The Use of an Interactive Simulator to Teach Automotive Troubleshooting

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CERTIFICATE OF APPROVAL

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Abstract

The purpose of this project was to develop a Flash based interactive simulator to help automotive students learn how to troubleshoot automotive electrical faults. The simulator consists of a case library based on real world solved faults, background system information, and interactive diagnostic scenarios for students to solve. It was developed based on two theory based models for teaching problem solving. The first model, dubbed the R2D2 model, developed by Bonk and Zhang (2006) integrates four learning activities: **R**eading; **R**eflecting; **D**isplaying; and **D**oing. The second model used was developed by Jonassen and Hung (2006) and has been named the "Troubleshooting Learning Environment" or "TLE". The question under investigation was: What does an interactive diagnostic simulator based on the TLE and R2D2 models look like? Once developed, the simulator was evaluated through the use of a focus group consisting of automotive educators. The simulator can be viewed at: http://people.morrisville.edu/~makila/starter/start.swf

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Introduction:

Many teaching tools are used to teach automotive service and repair. These range from traditional academic lectures and textbooks, hands on shop work, and computer based resources. I currently teach automotive electrical/electronic systems with a heavy concentration on diagnosing electrical faults. The courses that I teach consist of lectures, book work, and hands on tasks. Many of the students do not feel that they are able to get enough hands on time to be confident with electrical diagnosis. Due to the number of students, space limitations, equipment, vehicle, and instructor availability it is not easy to increase the amount of live hands on work. This project studies whether or not the use of computer based interactive diagnostic simulations could be an effective way to give students more diagnostic practice time so that they are better prepared to use the physical resources available. In some of the other IDT courses that I have taken I have been able to develop several Flash based tutorials and interactive simulations which I have used with my students. The responses to these have been positive from both students and other teaching faculty. For this project I developed an interactive Flash based simulation that could be used to help automotive students learn and practice diagnostic troubleshooting skills.

Background:

Nearly every part of a modern automobile is somehow either controlled or monitored by an electrical circuit or computer module. Sophisticated engine

management systems optimize engine performance, fuel economy, and tailpipe emissions. Antilock brakes, traction control, airbags, occupant classification systems, and tire pressure monitoring systems utilize computer modules to make automobiles safer. Heated seats, automatic temperature control systems, entertainment and navigation systems all provide for comfort and convenience. When these systems break down technicians need solid skills in troubleshooting electrical and electronic systems in order to diagnosis and repair the automobile properly. Weak troubleshooting skills lead to inconvenience and expense for the automobile's owner due to excessive time taken to diagnose, replacement of components that are not faulty, and in some cases damage to good components. Automotive technicians need solid electrical troubleshooting skills in order to quickly and efficiently determine what component is causing a fault.

Learning to efficiently diagnose electrical faults can be challenging because many automotive students feel as though electrical diagnosis is complicated and beyond their abilities. Additionally, it is much easier to observe how the mechanical parts of an automobile fit and work together to accomplish a purpose than it is to see how the electrons work in an electrical circuit or a computer module to accomplish a purpose. Due to the importance of electrical troubleshooting skills and the difficulty that some students have in developing these skills, educational tools and approaches to help students are needed.

Traditional lectures, textbook reading assignments, paper and pencil exercises, computer based training, and hands on exercises are all used as tools to help the

automotive student develop the skills that they need. Several automotive related computer based simulators have been developed by a number of companies. Electude (http://www.electude.com/) is a company based out of the Netherlands that has recently developed a number of computer based automotive teaching tools that include the Electude Diagnostic Trainer (EDT). Figure 1 shows a screen capture of the EDT user interface. This system is a high fidelity simulator that presents the learner with a series of engine related problems. The high level of fidelity is both a strength and a weakness in that it very accurately recreates a modern engine bay, but this level of detail on a computer screen can be overwhelming for a novice.

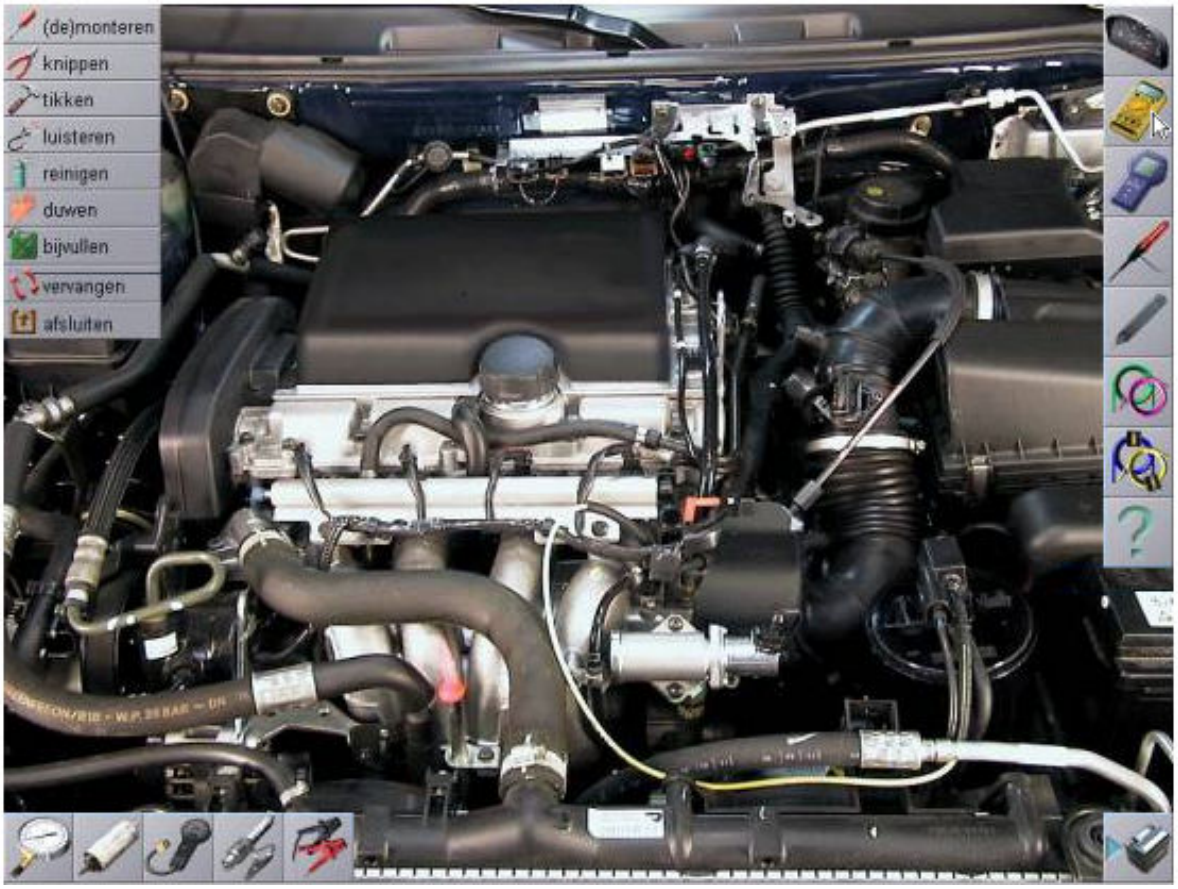

Figure 1: Screenshot of EDT user interface (http://www.electude.com)

CDX (http://www.cdxglobal.com/index.html) has also developed a number of computer based automotive teaching tools. CDX has developed more of an online automotive text, which includes text, images, animations, videos, worksheets, and online quizzes, rather than a simulation. However, they have developed a DVOM (digital volt ohmmeter) simulator to teach automotive students how to measure voltage, amperage, and resistance in electrical circuits. Figure 2 shows a screenshot of the CDX DVOM simulator. While Electude's simulator is highly detailed, CDX's is very basic and focuses on teaching the procedure of how to use one specific diagnostic tool.

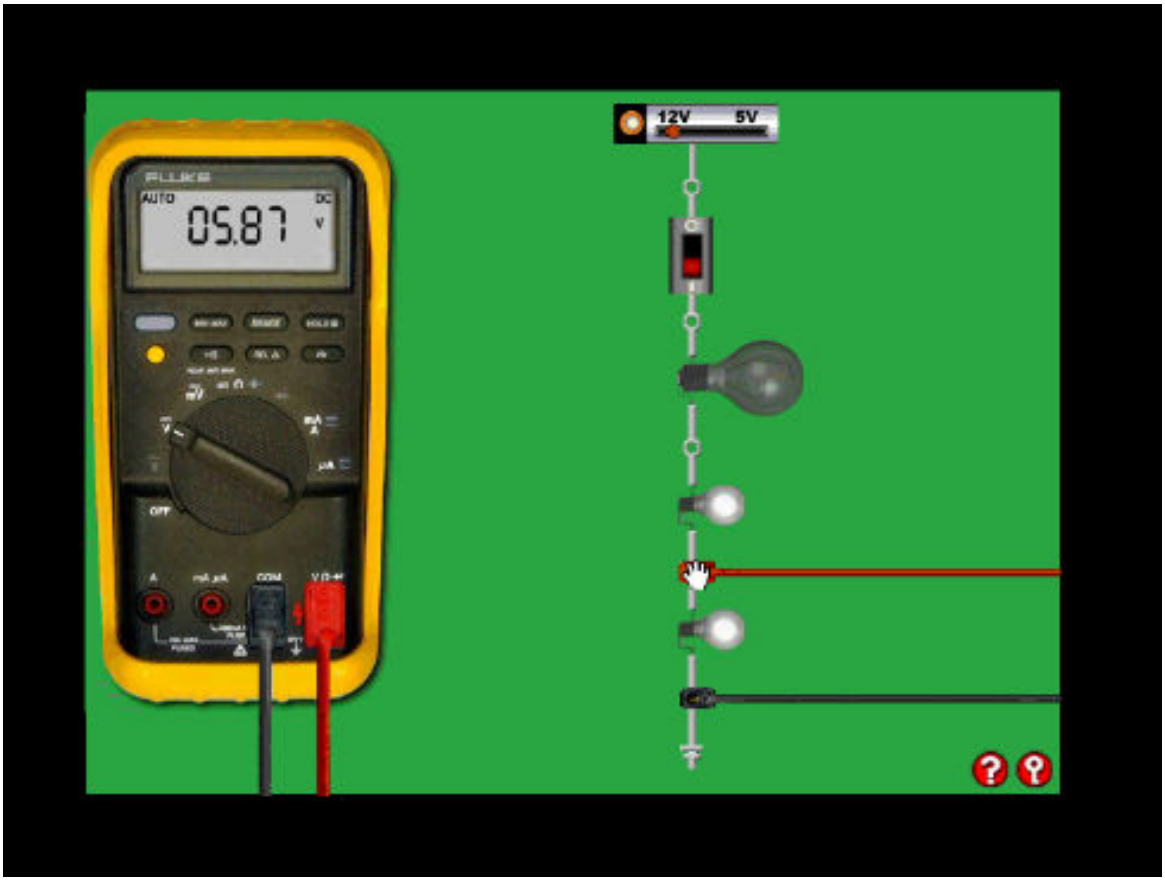

Figure 2: Screenshot of CDX DVOM simulator (http://www.cdxglobal.com/index.html).

ATECH training (http://www.atechtraining.com/) has developed a number of automotive teaching aids ranging from physical cutaway models to computer based simulators. The ATECH simulators are well developed and give the student practice on a wide range of automotive faults. The level of fidelity in the ATECH simulators is generally lower than Electude's and higher than CDX's. Figure 3 shows a screenshot of one of the ATECH simulators. All of these automotive simulators have value in terms of teaching automotive electrical troubleshooting; however none of them combine all of the components proposed by Jonassen and Hung (2006) or Bonk and Zhang (2006) as described in the literature review. The goal of this project is to implement all of the components outlined by these authors.

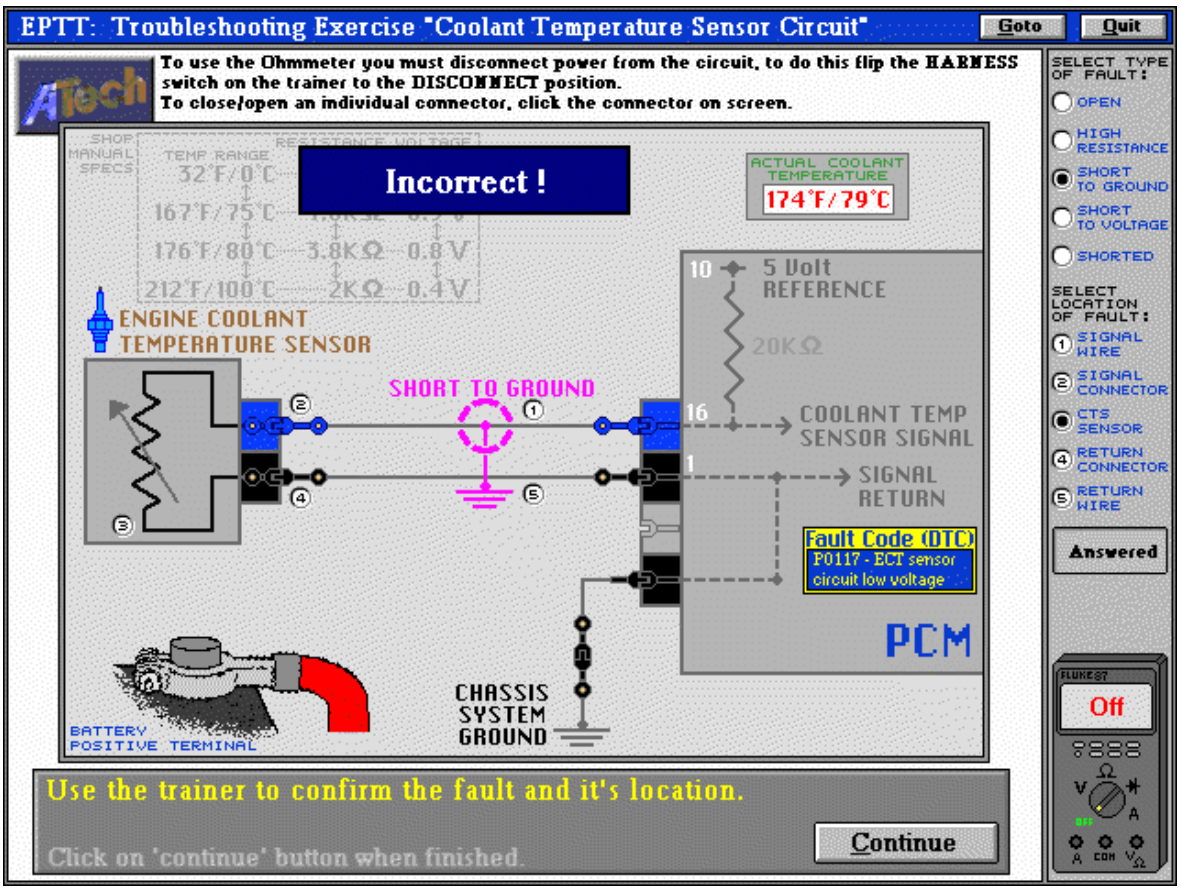

Figure 3: Screenshot of an ATECH simulator (http://www.atechtraining.com).

