in a 'preliminary' lesson, or once again might be learned naturally through the first lesson of the unit.*
4. *We definitely need to be sure that this one is taken care of when a module is shipped.*

## **SIMCITY AND PLANNING MODULE (CONTINUED)**

Julia Eichman is a physics and chemistry teacher at McDonald High School in Anderson, Missouri. She received the SIMCITY and Planning activity (along with the SIMCITY activity) in late April. She used the activity May 18 and May 22, 2001, and talked with Cheryl Lynn about the results on May 21 and 24, 2001.

### **EFFECTIVENESS**

Ms. Eichman stated that she thought that both the students and transportation professionals had great fun working on this activity. She noted that the manual and instructions were well written.

According to Ms. Eichman, the learning curve for the *SIMCITY and Planning* activity was a little steeper than the *Quick Fix* activity she had tried out before SIMCITY, since the students needed time to become familiar with the program. The class completed only half the activity in the first 90 minute block. However, as her students were working, her advanced placement students noticed them in the lab and asked to be included. By the time the class period was over, the lab was jam-packed.

### **PREPARATION**

The SIMCITY activity required more preparation time than expected, due to some omissions in materials and to the familiarity of the students with the program. First, it was unclear from the packaging that each copy of SIMCITY was actually a 5-copy pack. Nowhere on the outside of the packaging or on the CD itself was this noted, nor was it mentioned in the information she received from Ms. Lynn. The SIMCITY program still required that a CD be in the drive to run. Once she received a reply to her phone call, she had her network administrator burn 5 CDs from each she received, and then installed them on the computers in their lab. Since not all schools will have the ability to make CDs, it is recommended that they be made in advance and included in the mailing.

In addition, students needed extra time to become familiar with SIMCITY. To save time, Ms. Eichman had the students read the instructions for the *SIMCITY and Planning* activity prior to the class, which they did, knowing that they would have a pop quiz at the beginning of class. Even so, the students only finished half the activity during this class, since they had to learn how to play SIMCITY. Ms. Eichman recommended that 30 minutes be set aside at the beginning of the lesson to let the students play the game before tackling the activity itself. She also recommended that the manual include the instruction to turn off the disasters built into SIMCITY. Her first class was hard at work, really enjoying the activity, when aliens were sighted in the city and various natural disasters struck. Also, various copies of SIMCITY booted up in different speeds, so that some of the students were overwhelmed as their cities deteriorated faster than they could address the problems. Ms. Eichman recommended that checking the speed prior to beginning be included in the instructions and making sure that the program be started in pause mode. Plus, several students had problems with having a budget, even though they had used this concept in previous activities. Ms. Eichman suggested that teachers be prompted to cover this before beginning the activity.

### **PROCEDURE AND CONTENT OF THE ACTIVITIES**

*Ms. Eichman mentioned that she invited their TRAC volunteers to the class, so that they could play the game using the same scenarios as the students at the same time. The students were very excited about competing with the transportation professionals, but the professionals initially had some misgivings when they found this out. However, once the class began, everyone enjoyed the game. The TRAC volunteers began competing with each other, and to their relief, performed better than the students.*

## TRAFFIC TECHNOLOGY MODULE

On August 31, 2001 Gerry Swan interviewed Gerry Carruba who had tested the Technology module over the summer.

Q: Which of the module's activities have you used? How many times?

A: The first three activities were used twice with high school juniors and seniors in consumer math classes. Approximately three weeks were spent testing the activities and the teacher did many extensions to the activities, such as taking the students to an actual intersection to look at braking distances and what it meant to them as new drivers on the road.

Q: Have any other teachers used activity?  Yes  No

Q: How many students participated? Did they participate in groups or individually? What size groups?

A: Initially a class of six worked on the activities, but several more students joined us from other classes when we repeated the activities. Initially the students worked in groups of three, then in groups of four when more students joined. Either way worked fine.

### PREPARATION

Q: How long did it take you to prepare to do the activity (reading, assembling needed materials, setting up equipment, etc.)?