Literature Review:

Simulations defined

Simulations are immersive learning environments that recreate a real world situation, event, or environment (Bulger, Mayer, Almeroth, & Blau, 2008, p. 135). Alessi and Trollip (2001) stress that a simulation provides the learner with the ability to interact with a model of a real world situation or activity. Hartley (2006) defines simulations similarly as "technology enabled environments created to facilitate learning through immersion, engagement, and adaptive surroundings that ultimately provide guidance and constructive feedback to the learner" (p. 53). Hsu and Thomas (2002) point out that a major difference between a simulation and a tutorial is that a "simulation does not provide explicit feedback" (p. 959). Simulations use constructivist learning approaches to motivate learners within a safe environment which approximates a portion of the real world. Such learning environments are often very visual and help learners transfer information from the educational setting to the real world. Like any educational approach, simulations must be implemented correctly to be effective.

Simulations bridge education to real world

One frequently mentioned benefit of simulations is that they place information and principles to be learned into a real world context better than traditional textbooks (Taylor & Chi, 2000, p. 292). Scherly, Roux, and Dillenbourg (2000) note that the development of scenarios similar to those encountered in real life can be facilitated by simulations (p. 127). Learners can "experience greater authenticity and realism" through

the use of simulations (Kirkley & Kirkley, 2005, p. 45) and "interact with and participate in a virtual workplace" (Taylor & Chi, 2000, p. 292). Simulations can help the learner transfer knowledge gained in the classroom to the real world by bridging the gap between classroom theory and real life practical application (Lasater, 2007, p. 272). Simulations often place information into a narrative context (or story) which helps learners to see how concepts apply to the real world. This is an area that simulations seem to be much stronger in than traditional textbooks (Lasater, 2007, p. 274). Additionally, computer simulations can promote a better transfer of information to real world scenarios than reading content in textbooks (Taylor & Chi, 2000, p. 308).

However, it should be noted that some research suggests that learners may need help from their instructors to achieve more than a shallow transfer of knowledge from the simulation to the real world. Hsu and Thomas (2002) found that students using a simulation on the effects of mountains on rain fall had trouble transferring this to a weather forecasting problem involving a mountainous region. The students understood the phenomena illustrated in the simulation, but did not see how to apply it to the weather forecasting problem. Jonassen and Hung (2006) also warn that unless a simulation has a sufficient level of realism and allows for adequate practice of skills needed in the real world, that transfer of learning may be no better than in a traditional lecture setting (p. 90). A simulation must be well designed to facilitate good transfer to a real world situation. "Computer simulations with exploratory learning activities in authentic situations can facilitate students to develop the abilities of problem solving and transfer"

(Hsu and Thomas, 2002, p. 957). Simulations must be interactive and authentic to be effective.

Simulations motivate and engage

Student engagement and motivation are often mentioned as being strengths of using simulations in educational settings (Bulger et al., 2008, p.140 and Kirkley & Kirkley, 2005, p. 45). Bonk and Zhang (2006) point out that the use of "interactivity, visualization, collaboration, captivation, and technology sophistication motivate learners and promote effective learning" (p. 251). The interactive and active learning nature of simulations helps to motivate and promote learner engagement and a deeper level of learning (Lasater, 2007, p. 270 and Hennessy, Deaney, & Ruthven, 2006, p. 702). This is especially the case when comparing the use of simulations to more traditional methods such as lectures and textbooks. Bulger et al. (2008) found that using interactive computer simulations can promote better student participation and engagement than a more traditional teacher centered lecture approach (p. 138). Though, Jonassen and Hung (2006) point out that simulation alone may not result in a better grasp of troubleshooting than more traditional approaches (p. 90). Learners may feel more motivated in a learning experience which includes simulation because "they can make the decision to do something first, and then see what happens, rather than just getting spoon fed" (Hennessy et al., 2006, p. 712).

Simulations are constructivist

A learner centered, discovery based, constructivist approach is supported by the use of simulations. Boyd and Jackson (2004) point out that, "the simulated environment provides learners with a situation on which to build knowledge" (p. 5). Kirkley and Kirkley (2005) agree that simulations are best employed through a constructivist learning framework (p. 43). Hsu and Thomas (2002) state that, "a computer-based simulation with realistic (authentic) situations, learning activities with interactive explorations, multiple representations, and the capability of reviewing previous actions, aids learners in constructing their own knowledge and to cultivate their problem-solving skills." (p. 960). They found that multiple representations within a simulation were important in helping the learner to choose the mode of representation that best helped the learner construct knowledge and gain a broader view of the information by considering different representations (Hsu & Thomas, 2002, p. 968).

Simulations support constructivist learning approaches such as; guiding the learner to use existing knowledge to gain new knowledge (Hennessy et al., 2006, p. 710), personalized learning by allowing the learner to reach a goal through multiple pathways (Hartley, 2006, p. 53), and shifting a learner's focus from memorizing information to one of critical thinking (Juneau, 2006, p. 19). Simulations typically provide an environment in which principles can be applied and learned, rather than providing direct instruction of information or principles (Taylor & Chi, 2000, p. 293). Additionally, using simulations in groups of varying educational background can help to promote a community of learners who help each other, and allow students to learn and discover through their

failures in a safe environment (Clem & Simpson, 2008). Learners often report that the simulation scenarios in which they make mistakes and fail are often the scenarios that they learn the most from (Lasater, 2007, p. 273). Though Bot, Gossiaux, Rauch, and Tabious (2005) warn that in technical fields care must be taken to avoid an extremely constructivist approach to the point where a learner focuses on technically insignificant details and fails to learn the concepts needed in the real world (p. 112). It is important that the simulation is crafted to both allow for constructivist learning while still providing enough of a framework that the learner discovers skills necessary to succeed in the field.

Simulations offer a safe environment

Simulations are valuable education tools in situations where learning in the real environment without sufficient training could be dangerous (Hartley, 2006, p. 54). Simulations offer a low risk environment in which learners can practice applying theory to real-world situations without fear of doing real physical damage (Decker, Sportsman, Puetz, & Billings, 2008, p. 74). This allows learners to engage in situations which would otherwise be too dangerous, too costly, or impossible to observe (Hennessy, et al., 2006, p. 710). Additionally, the ability to fail in a safe environment can also enhance a learner's ability to learn from one's mistakes. "People do not truly learn until they practice and fail in a safe environment… Simulations help learners try and fail a task in a safe environment" (Hartley, 2006, p. 53). Further, as Lasater (2007) points out, learning through simulations can give the learner the chance to see the results of one's actions in a safe environment (p. 270). It should be noted that safety concerns do not just apply to the learner but also the system that is being learned. The increased cost and sophistication of

electronic components on a modern automobile mean that a simple novice mistake could cause thousands of dollars of damage. A computer simulation allows for such mistakes, along with their correction, with a much lower cost. A learner who has practice diagnosing automotive faults in a simulation walks into a diagnosis on a real automobile with some background experience gained in a safe environment.

Simulations help build visual models

Many educational topics are much easier for learners to grasp if they have a clear visual model to work with. Hsu and Thomas (2002) state that, "with capabilities for altering the natural time scale and simplifying real world models, simulations can make phenomena more visible to learners and accommodate individual cognitive levels" (p. 955). Monaghan and Clement (1999) point out that learner confidence in problem solving can be improved through better use of mental visualization gained through the use of simulations (p. 929). Simulations have the advantage of helping a learner by making concepts visual (Hennessy et al., 2006, p. 709). Simulations help to enhance learning, memory, and application of knowledge outside the simulation by helping the learner to build visual models of abstract concepts (Hennessy et al., 2006, p. 702). Additionally, learners can gain a better understanding of concepts through the use of simulations by giving them a visual model to rely on, rather than relying on memorizing facts and algorithms (Monaghan & Clement, 1999, p. 937). This is especially important in terms of developing educational methods that guard against students memorizing "equations and problem solving procedures without understanding the concepts behind them" (Jonassen, 2003, p. 271). Additionally, the use of animated scenarios instead of

static scenarios where appropriate, along with a reasonable level of realism supports the development of better visual models (Jonassen, 2006, p. 90). A solid conceptual model of an automotive electrical system is critical since it is not possible to visually see what the electrons are doing in the real circuit.

Implementation of simulations

Many researchers have much to say on the effective implementation of simulations; noting that like any educational approach simulations must be implemented properly to work effectively. Simulations must be designed with the learner in mind since a learner who has insufficient background knowledge may find a very sophisticated and realistic simulation to be overwhelming and difficult to learn from (Kirkley & Kirkley, 2005, p. 48). One approach to avoid this problem is to embed resources into the simulation to aid novice learners who might otherwise be overwhelmed with the realism of the simulation (Kirkley & Kirkley, 2005, p. 49). Jonassen and Hung (2006) suggest that a troubleshooting simulator should include components and how they relate to each other to make the system operate, and examples of failure modes (p. 93). The use of functional diagrams can help the novice learner visualize the system represented in the simulation (Jonassen & Hung, 2006, p. 99). Another approach is to use simulations to support content presented in existing lessons rather than using the simulations to directly teach the lesson (Clem & Simpson, 2008, p. 4) and (Hsu & Thomas, 2002, p 957). Using simulations to reinforce more traditional teaching approaches can be more effective than just throwing a student into a simulation (Hennessy et al., 2006, p. 704). Just as too much realism can cause a novice learner to feel overwhelmed, an overly simplified and

idealized simulation may be ineffective if the learner views it as being inconsistent with their experiences in the real world (Hennessy et al., 2006, p. 723).

Feedback and direction from an instructor or from the simulation itself is also very important for a simulation to be effective. Learners may end up wandering aimlessly through simulations and end up learning little without sufficient guidance (Hennessy et al., 2006, p. 727). Feedback is particularly important for students to be able to learn from both their successes and failures in simulations (Lasater, 2007, p. 274 and Decker et al., 2008, p. 74). A simulation which does not allow for sufficient feedback or debriefing will be nowhere near as effective as one that does. Without sufficient background knowledge and teacher guidance a learner may draw incorrect conclusions from using a simulation and end up learning a model which is not a reflection of reality (Monaghan & Clement, 1999, p. 939). The danger of giving too much feedback and guidance is that the power of a simulation to allow self discovery can be diminished by only allowing the learner to use the simulation in a constrained and structured manner (Hennessy et al., 2006, p. 724). Bot et al. (2005) point out that a student should be allowed to use their own knowledge and experience along with experimentation before the teacher steps in with guidance (p. 118). Simulations are most effective when learners are given both "room to test some of their own ideas" and "boundaries" (Hennessy et al., 2006, p. 712). Jonassen and Hung (2006) also point out that troubleshooters cannot rely on a system that they are problem solving in the real world to give them explicit feedback, so providing too much feedback in a learning simulation can diminish the learner's ability to transfer the skills they gain in a simulation to the real world (p. 102).

Troubleshooting skills

Expert troubleshooters rely on system knowledge, procedural knowledge, strategic knowledge, and experience with similar faults to efficiently diagnose faults (Jonassen, 2002, p. 9). System knowledge is a model or understanding of how all components in a system are related to one another and is learned most effectively through functional diagrams (Jonassen, 2002, p. 10). A good system model allows the troubleshooter to develop a conceptual model of the system and problem to be solved. "It is the quality of their conceptual models that most influences the ease and accuracy with which the problem can be solved" (Jonassen, 2003, p. 269). Procedural knowledge is less system specific and could be defined as knowledge of testing techniques and tools that might be applied to many different systems (e.g. using a digital multimeter to measure voltage in an electrical circuit) (Jonassen & Hung, 2006, p. 83). Strategic knowledge is also often not system specific and refers to general problem solving techniques and strategies. Expert troubleshooters will be able to formulate an efficient game plan based on strategic knowledge, while a novice may have no game plan and wanders aimlessly through the diagnosis (Jonassen & Hung, 2006, p. 84). Experience with similar diagnostic problems is one of the biggest differences between and expert and novice troubleshooter. Jonassen and Hung (2006) point out that that the ability for an expert to base their diagnostic strategy on previous experience is most important in terms of troubleshooting efficiency and accuracy. They go on to point out that, "because of the importance of experiential knowledge, it is essential that learners be required to practice problem-solving tasks" (Jonassen & Hung, 2006, p. 86). Learners can gain this experience through real world diagnostic problems, simulated diagnostic scenarios, or

through case stories of problems solved by expert troubleshooters. Simulated scenarios are likely the best option based on the advantages of simulations discussed above.

Troubleshooting learning models - R2D2 and TLE

Bonk and Zhang (2006) propose a model for teaching problem solving in an online format which integrates "four types of learning activities: (a) **R**eading/Listening; (b) **R**eflecting/Writing; (c) **D**isplaying; and (d) **D**oing." (251). They use the mnemonic 'R2D2' to help the educator remember the key components of this approach. The R2D2 model helps the learning process by engaging more than one type of learning and takes the learner from the acquisition of new information to the application of the information in problem solving (Bonk & Zhang, 2006, p. 262). Hsu and Thomas (2002) found that learners who reflect and discuss their experiences with a simulation develop important thinking skills (p. 960).