A: Hours were spent going through the materials, reading the questions and mapping out the materials. The initial estimates were off by about 50%.

Q: How did you parcel out this preparation time (i.e. how much for reading, assembling materials, setting up equipment, etc.)?

A: Reading: 90%  
Other: 10%

Q: Was the time and effort involved in preparation reasonable?

A: Yes

### FORMATTING

Q: What did you think of the format of the Teachers' Manual? Was there too much duplication? Not enough? How would you change the format to be more useful to teachers?

A: Using the manual was not a problem. It was easy enough to read and make copies from.

Q: What do you think of the activities table at the beginning of each *module*? How about the one at the beginning of each *activity*?

A: Both were fine

Q: Currently, all of the student handouts and worksheets appear in both the body of the manual and the appendix, along with the possible answers to the discussion questions. How do you feel about this?

A: Did not feel strongly about this one way or the other

## PROCEDURE

Q: Did you or your students have any difficulty with the activity or the discussion questions? If so, what sort of difficulties?

A: Nomenclature was needed for formulas and datasheets but over all very good

Q: How feasible is the implementation of the activity (including the group size)?

A: Implementation was no problem. Used it with groups of three and four and had students rotate roles.

## EQUIPMENT AND MATERIALS

Q: Was the equipment overly difficult to set up?     \_\_\_ Yes    x No

Q: Was everything you needed included in what you were sent?   x Yes   \_\_\_ No

Q: Did the equipment work the first time?   x Yes   \_\_\_ No

Q: Did the activity result in the expected data?   x Yes   x No

A: Most of the results were fine. In one of the activities the data calculated in the previous activity was used. However this ended up being too small to approximate real braking situations. Additional information was sent on actual deceleration rates. This solved the problem and allowed the successful completion of the activity.

## STANDARDS OF LEARNING

Q: How useful (if at all) are the national standards shown at the beginning of the *module*?

A: Not at all

Q: How useful are the national standards shown at the beginning of the *activity*?

A: Not at all

Q: Did the activity satisfy the SOLs you had hoped it would?

A: The activities satisfied many of Vermont's SOLs including algebra, group work, technology, collection of data and many more.

## EFFECTIVENESS

Q: What was this activity's greatest strengths:

A: The students were very engaged and the activities pushed and challenged them. The students were so engaged in the activities was that the class went to real intersections to look at stopping distances. There was a nice mix of hands on and number crunching in the activities. The meter stick activity was great way to start the module

because it was simple enough for students to get a handle on what was happening and they could keep referring back to it in the subsequent activities. The activities built nicely upon each other and offered great connections to real life transportation issues. As mentioned earlier the teacher extended the activities to extra discussions, experiments and field trips with the students.

Q: Its greatest weakness?

A: Nomenclature was needed for the formulas, braking data for use in one of the activities and some minor changes to labels on the data tables. Adding a sample problem or some more guidance for the math intensive activities would allow students to self start the activities and not have to have as much teacher introduction and guidance.

Q: How well did the activity fit into your curriculum? Was it an easy fit or did you have to stretch?

A: The content was different from what is normally done, but making a fit was no problem because of its applicability to the Vermont standards. The teacher plans to use the activity again this year.

Q: Did the activity illustrate the principles you had hoped it would? (Did the students learn what you wanted them to?)  
 Yes  No

Q: How well did the activity *physically* fit into your classroom?

A: The activities fit very well

Q: Did the activity hold the students' interest?  Yes  No

Q: Overall, would you use this activity in your classes again?  Yes  No

#### QUESTIONS SPECIFIC TO INDIVIDUAL MODULES

Thank the teacher and mention that you will send his or her answers back to make sure that we've correctly summarized their thinking, and would like them to respond to that mailing as soon as possible. Be sure to ascertain the quickest and most certain way to contact the teachers.

**Gerry Carruba**  
Northfield High School  
37 Cross Street  
Northfield, VT 05663;  
Tel: (802) 485-5751/4500  
[carrubag@wssu.org](mailto:carrubag@wssu.org)

Finally, when we have the revised version ready, would you be willing to test it out just one more time?

Yes

## TEACHER INTERVIEW SCHEDULE AND EXAMPLE VERIFICATION LETTERS

### Introduction

This telephone interview is the primary tool in evaluating the effectiveness and the ease of use of each of the new TRAC Modules. Please try to capture as much of what the teachers say, in their own words, where possible. Based on our previous interviews with teachers, we don't think we will have to ask every question—they will probably be pretty straightforward concerning what they like and don't like about the activity. Just take good notes and at the end of the interview, review the questions one more time to make sure that your teachers have addressed each issue fully.

In contacting the teachers, first point out that this interview evaluates the activities they are testing, NOT the teachers, students, schools, or TRAC program. The reason for the interview is to improve the activity based on **their** comments. Emphasize that this is the only way we can find out what needs to be improved, that we are relying on them to be honest with us. We know that their criticism is constructive and is intended to improve the activity and that it will not “hurt our feelings.” (Some teachers may be concerned about this, especially after you have established a relationship with them over the phone.)

In addition, since we cannot completely redesign an activity, or create a new one dealing with another concept, please try to keep your respondent on track—critiquing the activity as it currently exists.

Although each interviewer will introduce him or herself as is most natural, points that should be covered in your introduction are that:

- you are representing the Virginia Transportation Research Council
- we are evaluating this TRAC activity,
- their responses are extremely important to us, since this are the only way we can determine if the activity works and how to improve it,
- we aren't evaluating their teaching, their students, or schools, or even the TRAC program as a whole,
- we want them to be completely honest, since our goal is to create the best activities possible,
- the interview will take about 20 minutes, and if this is not a good time, we can reschedule, and
- we appreciate not only their testing the activity, but their willingness to give us their thoughts on how it should be improved

Finally, in writing up the results of the interview, please try to summarize the findings using the headings from the interview schedule: Preparation, Formatting, Procedure, Equipment and Material, Standards of Learning, and Effectiveness.

## TEACHER INTERVIEW SCHEDULE

(Date)

1. Which of the module's activities have you used? How many times? \_\_\_\_\_  
With which classes (include the subject and grade) \_\_\_\_\_
2. Have any other teachers used activity? \_\_\_\_Yes \_\_\_\_ No  
Do you think they would mind us contacting them? \_\_\_\_Yes \_\_\_\_ No  
Names and contact information: \_\_\_\_\_
3. How long did each activity take? \_\_\_\_\_ hours \_\_\_\_\_ minutes
4. How many students participated? Did they participate in groups or individually? What size groups?  
\_\_\_\_\_

### PREPARATION

5. How long did it take you to prepare to do the activity (reading, assembling needed materials, setting up equipment, etc.)? \_\_\_\_\_ hours \_\_\_\_\_ minutes
6. How did you parcel out this preparation time (i.e. how much for reading, assembling materials, setting up equipment, etc.)?

Reading	_____	hours	_____	minutes
Assembling materials	_____	hours	_____	minutes
Setting up equipment	_____	hours	_____	minutes
Other	_____	hours	_____	minutes
Other	_____	hours	_____	minutes

7. Was the time and effort involved in preparation reasonable? \_\_\_\_\_

### FORMATTING

8. What did you think of the format of the Teachers' Manual? Was there too much duplication? Not enough?  
How would you change the format to be more useful to teachers?

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9. What do you think of the activities table at the beginning of each *module*? How about the one at the beginning of each *activity*?

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10. Currently, all of the student handouts and worksheets appear in both the body of the manual and the appendix, along with the possible answers to the discussion questions. How do you feel about this?

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### PROCEDURE

11. Did you or your students have any difficulty with the activity or the discussion questions?  
If so, what sort of difficulties?

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12. How feasible is the implementation of the activity (including the group size)?

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13. Are there any special insights or tips you could offer to make this activity more “doable?”