Jonassen and Hung (2006) propose a model for teaching diagnostic troubleshooting referred to as the "Troubleshooting Learning Environment" (TLE) (p. 97). The TLE would consist of a set of problems to solve, a system model, a case library, and a diagnostic simulator (Jonassen & Hung, 2006). This model starts with the premise that the best way to learn how to troubleshoot is by gaining experience solving problems (Jonassen & Hung, 2006, p. 97) and (Jonassen, 2002, p. 10). The system model should consist of multiple representations of the system ranging from functional flow diagrams, physical exploded diagrams, images of components, and other information to help a novice build a conceptual model of how the system in question works (p. 98). The

system model should use visual representations as much as possible. The case library should present real world diagnostic stories illustrating various faults and the methods an experienced troubleshooter would use to diagnose the faults (p. 103). The case library is a critical component of the TLE model because of the importance of experience in the diagnostic process. Diagnostic stories are an important learning tool that technicians use to share experiences (Jonassen & Hung, 2006), so it makes sense to introduce learners to them early on in the troubleshooting learning process. The diagnostic simulator is the heart of the TLE as it would allow the learner to make observations and take measurements on a simulation of the system in order to practice troubleshooting (p. 101). The simulator would present the learner with a series of faults to diagnose so that the learner could gain experience troubleshooting. The learner would be able to refer to the case library and the system model to help guide them in their diagnostic approach.

Problem Statement and Research Question:

It is important that students training to be automotive technicians acquire a solid foundation in electrical troubleshooting to succeed in the automotive repair industry. No single teaching approach is the solution. However, a computer based diagnostic troubleshooting simulator, if properly developed, could be a very effective learning tool to accomplish this goal. Jonassen and Hung (2006) have developed a theoretical model for a Troubleshooting Learning Environment (TLE) that appears to be a very promising framework from which to develop an automotive electrical diagnostic simulator. At this point their model has not been widely applied or evaluated for its effectiveness. Bonk

and Zhang (2006) have also proposed the R2D2 (Read, Reflect, Display, Do) as a framework for developing online delivery to teach problem solving. Combining the TLE and R2D2 models should result in an effective tool for teaching troubleshooting.

The purpose of this project was to develop and evaluate an interactive diagnostic simulator using the TLE and R2D2 models, to help automotive students learn how to diagnose an automotive cranking (starter) circuit. The primary question under investigation was: What does an interactive diagnostic simulator based on the TLE and R2D2 models look like? A secondary question explored was: How will a group of automotive educators view such a simulator's value?

Methods:

This project involved developing an interactive diagnostic simulator using Flash. The completed simulator can be viewed at: http://people.morrisville.edu/~makila/starter/start.swf. The simulation design incorporates elements of both Jonassen and Hung's (2006) TLE model for teaching troubleshooting and Bonk and Zhang's (2006) R2D2 model for teaching problem solving in an online medium. The focus of the simulator is the automotive cranking/starter circuit with a goal of helping the learner better diagnose no start situations where the vehicle's engine does not crank over. This automotive system was chosen since it is often one of the first major systems taught in introductory automotive electrical courses. Additionally, the diagnostic approach used for this system, once mastered, can be applied

to a wide variety of systems on an automobile. Success diagnosing this system sets a foundation for success with other systems. The simulation consists of a diagnostic case library, a functional system model of the cranking circuit, and interactive diagnostic scenarios.

Case Library

The diagnostic case library consists of real world diagnostic stories that illustrate various faults that can cause a no crank situation. The stories also illustrate diagnostic procedures and strategies that can be used to successfully diagnose such problems. The stories are primarily based on no crank problems that I experienced while working as an automotive technician and as an automotive educator. As pointed out by Jonassen and Hung (2006) diagnostic stories play an important role in technician's sharing of information to help each other better learn how to troubleshoot. Additionally, experience is heavily used by experienced technicians to guide the diagnostic approach followed (Jonassen & Hung, 2006). Because of this, case studies can be used to help novice technicians gain experience through other more experienced technicians' experience. The case study library is an important part of the TLE model for teaching troubleshooting proposed by Jonassen and Hung (2006). Case studies also satisfy the 'Read' portion of Bonk and Zhang's (2006) R2D2 model. The case stories were developed using Camtasia Studio and combine audio and images in a podcast style format. Figure 4 is a screen capture from the opening title scene for one of the case studies.

Figure 4: Example opening screen for a diagnostic case study story.

System Model

The learner can access a section of the simulator that provides a system model for the automotive cranking circuit as a reference. This section of the simulator presents the learner with a basic wiring diagram, a functional block diagram, photos of major circuit components, component locations, and the chance to practice testing. The functional block diagram shows the components involved in the system and how they interact with each other to crank over the engine. Jonassen and Hung (2006) point out that a conceptual model of how a system works is an important part of the experienced

technician's approach to troubleshooting and that a functional diagram is especially effective at representing this for the novice. The functional diagram is be a visual representation of how the cranking system works and as such will satisfy the 'Display/Diagram' portion of Bonk and Zhang's (2006) R2D2 model. Figure 5 shows a screen capture of what the functional block diagram, included in the system model, looks like in the completed simulation.

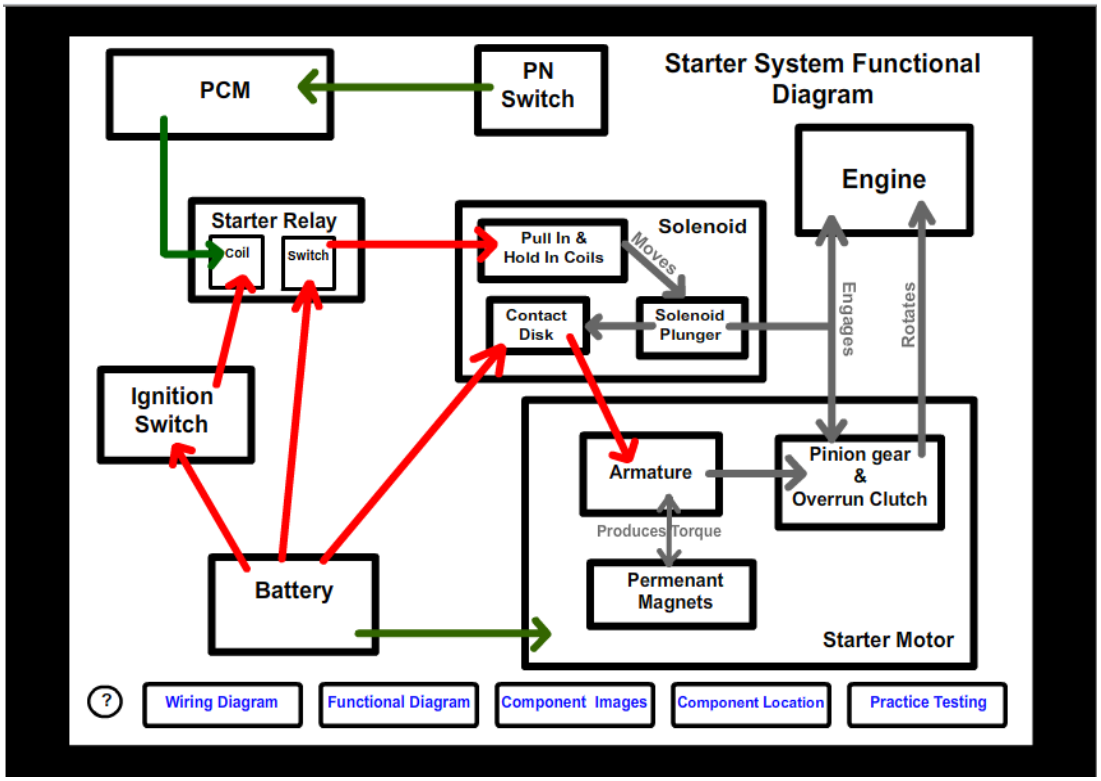

Figure 5: Screen capture from the system model section of the simulator.

The system information section also includes component images and a component locator that the learner can use as a reference. This provides the learner with actual pictures of what the items look like on the vehicle so that the learner can better connect the diagrams used in the simulator with the real world vehicle. The component locator

helps the learner to physically locate the components on the vehicle; again helping the learner to connect the simulated vehicle with the real world vehicle.

The system information section also provides the learner with the opportunity to practice testing on a vehicle that does not have any problems. The learner can choose from the same menu of tools provided in the diagnostic scenarios and can see what results a test would have on a typical good vehicle. This section gives the learner the chance to practice using the tools before using them to diagnose a vehicle with a fault. Additionally, the learner can refer back to this section while working through a diagnostic scenario if he or she is unsure of the results of a particular test on the vehicle with a problem.

Diagnostic Scenarios

The interactive diagnostic scenarios allow the learner to practice and gain experience troubleshooting no crank faults on an example vehicle. Each scenario presents the learner with a vehicle and a customer complaint to troubleshoot. The diagnostic simulator allows the learner to take measurements using a variety of common automotive diagnostic tools at various points in the cranking circuit. A wiring diagram is presented to the learner so that he or she can take measurements throughout the circuit to help determine the fault. Using a wiring diagram as a diagnostic road map is a critical skill for technicians to learn. The learner is also able to refer to the case library and the system model while working on the diagnostic scenarios to help him or her with the diagnosis. While working through the scenario, the learner is not given explicit feedback by the simulator to guide him or her through the diagnosis. This is to reflect the fact that

in the real world the technician cannot rely on the vehicle, customer, or an instructor to step in and give explicit feedback. The technician must rely on an understanding of the system, testing procedures, past experience, and an understanding of the measurements taken on the faulty circuit to successfully diagnose the problem. The symptoms that the vehicle displays along with the diagnostic tests that the technician carries out need to become the feedback that is relied on to diagnose the problem. The simulator is an important portion of Jonassen and Hung's TLE model for teaching troubleshooting and also satisfies the 'Do' portion of Bonk and Zhang's R2D2 approach.

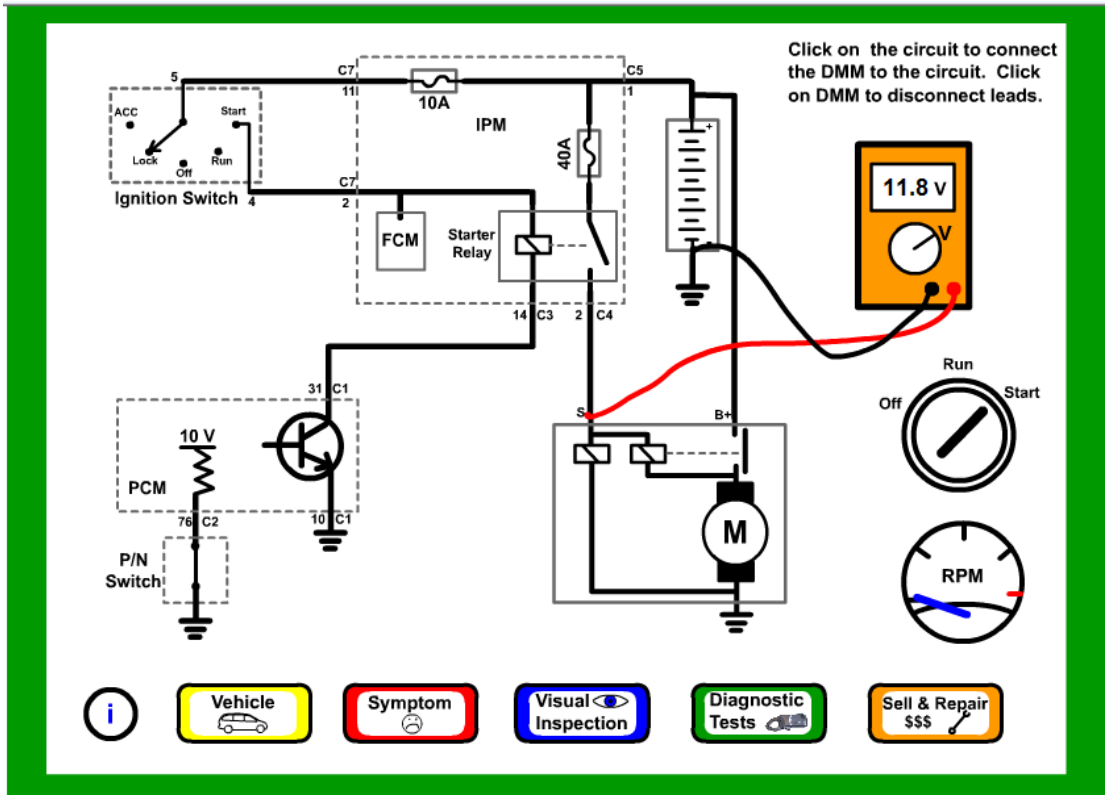

Figure 6: Screen capture from the testing section of a diagnostic scenario

Discussion Forum

The discussion area of the simulator will allow learners to discuss what they think is the needed repair in each of the different scenarios. This gives the learners a chance to discuss what testing in the simulator they carried out and why they think a specific repair is needed to solve the problem. They can also discuss how a particular scenario is similar to a case presented in the case library or possibly even a case that they experienced personally. The instructor would act as a facilitator for the discussion area to ask leading questions if the learners become lost or confused. Additionally, the discussion area would be used to reveal what the actual needed repair is for each of the scenarios after the learners have had a chance to discuss their testing approach and recommendations. The discussion area is a forum to help the learners collaborate and reflect on how they approached each of the diagnostic scenarios. As Jonassen and Hung (2006) emphasize, the sharing of diagnostic stories is a major method that automotive technicians share knowledge with each other. There are a number of online professional technician forums such as iATN (International Automotive Technician's Network), in which automotive technicians post help requests and diagnostic success stories. These forums are an important resource for collaborative information sharing among professional technicians. Having learners participate in a simulated discussion forum, as part of the learning process, not only simulates diagnosing but also a life-long approach to learning. This discussion area should help learners reinforce their troubleshooting experiences and satisfies the 'Reflect' portion of Bonk and Zhang's R2D2 model.

Focus Group Evaluation of Simulator

The simulator was evaluated through the use of two exploratory focus groups consisting of automotive educators. The groups were solicited from automotive educators who participated in the 2009 Automotive Training Fair held at Morrisville College. The first group was run on Monday June 15th, 2009 and the second group was run on Thursday June 18th, 2009. This will allow some time for modification of the discussion questions used for the second group based on data collected from the first group. The volunteers were asked to use the simulator and then participated in a focus group discussion to determine their experiences with the simulator.

A focus group was chosen since the intent of this project is to develop and explore the use of a simulation using the TLE and R2D2 models described earlier. Focus groups are generally well suited for studies that are geared towards exploration of a topic rather than explaining or describing a topic (Babbie, 2007). Focus groups have traditionally been used in marketing to explore potential customers' reactions to a product or a proposed product (Babbie, 2007). Information gained from such marketing focus groups can help to determine if a product is worth developing further and may also determine ways to improve the product. Additionally, as Barbour (2007) points out, focus groups are particularly suited to not just explore what participants of a group think, but also why they think that way. Exploring why a group thinks what they do should give a more complete picture of how well the simulator incorporates the features proposed by the TLE and R2D2 models. Using a focus group of automotive educators who might use a simulation as a teaching tool would be an ideal way to gain feedback to determine the

educational value of the simulator and even determine ways to improve the simulator. The focus group interview guide in Table 1 was developed using guidelines and suggestions from Stewart, Shamdasani, and Rook (2007). Due to time constraints neither of the focus groups covered all of the questions in the interview guide.

Table 1: Focus Group Interview Guide

What important troubleshooting skills do you think this simulator would help a student develop?
If you currently use computer based simulators to teach automotive troubleshooting (or have used them to learn troubleshooting), how does the simulator that you just used compare?
Do you think that the diagnostic scenarios are realistic enough that students could transfer what they learn in the simulator to a real automobile? [Probe: What specific skills do you think students could transfer to a real automobile?]
One way in which this simulator differs from most currently available automotive simulators is in the use of the library of real world solved diagnostic stories. Do you think that this is a useful feature? [Probe: Why or why not? What makes you think this?]
Another way in which this simulator differs from most currently available automotive simulators is in the use of the discussion forum. Do you think this is a useful feature? [Probe: Why or why not? What makes you think this?]
Would you use this type of teaching tool? [Probe: If yes, why and how would you integrate it into your classes? If not, why not?]
If you could change the simulator in any way, what would you change? [Probe: Why? How would this change make a difference?]
Is there anything about the simulator that you would like to comment on that has not been discussed?

A transcript of the focus group was made based off of a digital recording of the group using Camtasia Studio recording software. The diagnostic simulator, the current discussion question, and the 'talking participant identifier' were displayed on a laptop running Camtasia Studio (see Figure 7). A microphone was connected to the laptop to capture an audio recording. The 'talking participant identifier' is a small Flash program that has a numbered seating arrangement for the participants in the focus group. Clicking on the number assigned to the seat of the participant who is talking made it easier to identify the speaker when transcribing the audio recording. Additionally, displaying and recording the discussion question and the simulator along with the audio made it easier to develop a transcript. Using Camtasia in this way has the advantage of avoiding the

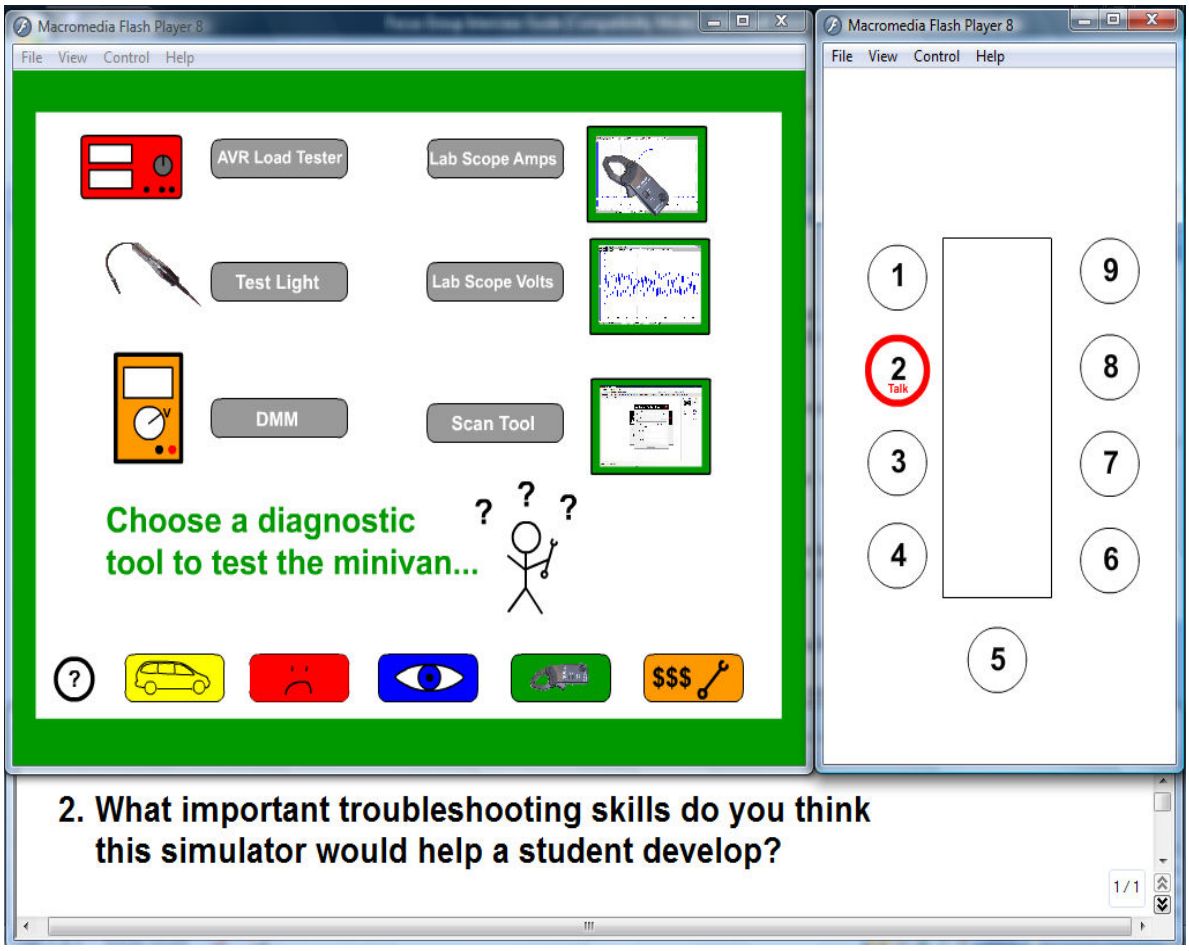

Figure 7: Screen capture of simulator, participant identifier, and discussion question.

problem of identifying comments made by the same individual based on voice alone in an audio recording. Though, it was found that this was not really necessary as it was not difficult to track individual speakers based on their voices. It also allows for a more confidential and anonymous recording of the focus group than would be possible using a video recording. The one disadvantage of this approach as opposed to using a video recording is the loss of facial expressions and other body language. However, due to the nature of the project under investigation it is not likely that the loss of this information will be significant.

Data Analysis:

A number of important key themes emerged from the focus group discussions. These included discussions about the method of feedback in the simulation, the teaching effectiveness of the simulation, and the importance of a real world feel to the simulation.

Method of Feedback

In the original design of the simulator the learners were to receive feedback through a discussion forum. Once the learner thought that they knew what would fix the vehicle in a particular scenario, he or she were to post what tests were conducted and what should be repaired to a discussion forum. The forum was to serve as a place where learners could collaborate and reflect on the diagnostic scenarios. Feedback from the instructor was to be provided through the forum also; this would include letting the learners know if their diagnosis of the scenario was correct. The version of the simulator

that the focus group participants worked with was set up with a discussion forum. Figure 8 shows screen captures illustrating what this looked like.

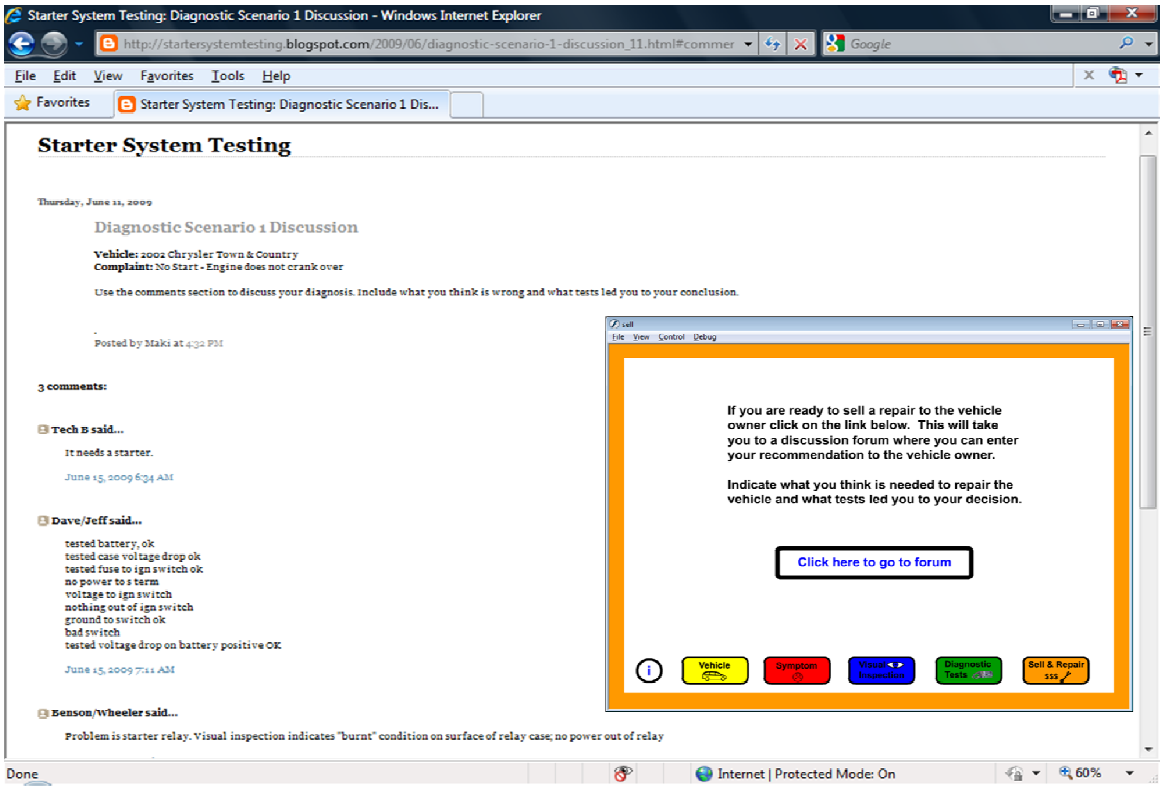

Figure 8: Screen captures of discussion forum.

Two concerns were brought up in regards to the discussion forum. One was that good students would work through the scenarios and then post their thoughts, while weaker students might skip the scenarios, wait for the better students to post, and then copy them. Another larger concern was the lack of instant feedback with the discussion forum approach. One participant stated:

> *Well, like I said the instant gratification kind of thing - you know, I think kids want to know if they were right or wrong and they want to know right away. 'Did I get it right? How'd I do?' So that would be definitely - because sometimes when they do something like this and then have to wait two or three days for the results they don't want to deal with it - they don't even want to look at it. So that is a big one.*

Additionally, while observing the instructors work through the scenarios it was evident that they did not like the discussion forum and really wanted to see feedback instantly as to whether or not their diagnosis was correct. However, one instructor did point out that giving instant feedback might encourage learners to just randomly click on possible repairs until the vehicle is fixed rather than going through the testing procedure. These concerns regarding the need for better and more instant feedback are consistent with a number of authors cited in the literature review. Lasater (2007), Decker et al. (2008), and Hennessy et al. (2006) all pointed to the need to have sufficient and appropriate levels of feedback to help learners to succeed. This was not being provided by the discussion forum format.

On the other hand, a facet of the discussion forum that was seen as a positive was that it might encourage learners to think about the testing. One participant pointed out that:

> *It definitely puts some ownership back on the students, they are going to think about what they were testing; they have to put some thought into it rather than just click and replace the part.*

Due to these observations the current version of the simulator does not include the discussion forum. Instead, once the learners think that they have diagnosed the fault they can sell the repair by entering a brief description of the testing that they did and indicate what component should be repaired. If the scenario has been correctly solved, a repair order can be printed and handed in to the course instructor to demonstrate that the scenario was completed correctly. Figure 9 shows the screen where learners enter a brief

description of testing that was done. Figure 10 shows a screen capture of a repair order from a correctly solved scenario; it includes the learner's name, the complaint being investigated, the testing description as input by the learner, and that the scenario was solved correctly. If the scenario is not solved correctly the learner is instructed to start over on a new scenario. Every time the learner starts a scenario the simulator randomly chooses a specific scenario from a library of scenarios.

This approach was adopted so that the simulator would give the learner instant feedback as to whether or not their diagnosis would fix the vehicle since this was a major concern expressed by the focus group participants. However, it attempts to maintain the positive aspect of the discussion forum; encouraging learners to think and reflect about the testing done because they do not simply choose the component to repair but enter a brief description of the testing that was done. This is consistent with Bot et al. (2005) who found that a learner should be allowed to use his or her own knowledge and experience along with experimentation before feedback is given. Additionally, this approach should also reduce the problems of learners guessing at a solution without testing or sharing a solution with classmates. Guessing is discouraged since if the scenario is not solved correctly the learner starts over on a new randomly chosen scenario. This randomization of scenarios should also prevent learners from copying solutions from each other since they do not know if they are working on the same scenario as a classmate until it is correctly solved. Additionally, since an instructor can collect and check the repair orders to see if the testing steps described by the learner

matches the problem at hand, this should further encourage the learners to actually work their way through the entire scenario.