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### EQUIPMENT AND MATERIALS

14. Was the equipment overly difficult to set up?  Yes  No  
What would you do to make it easier?

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15. Was everything you needed included in what you were sent?  Yes  No  
What else did you need? \_\_\_\_\_  
Was this extra equipment/material difficult to find?  Yes  No  
Do you think that this should be included in the TRAC PAC?  Yes  No

16. Did the equipment work the first time?  Yes  No  
Did the equipment ever work?  Yes  No  
Did it just need “tweaking?”  Yes  No  
What tweaking did you do?

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How long did that take?  Hours  Minutes

17. Did the activity result in the expected data?  Yes  No  
If not, why not? \_\_\_\_\_

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**STANDARDS OF LEARNING**

18. How useful (if at all) are the national standards shown at the beginning of the *module*? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
19. How useful are the national standards shown at the beginning of the *activity*? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
20. If they are useful, should they be placed somewhere else? Should they be abbreviated? Lengthened? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
21. Did the activity satisfy the SOLs you had hoped it would? \_\_\_\_\_  
Which SOLs did it satisfy? \_\_\_\_\_  
Should the standards be handled differently? \_\_\_\_\_

**EFFECTIVENESS**

22. What was this activity's greatest strength?  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
23. Its greatest weakness?  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
24. How well did the activity fit into your curriculum? Was it an easy fit or did you have to stretch? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
25. Did the activity illustrate the principles you had hoped it would? (Did the students learn what you wanted them to?) \_\_\_\_\_ Yes \_\_\_\_\_ No  
If not, what do you think went wrong? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
26. How well did the activity *physically* fit into your classroom?  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

27. Did the activity hold the students' interest? \_\_\_\_\_ Yes \_\_\_\_\_ No  
If not, why do you think it didn't? What would you change? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

28. Overall, would you use this activity in your classes again? \_\_\_\_\_ Yes \_\_\_\_\_ No  
If not, what would have to be changed for you to use it again? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**QUESTIONS SPECIFIC TO INDIVIDUAL MODULES**

Thank the teacher and mention that you will send his or her answers back to make sure that we've correctly summarized their thinking, and would like them to respond to that mailing as soon as possible. Be sure to ascertain the quickest and most certain way to contact the teachers.

Best address: \_\_\_\_\_

Also, we are planning to refine the activities based on your comments this summer. Is there some way that we can contact you this summer if we have any questions?

Best address: \_\_\_\_\_

Finally, when we have the revised version ready this fall, would you be willing to test it out just one more time? \_\_\_\_\_ Yes \_\_\_\_\_ No

**EXAMPLE INTERVIEW VERIFICATION LETTERS**

May 4, 2001

Ms. Lynn Shine  
Phoenix Center  
291 Locust Avenue  
Annapolis, Maryland 21401  
Fax 202-222-1652

Dear Ms. Shine,

Thank you so much for your feedback for the Maglev and Motion modules. We will be using your recommendations this summer when we revise those two modules. If I missed anything in the attached summary or if you think of any additional suggestions, then please let me know.

Take care,

John Miller  
Virginia Transportation Research Council  
530 Edgemont Road  
Charlottesville, Virginia 22903  
(804) 293-1999  
(804) 293-1990 (fax)  
[jsm3f@virginia.edu](mailto:jsm3f@virginia.edu)

**EXAMPLE INTERVIEW VERIFICATION LETTER (CONTINUED)**

May 16, 2001

Cathy Epps  
Thomas Dale High School  
3626 West Hundred Road  
Chester, Virginia 23831  
FAX 804-768-6256

Dear Ms. Epps,

Thank you so much for meeting with me today. I was impressed by the Rube Goldberg activities—I thought what the groups had done was pretty cool, even those that had allegedly played cards until last week!!

I wrote up my notes from our meeting. Please let me know of anything else that should be added or modified. Your comments will be helpful for us this summer as we revise these modules. (I also realized when I returned to my office that I had forgotten to ask you what group size you used for the construction activity—e.g. did students work in groups of 1, 2, or more?)

At your convenience, I'd also like to talk to you toward the end of the semester about construction activity 5 provided you have had a chance to try that out with some of your students.

Take care and thanks again for your time.

John Miller  
Virginia Transportation Research Council  
530 Edgemont Road  
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