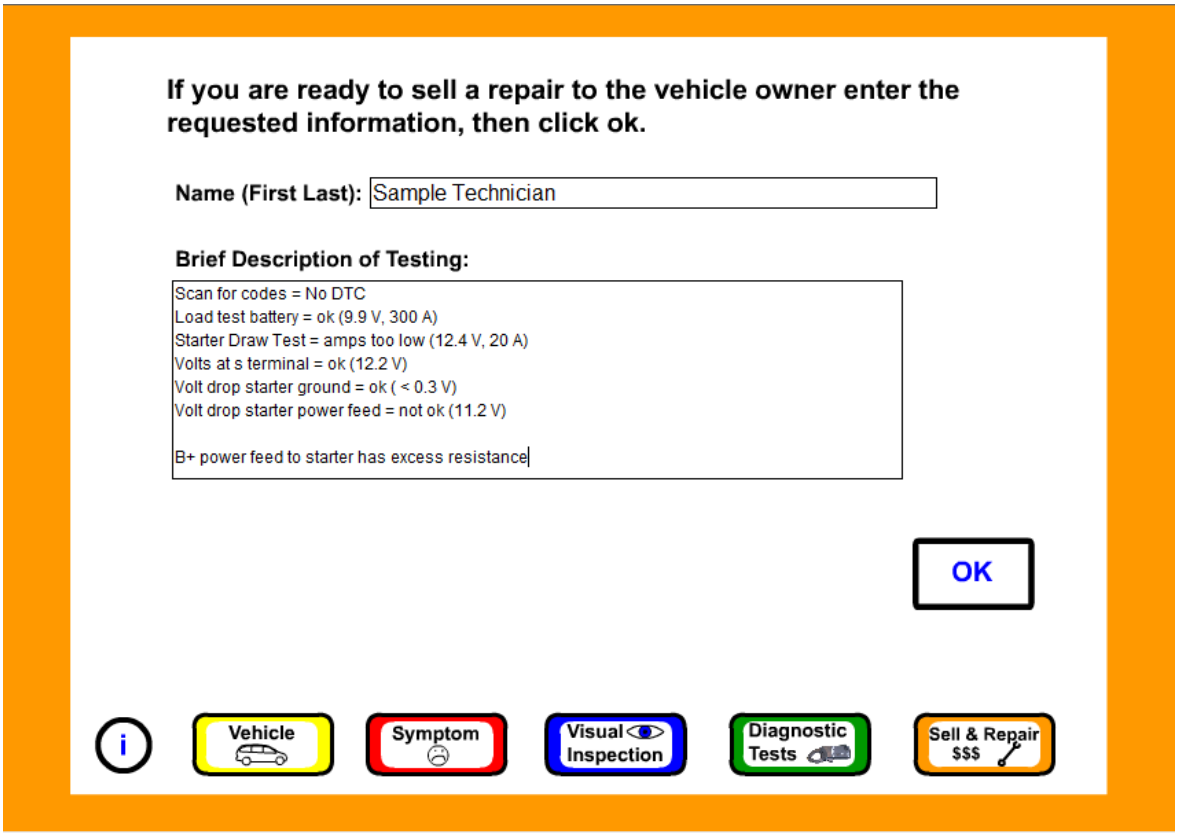

Figure 9: Screen shot of repair order input screen with example information.

It is hoped that this approach to providing feedback will allow for sufficient feedback to provide adequate guidance to the learner without giving too much feedback. Just as a number of authors (Lasater 2007, Decker et al. 2008, and Hennessy et al. 2006) pointed out the need for feedback, Jonassen and Hung (2006) pointed out the danger of providing more feedback than a system in the real world would provide. Troubleshooters cannot rely on a system that they are problem solving in the real world to give them explicit feedback, so providing too much feedback in a learning simulation can diminish the learner's ability to transfer the skills gained in a simulation to the real world

(Jonassen & Hung, 2006). The approach adopted with this simulation tries to balance the desire for instant feedback with the need to not give too much feedback, by mirroring the type of feedback a technician who is troubleshooting a vehicle would experience. He or she would only get feedback once the diagnosis was complete and a repair had been made to the vehicle. Eliminating the discussion forum from the simulator in favor of instant feedback may reduce the amount of 'reflection' that the learner does – an important component of Bonk and Zhang's (2006) R2D2 model for online teaching. However, it is hoped that the description of testing that the learner is required to input will make up for this.

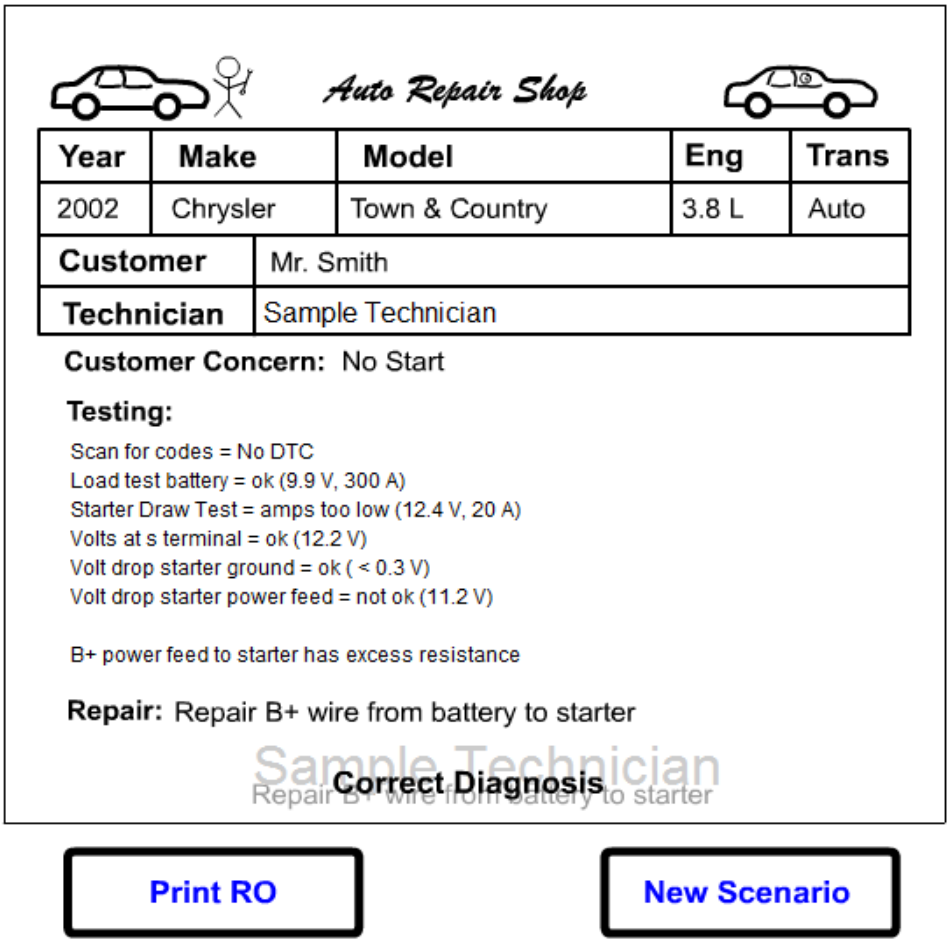

Figure 10: Screen shot of repair order for a correctly diagnosed scenario

Teaching Effectiveness of Simulator

The responses to the question of whether or not the focus group participants felt that the diagnostic simulators were realistic enough to enable knowledge transfer to the real world were very polarized. The discussion opened with the following exchange:

> *Without a doubt, I don't think you can get any more real world with the pictures and the background and the testing they have to do – the only way it could be better is having them actually do it on a real car.*
>
> *That begs the question of whether simulation works or not with students.*
>
> *If it is on a computer screen it works just about better than anything.*
>
> *No, not necessarily – in my experience kids do not like using simulation software.*

Two of the participants who felt the strongest for and against the use of simulation are currently using the same commercially available computer based simulation software – the system that they are using is about a $200,000 package. The one individual thinks it is quite effective whereas the other does not. However, after discussion among the group members no one expressed disagreement with the following conclusions (including the individual who stated that kids did not like using simulation software). First it was noted that the students who were most likely to benefit from simulations were the motivated and interested students – it didn't matter whether these students were the more gifted students or lower functioning students, those that are motivated are those who benefit. One participant even pointed out that he has observed that students with learning disabilities (who are motivated) are the ones that seem to benefit most from the use of simulations. He indicated that the self paced nature of the simulation seemed to be a large factor with success for students with disabilities. This finding that simulations are more effective for students who are motivated, rather than the simulation itself promoting

motivation, is in contrast with the findings of a number of authors cited in the literature review. For example both Bulger et al. (2008) and Kirkley and Kirkley (2005) stated that learner engagement and motivation are strengths of using simulations in educational settings.

Secondly, the group thought that it was very important that simulations be used as one teaching tool in a toolbox of teaching tools, rather than as a does everything teaching tool. As one participant pointed out:

> *I think it all comes down to using multiple resources. Some of the simulation software is good and some percentage of students will work with it well, some will work with hands on well – and it goes back to that differentiated instruction. This is great for some kids, but for others it is not going to work.*
>
> *It is a good middle ground, but it is god for certain functioning students – just like that board [points to a physical mock up of a headlight circuit] behind you is great for some students, so you can't replace one with the other it has to be all worked as a total package.*

Just like any other teaching tool, simulation needs to be properly integrated into a curriculum to work effectively. Using a computer simulation in place of on the car hands on exercises was seen as an inappropriate use of simulation by most, if not all of the focus group participants. However, using simulation as a tool to help learners prepare for, and better understand the hands on exercises, was viewed positively. This is consistent with research done by Hennessy et al. (2006), which found that using simulations to reinforce more traditional teaching approaches can be more effective than solely relying on a simulation. Instructors who have faced pressure from administrators to completely replace costly hands on shop time with computer simulations felt very strongly that simulation should not replace hands on training, but could be a useful

supplement. It should be noted that the purpose of the simulator developed for this project is not to replace hands on training exercises but to better prepare learners to use the more expensive hands on time more effectively.

One participant pointed out that this simulator gives the learner more flexibility, in terms of how he or she could approach diagnosing a scenario, than a commercially available computer based simulator that his school is using. The following comments by two participants, highlights this:

> *The computer based training we are using doesn't allow for the student to think out of the box – you know what I mean? – to say, 'alright I know all this but let me give um, this is a shortcut for me as a technician.*
>
> *That's a lot of them [commercially available computer based training]*
>
> *I can test all these things by doing this one instead of doing these ones methodically – it doesn't allow for thinking out of the box.*
>
> *I can pick any test that I want, it doesn't – if I do one that they thought I should have done another one first it doesn't say, 'too late you have to start all over again' because of that – I think this flexibility is fine, it allows a student to think out to the box and think about a better test or think of a test that best suits – I don't care which one they use – if they've got one that they understand and they can use it to diagnose the problem I think that is fine.*
>
> *Yeah, because a lot of people are going to come up with the same answer in different ways…*

The ability to choose from a variety of diagnostic tools and choose the order in which testing is done was seen as being important in helping students to think out of the box and to develop diagnostic skills. As noted in the conversation above, many commercially available computer based simulators force the learner to rigidly follow a set of steps in going from the customer complaint to the solution. At times this may be an appropriate

approach, however as noted above different learners/technicians will find the same solution in different ways. It is not uncommon for two expert automotive technicians to approach the diagnosis of the same customer complaint in different ways. The simulator designed in this project has the flexibility to allow for different approaches to the same problem; something not all simulators allow. This was viewed by the participants as a positive aspect, especially those who have seen learners struggle and become frustrated with simulators that force a more rigid approach. Additionally, this is consistent with Hartley's (2006) findings that simulations support constructivist learning by allowing the learner to reach a goal through multiple pathways. This flexibility was a result of the simulator design following a constructivist approach to learning and also a desire to reflect how expert technicians approach diagnosis.

Many of the participants indicated that they thought that the simulator was useful enough that they would consider using it with their students. How the simulator would be used by the participants varied some based on the level of students that they work with. Participants who work with lower level students indicated that they would be more likely to use the simulator as a instructor led group activity. Those who work with higher level students indicated that they would be more likely to assign it to students as an independent homework assignment or possibly as a review assignment.

Real World Transfer

One of the goals of this simulator was to be realistic enough so that the knowledge that the learners gain from it would be relevant to real world diagnostic

situations and that this knowledge would readily transfer to such situations. Discussion among focus group participants pointed out areas where it was thought that the simulator was successful, as well as areas where it was not as successful and needed improvement.

The use of a specific vehicle and actual photos from that vehicle rather than using a generic vehicle was seen as important in terms of real world transfer and engagement. The following comments were made by participants in the focus group:

> *One thing I liked about your scenarios was that you were working on a specific vehicle rather than a generic vehicle and you were able to click on the diagram and see pictures from the specific vehicle rather than a generic picture.*
>
> *With a specific scenario it gets the kids invested and connected with Mrs. Jones and her Caravan, where other ones [generic scenario] it is just so, here is the schematic, here is the malfunction, and they are not connected.*

Overall this was seen as being a very important positive component of the simulator. It was further pointed out that this also helps the learner transfer knowledge from the simulator to a real vehicle. A simulator that just uses generic schematics rather than linking the schematics to actual photos does not help the learner transfer what was learned to a real vehicle. A number of participants pointed out that they have observed learners work through a simulator and then go to a similar activity on a real vehicle and become totally lost because the learner could not link the schematics used in the simulator to the actual vehicle. This is consistent with Hennessy et al. (2006) who found that an overly simplified and idealized simulation may be ineffective if the learner views it as being inconsistent with their experiences in the real world.

Two suggestions that were made to improve the simulation in regards to real world knowledge transfer were the addition of more pictures to the testing section of the simulator scenario and also the addition of sounds. The current simulator scenarios primarily use photos in the visual inspection section of the scenario and use a wiring diagram schematic in the testing section of the simulator. It was suggested by the focus group participants that the use of photos or possibly even video be added to the testing section. This way the learner would not only be able to see photos of the vehicle components but would also be able to see photos of the testing tools correctly connected to the component or circuit being tested. It was thought that just as using a specific vehicle and photos in the visual inspection section would enhance knowledge transfer, that using photos in the testing section would also help enhance knowledge transfer. Additionally, it was suggested that adding sounds to the simulator would also help enhance the transfer of knowledge to the real world. Since while testing, a technician should pay attention to important sound clues (such as the click of a starter solenoid or relay), it was felt that incorporating these into the simulator would further improve it.

The case study stories were viewed as a positive addition to the simulator by participants in the focus groups. The following comments were made in regards to the value of using the case study stories:

> *Real world - the flat rate aspect, letting them know the time factor exists.*
>
> *Some of them will remember the story - it gives relevance to what you taught them.*
>
> *Especially as technicians, we remember things we got burned on – that sticks.*

> *Oh, yeah – when I teach I always relate something to something I screwed up on and how I learned from that, and I think my students always come back to 'Remember that story you told us about that kid who was cleaning that wheel bearing in his hand with the air and it blew up in his hand?' Well – it is a relevant story that maybe when they go to clean the bearing; they will remember not to use air.*
>
> *The case studies are definitely an addition not a distraction*

Additionally, one of the participants told a story about a no start diagnosis on a Chevy pickup that he was involved in as a technician that was very similar to the 'Botched Blazer' case study that is part of the simulator. The comments above and the telling of a diagnostic story by one of the participants really reinforced the validity of using case study stories to teach . This also reinforced the assertion by Jonassen and Hung (2006) that diagnostic stories play an important role in technician's sharing of information to help each other better learn how to troubleshoot.

One focus group participant pointed out that the case study stories should have a text box to go along with the audio. This would make the case studies more accessible to those who are hearing impaired or deaf, or those who would just rather read the case study rather than listen to it. This suggestion pointed out a definite weak point in the current case study format.

Conclusions:

The purpose of this project was to explore how the TLE and R2D2 models can be used to develop a diagnostic simulator to be used as a tool to teach automotive electrical troubleshooting. Feedback from a group of automotive educators pointed out both strengths of the simulator and weaknesses where the simulator needed improvement. One perceived major weakness was that the simulator did not provide instant feedback to the learners. This feedback led to redesigning the simulator so that it no longer uses a discussion forum and instead provides the learner with instant feedback. Further study would need to be done to determine whether this change improves the simulator. Additionally, it was pointed out that simulators like any other teaching tool must be properly integrated into a complete teaching curriculum and that a learner's level of motivation and interest is a significant factor in the effectiveness of a simulator. The real world aspects of the diagnostic stories in the case library were seen as a definite strength to the simulator. It was pointed out that a weakness in the case library is that in its current form it is not accessible to the hearing impaired or deaf as there is no text captioning for the audio. This is something that could definitely be addressed in the future with the addition of text captioning. The use of a specific vehicle and the inclusion of photos were also viewed positively in terms of being able to transfer what was learned in the simulator to the real world. It was thought that the simulator could be improved by including more photos, sounds, and possibly video clips especially in the testing section of the simulator.

Based on the feedback received from the focus group participants it would be reasonable to make the following suggestions. First, using the principles suggested by the TLE and R2D2 models to develop an automotive diagnostic simulator that could be used as an effective teaching tool seems to be very promising. Second, to further evaluate this type of simulator it would be necessary to test it with a group of automotive students at this point. Finally, developing a wider variety of case studies and diagnostic scenarios using the format outlined here would also be worth doing.

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Appendix A: Consent Form

The Use of an Interactive Simulator to Teach Automotive Troubleshooting

You are being invited to participate in a research study. Please take a few moments to read the explanations that follow to help you decide whether to participate or not.

Description of Study

This purpose of this project is to explore the use of an interactive diagnostic simulator to teach automotive troubleshooting. If you choose to volunteer you will be asked to use a diagnostic simulator and give feedback about the simulator through a questionnaire and/or short interview. Information gathered from this project will be used as part of a Master's Thesis Project at SUNYIT.

.

Risks and Discomforts

I anticipate minimal risk to volunteers in this project and if at any point you wish to withdraw from the project you may do so with no consequence.

Possible Benefits

Your involvement in this project will help to explore the use of simulators in learning how to troubleshoot automotive electrical faults. Feedback that you provide will be invaluable in determining if the use of simulators is useful and in providing suggestions as to how the simulator could be improved.

Confidentiality of Records

Your identity will be kept confidential. Any questionnaires or interview notes will have names or other identifying marks blacked out to preserve your privacy.

Contact Information

If you have any questions or concerns about participation in this study please contact Loren Maki at makila@morrisville.edu or (315) 684 – 6730 ***or*** *Prof. Kathryn Stam at stamk@sunyit.edu or (315) 792 – 7241.*

Statement that Research is Voluntary

Any participation in this study is completely voluntary. You may decline to answer any questions or withdraw from the study at any point without any consequences.

Statement of Consent

I have read the above information, and have received answers to any questions I have asked. I freely consent to take part in the study.

Your Signature _____ Date _____

Appendix B: Focus Group Transcripts

Monday (6/15/09) session: 13 Participants (Participants designated 1 – 13; M: Moderator)

M: What important troubleshooting skills do you think this simulator would help a student develop?

8: How to use a flow chart…

2: How to use a DVOM as far as voltage… because obviously your DVOM there only had volts and no amps or ohms…

M: A follow up to that as someone else brought that up also… Do you think that it should be expanded to include more measurements than just volts?

2: Yeah because kids are going to… they are going to look at a DVOM and if there are only volts there they are going to go to the volts, but they have got to be able to select or reference any information they have stored in their brain… whether they are going to use a load test or they are going to use a voltage drop test or they are going to use a resistance test on something…

3: A lot of the information that you are going to run into now is going to have flow charts so that takes that right out of the picture… they are not going to have to, they are going to say… you know… use your DVOM to check voltage at this point…

[The following exchange is in regards to the 'Botched Blazer' case study]

2: But some them won't say or will ask for resistance test, so if some of the flow charts said a voltage drop or check the resistance on the circuit…, or the next one might say a load test on the battery… I mean like the first scenario that you had you never did a load test on that practice scenario… you never did a load test… you just did a voltage test… when you did on the Blazer, that practice test… you only did a voltage test you never did a load test…

M: Yes, that was a mistake…

2: Because you never did a load test on the battery…

M: Yes… some of the case studies will have left out tests that are mistakes basically…

2: But that's what teaching part of basic functions is always test the battery first, always test the voltage at the battery… always a load test on the battery before you do any starting or charging tests

8: Yeah, but then he had the real life scenario of the flat rate technician starting out with you have 0.5 hours to diagnose it… immediately you are fast forward and you don't want any wasted volt measurements…

2: But he already said that he only spent 10 minutes testing on it…

8: Right…

2: …so he didn't spend the entire time with testing… if you are any technician worth your salt you be doing more than just a voltage test on it

8: Well that would be nice…

2: … because he just screwed himself…

8: But this is the first time I have seen a real world application where what really matters here … is money… I want to make money and he put that aspect in it…

2: …but he just got burned…

8: I know and he showed that on there… however on that facet where else have you ever heard that? I mean, when I went through school nobody ever explained what flatrate versus hourly was… he brings the real world into it having a level of intensity that might uh …

3: It is different here looking at from you are already a technician out there and then you are looking at it from a teaching standpoint right… you have got to go back to that

8: Right…you've got to go basic, basic, basic…

3: But I see from a technician you are right making money flatrate…you are jumping the game…

8: When you go to the dealership and you say my BOCES teacher never told me about this…

2: But that's the whole point of us being automotive educators is trying to ingrain or instill that sometimes you can't skip these steps… you skip these steps you get burned…

8: Well, obviously he pointed that out…[in the case study]

2: Well that's what my point was … is that the second part was that yeah you skipped a step and you got burned in that whole scenario…

8: Right…

M: To follow off of that… do you think it would be good to go back into that case study and modify it so that the important lessons in the end included a strong reinforcement that not only was checking the starter draw missed, but that also load testing the battery was skipped… the battery was obviously dead because a booster pack was used. Do you think that would be a good addition to add that I got burned not just because I skipped the one step but skipped the real basics… I didn't do a battery load test, I didn't etc…:
2: Yeah, from a teaching standpoint…

13: What about the customer complaint?

10: Yeah, just being clear with the repair order…ask if they were driving on the highway when it stalled… you know, maybe get more information…something like that…

8: And again I mentioned the audible aspect… don't you think that alternator would be a little noisy before it set up… that bearing, knowing GM products like I do that bearing growls… you get an rpm relate growl…

2: Exactly, those things are howling for a while before they go…

8: Yeah…

?: Yeah, turn the music up… turn the radio up…

M: So, another lesson to add would be to reinforce that you had better talk to the customer…

8: Right…

2: Verify customer complaint..

[End of exchange on the 'Botched Blazer']

5: Manipulation of the DVOM leads…

8: Yeah, maybe a click and drag type of thing…

5: Maybe when you click on it [test point in diagram]… you have it set up nicely where if you want to test whatever you can… make a choice 'What are we testing here?'… 'What are we looking at?"…maybe one or two questions and if it is correct or not… they are prompted with the correct answer… I don't know that may be a lot of work…

2: Yes, I've used simulator software before where you have to actually click on the lead itself and then where it wants to go to… so if you clicked the negative um lead and then where you wanted that negative lead to go and then positive and where you want that to go… because I've seen other simulator software that does that… because that is what a kid's going to do… they are going to put it wherever they want to do it…so they have to

be able to understand that that lead is incorrectly hooked up and you are not really gaining anything any valuable information…

6: {inaudible}… you can control the leads where you want them…
M: So, I see two comments in there… One would be to make it easier to connect the leads … Two, would be to make it more intuitive… well, not intuitive, but a little feedback as far as from the teaching side of things…

5: What are you looking for here? You are looking for _____... give some information here… you are getting something else… you know

2: Yeah, because we did that when we were hooking it up… we actually didn't have it in the right spot and we didn't get a reading and we were like what did we do… why didn't we get a reading…

3: If you go change leads you had to go back and click and it wipes them both and you had to start over…you couldn't just move a lead…

5: One thing I liked about the multimeter is that the battery doesn't go dead [laughter]…

8: That's the other reason it doesn't have the ohm feature, so you can't pop the fuse…

2: That would actually be something good to have in that simulation, is actually blowing the fuse… you just hooked your meter up wrong and this is what happened to your meter

5: Snap On will be here Thursday and that will be $800 [laughter]

M: A couple of you already started into my next question… which was comparing it to other simulators… someone brought up CDX and AutoLab was also mentioned… The question is: If you are using a computer based simulator with students, how does the simulator that you just used compare in terms of either things that are bad about it or good about it?

1: Well I have had a limited experience with another simulator and I had trouble with those even with my experience… I felt this was much easier to use and I think this one would be better for the students. I would not make this one any more complicated. Keep the problems simple…

2: But you know what? Because it is good and it is bad… because what you could do is have a basic setup for beginning students so that there is very little that they can do with it and then you can have an advanced level that a student can do more things with it… do you understand what I mean?

M: Yes… kind of like a tiered progression where they start out with the easier and then move into the harder material…

2: Yeah… so that's more like real life where you are going to have all these choices of all different instrumentation and you are going to have the ability to screw it up

13: The problems could get more difficult as well…

2: Or a multiple problem scenario…

5: One thing I liked about your scenarios was that you were working on a specific vehicle rather than a generic vehicle and you were able to click on the diagram and see pictures from the specific vehicle rather than a generic picture…

2: Or the component being a picture from a Ford and you are working on a Chevy…

1: With a specific scenario it gets the kids invested and connected with Mrs. Jones and her Caravan, where other ones [generic case studies] it is just so here is the schematic, here is the malfunction and they are not connected…

5: Instead of Mrs. Jones maybe it should be Mrs. Jones's daughter [laughter]… like maybe she is a cheerleader and needs to get to work today…

M: Any other comments on other simulations and comparisons with this one?

M: Do you think that the diagnostic scenarios are realistic enough that they will transfer and be useful outside of the classroom?

13: Without a doubt I don't think you can get any more real world with the pictures and the background and the testing they have to do… the only way it could be better is having them actually do it on a real car…

2: That begs the question of whether simulation works or not with students…

12: If it is on a computer screen it works just about better than anything…

2: No, not necessarily… in my experience kids do not like using simulation software.

12: We've got AutoLab set up at our school…

2: It sucks…

12: Uh… no, when using it correctly as far as getting the kids to use if correctly… I think between what they offer, what they have… I think a lot of it definitely… it is only meant to… it isn't solely a way for a kid to learn, but hopefully a way to reinforce what you just went over… we actually end up… three of use teach… we have chassis lab, we have engine and engine performance lab and we have a computer lab and we have a theory room… so, we move 120 kids through there in a day… the kids move through self paced, some of the kids have some learning disabilities… a lot of the computerized simulation

stuff really levels the playing field, because for one it reads to them and you know… brighter kids, do they really need to use it? Probably not so much… they do it to get a grade… I think a third to half the kids have IEPs [individual education program] and uh some of them have their headphones and use the simulator that way… not all of them… 2: I have the exact same stuff you do and I have uh… and my attitude is completely 180 degrees out…

12: Really?!

2: What I have experienced with it is that it is babysitting… and I've had it for four years…

12: Yep…

2: And we have tried it every which way to use it and I don't… I don't… I see more value in a hands on simulation than I do in a computerized simulation…

12: I… I definitely agree with the babysitting at least to a point because there are that third of the kids that are there to disrupt and be a pain in the ass… let's face it that's what we deal with, but it helps some of the kids that have learning disabilities who really want to do this and you know that's the trade off

2: But the kids with learning disabilities that really want to do this what is your percentage of that over… in an overall scenario of all your students?

12: At least thirty percent…

2: That really want to do this?

12: Oh, I'd say that most of the kids that come to us that have the learning disabilities that will try and be a student… you know the real severe IEPs… um, you know I mean that normally if a kid has a pretty severe IEP that at least our guidance department realizes it is a real tough curriculum and they are not going to throw some kid who is also a behavior problem and has severe learning disabilities… we will get some of the behavior problems but we don't normally get that combination of behavior problem and learning disability…

2: You must have a great counseling department [laughter]

3: We've got to deal with all those and I'm just tired of the meetings… you know with these kids and all the people they bring to the meeting and I don't have time to keep meeting with this… you know… I could have told you what was going to happen.

12: Here is another thing that I… I can go in if I ever get called on not meeting the kids on the IEPs needs… I can say wait a minute now…

2: Oh, yeah granted it can cover your ass, but are you really… I mean…

12: I've seen grades get a little bit better but I've seen most improvement in the kids with the learning disabilities that want to learn… I mean granted there's a third to half the kids that don't listen… they are there because they didn't know what else the hell to do… hopefully you are helping to teach them something to function in society… not that we want them in our industry… you know, because I tell some of them, I don't want you in our industry, but you know maybe you can go work at McDonalds be there every day and earn a living… or whatever the case may be, but um… these kids have grown up, these kids are a generation that have had a screen in front of them and I don't know you know… here's my point being I don't like to get up and talk in front of them too much or in the theory room use power points. I try to limit it to fifteen twenty, minutes because you get beyond that and if they interactive with remotes… let's face it if you go half an hour, two or three of them are going to fall asleep so while the other kids are answering questions with remotes… so how much can you actually lecture and the thing of it is to do a demonstration if you haven't given them the theory in lecture we are just going to train a bunch of parts changers who are monkeys just swinging wrenches. Trying to just teach some diagnostics… you know? That's only my point… yeah I do agree with you there is definitely some babysitting. We have a few TAs… with 120 kids a day we have 2 TAs and 3 teachers and we have to have someone kind of going around and the one guy's wife… the TAs are husband and wife… she… we call her the nipper, you know… she basically chases these kids around in the computer lab to make sure they are on task, when they are not we throw them out and send them down to the principal's office or whatever. But I agree… we are all facing the same kind of situation.

2: But that… have you used the ATECH [physical simulators] trainers at all?

12: Uh, not as much as I thought we were going to.

2: I mean have you had and seen ATECH vs. AutoLab because they are different trainer styles.

12: Um, we have some of the really old ATECH stuff, some of the old ignition and fuel injection stuff and we do use those. We use those more in the theory room as part of the theory deal and demonstraion.

2: Now, at "3's" school they have AutoLab and they have ATECH.

3: Five ATECHs, but… well you've been at our school… you guys have a well oiled program too… yeah, the ATECH trainers are definitely better, the kids go from AutoLab to a car and are lost… they're like 'where's that little marker diagram'… 'Dude… it's not the… it's a car, go find the part!'

2: Yeah, or you get to them and you say uh go find the MAP sensor and they don't know what a MAP sensor is because on the board it is just labeled MAP sensor and it's got

three or four prongs on it and that's what they say MAP sensor is… well, what's a MAP sensor look like when they get to the car or where's the MAP

3: Or where's the holes that I can plug my wires to? [laughter]

?: It's called a break out box guys.

2: That's the downfall of any simulation software I've seen.

8: On the other hand with computer simulation and hands on simulation both together

2: Together they can work…

8: Right.

2: If you've got students who are um willing to learn…

8: Right…

2: If they are not willing to learn, that's the whole point… willing to learn and the babysitting part.

12: That's the fine line you are always walking… how much babysitting am I doing versus how much teaching

8: True, and busy is better so the hands on is good, however, conceptually the stuff on a vehicle… you can't see all the components all at once, how they hook together it is lost sometimes so, with the basic level stuff computer simulation allows them to see this begets this begets that, then go to the hands on stuff. A lot of these guys as you know are tactile learners… they have to have the feel, they have to be able to touch the stuff

2: That's the same thing that I get everyday – 'I don't want to work on a computer because I learn best in the shop… every single student I have every had says 'I don't want to be taught theory, I don't want to be on a computer, I am taught best in the shop'. Well if you don't understand the theory you can't understand the practical application of it.

5: Well yeah…

13: What I like about these… and I am not familiar with ATECH stuff or AutoLab stuff… what I like about this is that it actually has real pictures and you are getting familiar with the parts, but this is the gateway to working on the car… that's my opinion anyway

8: Right…

13: Because if they can't do this I'm not going to let them touch a car. Because if they can't do it correctly here [in the simulator] what are they going to do to the car?

[Indication of agreement from many]

12: The cars we are using are all donated through the AYES program and NATEF… the oldest one's like a 1999 and we have 2007's and 2006's .

3: But the AYES is starting to go away.

12: Yeah, unfortunately… it is tough to get kids in the dealerships because dealerships are hurting.

3: We lost a lot of them around our area.

M: A couple things that came up… One is that there is going to be different responses to any teaching tool as far as no one tool is going to work for everybody. And another thing brought up… a couple people brought up towards the end… is the hands on being really critical and one thing I didn't mention that I should have pointed out is simulation in my mind isn't a replacement for the hands on, it is a preparation for the hands on so that the hands on time is more productively used because hopefully they come in with a higher background level that now they maximize the expensive hands on time. Of course that leaves the question of, does this simulation or any simulation bring them in more prepared or is it just busy work babysitting? Is this realistic enough that a student who goes through this simulator, for example could they be turned loose on a car with a no crank with an AVR tester and a voltmeter and start a better level to maximize that hands on time than if they had just seen a power point on it, seen a demonstration, or they had read about it in a book? Any thoughts on that?

8: With the component identification facet there that really helps, so they know as he said a MAP sensor isn't just three prongs that stick out there and as mentioned previously having it brand specific helps them to recognize it.

3: Yeah, definitely…

2: I would say the same thing as that you know you have to have levels of training in levels of tool usage that you know you may have a certain group that will work on a simulation software and that translates into a simulation practical work and then you work up to going into a live scenario. Um… because not one area is going to take it all other than what our administration always thinks that… simulation, I can just teach kids on a computer then.

3: Why do they know best the administration? Because they are money driven, so it is not always… they think it is in the best interest of the students, though it is not always in the best interest of the students. We all work with what we have. We've got to make the best of it.

2: And in a lot of cases a lot of this stuff that we get from a teachers standpoint is not what we want but what we are given. I was given AutoLab… I was told to use it. I was not give the choice…

12: I… I had to kind of fight for it, it was almost a $200,000 revamp of our program and um… I don't know I still… there are probably two types of kids who are gaining from it: the kids who are learning disabled and really want to learn it and the kids who are the brighter kids who really want to be techs and probably already have jobs in the field because it is self paced, those kids take advantage of it. The kids that you are going to baby sit, you are going to baby sit all of the time. Uh… so you basically deal with them the best you can, but in the end I see some kids get quite a bit out of it, but you get out of it what you put into it.

2: But that's the problem with… but that's the problem with the AutoLab is you get out like with any computer you get out, garbage in garbage out. So if they are just there to waste time that's what they are going to do, they are going to wreck the equipment, they are going to damage it because now it is… you know this is boring, um… I don't want to do this so I'm just going to wreck what I've got and it is an expensive wreck is what it becomes.

12: I don't know… some of it like I said is you have to have enough support people to help with it and um yea if it is just one person and you have a computer lab, a theory room, you can't watch everything that is going on… because the kids… because we're still working on it, because you still have the kids who wander… we tried to do it synchronized and the problem was the synchronized interfered and didn't work well and screwed up the AutoLab stuff… actually you could sit at the instructor's desk and watch all the screens and the minute Johnny went off you could shut his computer off… that didn't work it wasn't compatible so now it is just a matter of tweaking it… so now we are going to try turning all the screens so that they face where one can stand and watch if little Johnny goes off task you can go over.

2: The other thing I noticed about AutoLab too is that some of those… some of those um things that they have to do on it are complex. And in a lot of cases you have to have a lot of one on one time to work on it… if you don't have the support… see I have sixteen computers and sixteen kids in the AutoLab at one time with myself.

12: Yeah, um… usually we have it set up so that they can do it in groups up to three and then you try to pair some of the brighter ones with some who want to learn but aren't as sharp and uh… let the kids do some of the teaching. Because otherwise you are only one person.

2: I've tried that, but then you get kids that monopolize the time because that's… there are other greater issues here of being spoon fed all this information… being spoon fed the last ten years they don't want to think.

12: The kids have changed. Since 1993 to now the high school seniors are a lot different.

13: You made a comment about the disabled students… were they able to go from the AutoLab to actually doing on the car with some success or was it…

12: Um… I see where they can actually… in some sorts they struggle now, it is almost like wow they have the knowledge, you can almost see the light going on in their head but they get to the car and I think they have seen so little success no matter where they have been they hesitate so they won't trust what they already know. So you have to go over and there is a point where one on one you have to go over and reinforce. You say, hey I saw what you did in there, in the computer lab… you already know this you just have to tell me you know this. Try it… if you break it or something happens we'll order the parts from NAPA, don't worry about it. And I have just seen some kids… well one of my highest averages in my classes is one of the most severe IEPs I've seen in a while. All my tests, I give a lot of written tests, Erjavic is the book I use, and all my tests are right out of there… 50 question chapter test every week… this kid might take two days to take the test and he has to be read to but he has an A overall average. That's really good… he cares more about one question than some kids care about the whole test… he put that much time into it. Like I said it all boils down to effort we can lead them to water but we can't make them drink. You can be as enthusiastic as hell but you know some of the stuff we teach can be dry… I mean I get up there I'm animated I'm loud trying to do whatever I can to keep there attention… some of them, kids are different… some of them just fall asleep they don't care what's happening in front of them… it's amazing.

M: So, a big thing there would be you've seen both ends of the spectrum good students and weaker students benefit if they were motivated?

12: Yep…

M: However, if they aren't motivated it doesn't matter.

12: And the thing of it is to a point how much are we supposed to be cheerleaders and motivators versus educators and teachers? We are there for the kids who want to learn it, try to save those we can, I spent four years all day teaching kids nobody wanted to teach and um took me four years to figure out I couldn't save them all. You do the best you can with the ones who want to learn, you can't help people who don't want to be helped.

8: Yeah, but you have to do something with them though. You can't let them sit there in the corner and be quiet.

12: Oh, no… you basically give them tasks… if they are off task you basically have to have some kind of support in place for them to do whatever

3: Or you give them jobs, doesn't even have to be something in automotive, you give them something in the shop that they feel comfortable with… some shut down because

they don't feel comfortable or have no confidence… give them something they might know a little bit about or like… oh, wow it's not what I'm teaching right now I might have already taught it… let them go do something on that, it keeps them busy, they're happy

2: I think that's were the fact that making something like this so that the success rate… if they feel successful they are going to want to continue, if they don't feel successful if they walk into it, look at it, and go. 'that's way too damn hard, forget it I'm out of here… I'm checking out I'm going to go screw around on the computer instead of doing this task'. So, I think there is levels of…of…of this that you have to do, and that's even in the same class, we all have lower functioning, mid functioning, and higher functioning students and it's being able to route the information for each or differentiating what your doing

10: Teaching to the different learning styles…

2: Yep…

12: And that's another thing… right down to that whole teaching to different learning styles this along with any way to reinforce… because it reinforces your theory… the days of being able to stand up in front of kids and talk to them and write on a board or whatever… you can't… they're used to having some kind of a screen some kind of hit a button and crap happens by one key stroke…

8: That's exactly…

12: We are trying to teach up there oh you know… electrical just even trying to teach electrons and protons and all that. These kids just fall right asleep. I start with powers and grounds, divide the circuit, ok let's go… let's make stuff happen, because if it doesn't happen in ten minutes they have lost interest. The computer stuff can move as fast as they want.

5: You talk about the computer thing and obviously it is the computer generation… and I sometimes get stuck in the basic manipulation of the computer on my desk and they will help me… they are ahead of the curve, they are ahead of me and I have a nephew that teaches in Staten Island, just graduated, he teaches Math in Staten Island and he says 'do you have a Smart Board' and I say no, I just got the projector and all that stuff and he says 'don't tell me you are still doing chalk and talk cause that doesn't work with the new generation'. The computer is so much more flexible, there is so much more stuff on the internet that you can bring in and so many programs and all that. I got one day… and I tell them I'm not an artist… I am drawing drum brakes and I start drawing shoes as a half moon and some other things and I hear some giggling and I step back from the board and talk to the kids for a minute and look at the board and it looked sort of like female anatomy

8: You got their interest [laughter]

5: And so I saw why they were giggling, though I didn't let on… I'm no artist…

8: Apparently you were better than you thought [laughter]

5: … the computer kind of brings the piece you were looking for I guess.

8: Yeah, but…

12: Even with all those pieces and like you said chalk and talk… there are three of us that teach together and two of us are taking the whiteboards down out of the theory room and I'm the kind of guy who keeps chalk in the engine lab because I'll start drawing on the floor… the kids are like 'what are you doing'… that kind of holds there interest for a little bit. We tried to do it without any kind of chalk board, we couldn't teach… we need a whiteboard somewhere too… because they were just relying on a screen.

2: I put white boards in my lab, because you know what, I walk into my lab and a kid doesn't get it by looking at it, I'll walk up to the white board now and I'll draw out a schematic of a starter circuit… say listen… and I'll draw out my little stupid, um, relay and how you know the electromagnetism on the relay, how it operates, then they start to go… yeah, now I get it.

8: Yeah, you've got to have some of that… I have an easel and paper.

3: Heh, yeah that's old school too… that damn easel paper, you see how expensive that is… Dude, it is only big paper! I didn't buy the lumber yard…

2: It comes down to not using one resource…

8: Yeah…

2: I think it all comes down to using multiple resources. Some of the simulation software is good and some percentage of students will work with it well, some will work with hands on well… and it goes back to all that differentiated instruction. This is great for some kids, but for others it is not going to work.

8: It is a good middle ground though…

2: It is a good middle ground, but it is good for certain functioning students… just like that board [points to a physical mock up headlight circuit simulator] behind you is great for some students, so you can't replace one with the other it has to be all worked as a total package.

3: Smart board is the all around package… you can draw, you can project, you can everything… there is so many things you can do with it… it is unbelievable.

12: I'm not a big fan of the Smart board…

2: I'm not a fan of the Smart board… I'm a fan of a projector and…

12: Know what it is? It is the whole set up time…
2: Yep…

12: Because unless you've got that board mounted somewhere and the projector's mounted permanently, that whole trying to go through the whole…

3: Oh, ours is…

2: Mine… mine…

12: See, we've got to move stuff around…

2: See mine's even mounted permanently and still the… you have to reinitialize the program once and a while, because if your computer screws up there goes everything.

3: Well that's the technical difficulties of it… the board itself…

2: I know, but that's where you get into the technical difficulties while you are trying to teach a class… you're up there teaching and all of a sudden you have a technical quirk and there goes 15 minutes of your teaching time right out the window and we know how important our teaching time is.

12: Well we still have an overhead…

13: Question… back to what you said… That it didn't matter what thing you used they weren't going to learn it… why do you think that is? Is it because of knowledge…

12: No interest…

13: Thank you… that's what I was wondering, if they are not motivated.

2: Motivation… I had… I had… I would say probably one of the worst years for motivation I have ever seen.

12: Yeah… I would agree.

[inaudible comment… lots of laughter]

2: It is intellectual motivation as well as…

8: It is the Chinese year of the slug…

2: …physical motivation.

12: They all got to sit down… I don't have any chairs in my lab… there is none. They still will find something…

2: They'll find a tire to roll over and lean against the wall and go like this [reclines with hands behind head]

10: It is amazing… lazy.

8: Ah, it's just a paradigm shift… we are old fashioned.

5: Just like our teachers were… right?

3: But our teachers could slap us… [lots of laughter] and we weren't going to tell anyone because we weren't going to go home and tell our parents because we'd get slapped again…

2: Exactly, my mother would backhand me because my teacher backhanded me…

3: I don't care whether it was your fault or not, you were still getting slapped again!

2: And then when your father gets home he is going to slap you…

M: So, the simulator would be more effective if it slapped the students? [very loud laughter]

2: The simulator needs test leads so that if you do the wrong thing is shocks you…

13: See… Thank you!

?: You need a whoop ass adaptor…

5: You talk about the whoop ass and all that stuff… when I was in 5th grade I had progressive thinking teachers, we had to sit in a horseshoe instead of rows… we would have 25 spelling words on Monday and a quiz on Friday. Well for practice he had this monstrous dictionary and he would walk behind you and he would go the word is whatever… and he would hold the dictionary over your head and when he got done he would say 'Are you sure?'… if you were wrong, boom, he would drop it on your head, your lights would flicker and then you would try again. It got to the point where if the word was 'cat' and you spelled it c – a – t… well, 'Are you sure?"… and you are second guessing yourself, so I don't know… it was effective, but not really effective.

8: You've got a flat spot up there I notice… [laughter]

3: And many concussions…

5: Exactly…

M: Ok, a couple other questions as we are headed towards lunch pretty quickly. Ummm…Going along with comparing it to other simulators, one way that I think this simulator is a little bit different, at least from what I've seen, is by including the case studies as far as being a little mini lecture, story, diagnostic story that can pattern what the student is to be learning. Do you think that is a useful feature and if so why and if not, why not?

2: Reinforcement…

8: Real world… the flat rate aspect, letting them know the time factor exists.

M: And there was a comment on the end…

12: Some of them will remember the story… it gives relevance to what you taught them.

5: Especially as technicians we remember things we got burned on… that sticks.

2: Oh, yeah… when I teach I always relate something to something I screwed up on and how I learned from that … and I think my students always come back to 'Remember that story you told us about that kid who was cleaning that wheel bearing in his hand with the air and it blew up in his hand". Well… it is a relevant story that maybe when they go to clean the bearing, they will remember not to take an air thing and…

8: Nah, they're going to do it…

3: [laughing]… they're going to do it.

M: But then they will have their own story to tell later.

3: Oh yeah… it is like getting shot in the face with a 22.

2: The case studies are definitely are an addition not a distraction.

M: Along with that another thing that is a little bit different that instead of the simulator saying 'yes, you are right' or 'no, you are incorrect' putting the students into a discussion forum and having them post what they think. Do you think that is useful or not useful? Why or why not?

5: One concern would be students waiting until some one else had posted and then just copying them.

11: Hide the previous comments would be good… but it definitely puts some ownership back on the students, they are going to think about what they were testing.

8: Right…

11: They have to put some thought into it rather than just click and replace the part.

8: It eliminates guessing.

2: But then you get to a point though and they want to know the answer, they do need to have some instant gratification… society is now all based on instant gratification, there has to be some way that ok, they have to post a certain amount and then they get feedback.

13: What I don't like about the instant feedback is that kind of takes the thing out of them 'well ok I'll just guess at this… I'll try this now, I'll try this now…"

2: You are right, but they would have to go to a certain point to get to that answer. So, it wouldn't just be let me guess one thing and then if that is wrong I'll guess again there has go to be like… show what testing routines you did. For example on the first scenario there was… you would need to test the battery, you would need to test your power to the s terminal, you would need to determine power to the battery terminal and you would need to have that chronological sequence… so it also teaches them sequencing or flow charting. So, you have to get them into that thought of there is a flow chart that I have to do even in my mind and I have to write that down.

5: If they show the flow chart and they make the wrong conclusion you can see exactly where they went wrong

6: Isn't there a flaw in this idea of posting because it supposes a certain level of communication that some kids don't have… uh… I would require kids to write answers and I would get back, 'oh, his IEP doesn't require him to spell correctly', with spelling he wouldn't even try, he would just scribble the words or type out some kind of garbage word, so are we supposing a certain level of capability that is excluding a certain population that we are forced to deal with… I'm talking about high school.

2: That's huge…

8: Right… though do you have a slot you are projecting this for, are you assuming this would be for college students?

M: Likely I would see it used after a student has some basic electrical but haven't had a lot of experience on real live car problems. One thing to comment on that, as far as an individual not being able to put their thoughts into text … Do you think that is an important skill for a technician to have to diagnose, repair, or fix cars today? So, in other words, this is a problem but is it a problem where they need those skills and does this simulator force them to exercise those skills and practice those skills before they hit the real world?

2: Anybody that has worked at a dealership knows that you get paid by the word…

?: Yes, absolutely…

8: Whether that is good or bad…

2: The ink in the pen is worth more than its weight in gold. So, unless they can write down what they have done, there is no way they are going to get paid. So, they have to be able to have that written communication of what circuits they have tested, uh, what they have done as far as testing routines to be able to get paid and a lot of kids don't have that ability and that is a problem.

12: Do you guys have, um, English integration.

2: Yes…

12: That tries to teach some skills as far as technical writing. And, you know I tell them, or course none of them want to write, your best technical writers are those that write the least and say the most.

8: Right…

12: Unless you are in a Ford dealership and you are trying to get an hour for diagnostics and then of course you have to fill up the whole back of the RO [repair order]

2: And then another page…

12: Yes, see attached…

8: At some point they have to learn that you need to be able to read and write to be a technician.

12: The whole idea of sending little Johnny to become a mechanic because he can't read, write, or do math… you know it is engineering level stuff that we are teaching them, at the high school level we are teaching college level stuff… it is the material, we can't change cars, they are what they are.

2: In the technical manuals you can't write a technical manual at a third grade reading level when the technical manuals are at a much higher reading level

8: Try finding a textbook at that reading level.

3: Are we teaching too high a level?

M: I think that is a whole different discussion topic… What level should high school teach at? What level should college teach at? And more importantly what level are employers expecting an entry level technician to be at? I think that topic is more than we have time for right now though.

13: I think that goes back to motivation because we've had guys from both aspects… guys who have gone to the BOCES and those who have never touched a car before in their life and they bust their butts working circles around these guys who have supposedly gone to BOCES because the guy from BOCES wasn't motivated and I think a lot of this comes back to the motivation part of it… how hard do they want it?

12: Do they want it bad enough?

2: Or, I mean on that same vein is whether you have a second grade reading level versus a twelfth grade reading level because I can read a book on how to build a pool but if I don't have the ability to read the book could be written in French.

3: That's one of the biggest issues is reading, if a kid can't read the sentence, if he doesn't understand two words in the sentence, how well is the kid going to read that sentence? And then to read a paragraph or something concerning an issue he can't get through it and is totally lost.

2: So, if they are trying to find the background or system information and they can't read that system information how are you going to get them to diagnose?

M: Building off of that, since this is an important skill, of what you have seen of this particular simulator does the way the information is presented especially the discussion forum portion of it could it help develop those reading and writing skills or would it be the type of things where those with good reading and writing skills would participate well and those who don't would be locked out of it?

2: It is more the latter… than the former. The kids who can read and write well and can communicate in the written word will thrive in that scenario those who can't just shut down and can not do it. Because it is past practice, they won't do it.

8: Conversely there are the ones who are wonderfully literate and can read/write engineering but they come into the shop and don't know which way to turn a bolt. So, obviously that is not as critical as the reading and writing, but it is a factor to consider as well.

3: We had some kids this year who could come in and couldn't fix a sandwich in the shop but they were good at book work and passed all four NATEF exams. Of course you only have to get half right on those

8: I worked at a dealership where we had a guy came through the GM ASEP program and, uh, came in with the highest kudos… greatest thing since sliced bread… but was lost when it came to the hands on

2: That has always been… when I was a Ford tech… you know you have these senior level certified master technicians that went through the Ford Asset program, so they had all the technical knowledge, they have done all the trainers from Ford but you put them out in the shop and they don't even know where the battery is in the car. So, conversely it does have its down side.

M: One last question before we wrap this up. If you could change the simulator in any way what changes would you make?

8: I mentioned an auditory facet, the starter click or whatever. This is what it sounded like, since this can give keys to diagnosing also.

M: So have them doing a visual inspection through their ears as well as their eyes?

8: Right…

2: If you could actually show a picture of when you click the DVOM where the leads go from the battery positive and then on to the battery negative. If you could have a an actual visual representation showing the lead going there that might help too for some students. Because they don't know where the starter relay is or what it looks like or where to go with the starter relay… it is a drawing of it

13: I can think of a couple of students where they could do the tutorials, they knew what a coil was, but when they got to the car they didn't know what the coil looked like or where it was on the car … 'Well that's not what I'm used to, I've never seen a coil like that before'

2: Yeah… a round coil versus an e- coil because we all know that Ford, Chevy, Chrysler whoever, they could all be the same part but it is packaged different

M: So have a stronger visual link between the testing on the wiring diagram and what it physically looks like, similar to the visual inspection portion of the simulator?

2 & 13: yes…

11: Some of the later Ford stuff was doing that… I'm not too far out of the dealership… you would enter the step you wanted to do and then go to a 10 second video clip of a technician doing it

2: Yeah and it would have an actual voltmeter.

M: Any other final comments that you haven't had a chance to add?

2: A tutorial on an actual DVOM… a refreshment on using a DVOM and interpretation of the readings and scales.

5: Could you incorporate a service manager asking if they were done yet? [laughter]

5: Maybe having a sound or something like an air impact every time a screen changes. Little noises… it might be annoying, but it also might help get their attention.

11: Some of the Ford training had sounds and also would animate the wiring diagram to show the flow of electricity.

12: I think you have to go one step further with the smell…

8: Smell – o – vision…

?: Ooh… burnt electrical

8: Ok… let's get out of here…

Thursday (6/18/09) session: 2 Participants (Participants designated 14 - 15; M: Moderator)

M: General thoughts on discussion forum vs. direct feedback…

14: I think that [immediate direct feedback] would be beneficial to the student because you get that instant gratification kind of thing, but you know… it is a nice thing about a lot of stuff we do… that you figure out the problem, you put in the part and either it works or it doesn't work most of the time.

M: General thoughts on case study presentation…

14: If I want to read along there is nothing that explains it… that is the only thing that I would change as far as that goes, because I think it is nice to have the person talking but a lot of the times especially with the students when someone is talking they don't listen, they don't hear it and even sometimes with me – I don't know if you are the same way – but sometimes when someone is talking – blah blah blah – wait what did you say – you know – but if you read it they can say oh it says this. You get some students who are hard of hearing.

M: So the suggestion would be to add like a box of text like a closed captioning line to the frame

14: Yes, exactly – a dialog box. Just so that if they can't hear or their speakers are broken, or they are trying to study at night with a roommate sleeping – who knows.

M: With instant feedback approach would that potentially encourage the student to rather than do the testing stuff to go right to the sell part and say let me try this – and just keep guessing until they get it right

14: Maybe the student has to fill out an invoice with the labor and the part every time – so yeah they will get to the right spot eventually but they just spent $2,000 doing it or they spent $150 doing it

M: So, something where the program would track every time they sold a part not only would it tell them it would start a list

14: Yeah, saying you just cost the customer $1,000 and you went to this guy only charged $150 and they fixed the same thing you did. Basically that is just like real world scenario, because I'm sure you have seen it – everyone's seen it.

15: Absolutely, I like that.

M: That is an interesting solution to the problem of giving instant feedback.

15: This falls in that line – something that occurred when I was working for a Chevy dealer – I get the repair order, mid to late '90s Chevy, repair order says replace the starter… you go in there to crank it and no crank, ok? The repair order says replace the starter that's the um service writer diagnosing the problem. So it is pushed in the stall – you get the starter – take the old starter off that's been on there for a number of years, ok? The copper post breaks off – so that starter is no longer good anyway – so it is now getting a new starter whether it needed one or not. Put in the new starter and get in to start it up. Guess what? It still doesn't start. Take the serpentine belt off and it starts right up – the alternator is seized up. So, what did it cost? It cost the customer the starter plus the cost of the alternator and serpentine belt. If it had been given to me as a diagnosis I could have diagnosed it correctly – but it was just replace starter based on an assumption that was wrong.

M: That is just like the idea of the case library – I may get the rest of the details on that and add it to the case library if possible.

15: Sure.

M: If you are using computer based simulators how do they compare (pros & cons) to this one?

14: Not currently using.

15: Some of the scenarios we are using are anal. As far as… I mean … If you get to one thing whether you do this step first before this step… I mean as long as you did both steps I don't think it really matters, but they are so anal about you know doing it methodically this whole order that – like doing a resistance test rather than a voltage drop

test… you know what I'm saying… that to me is crazy… I think that the way that they do it that way goes back to the engineering point of view rather than the technician's point of view. I think that if you skip the resistance test that they are talking about and you went to the voltage drop test and do a voltage drop and found answers they should ignore that… I guess that's what I'm trying to say. Compared to this which gives you some flexibility. I don't think it matters in your scenario which way you do it… I don't think it matters to you whether I do a voltage drop test first or if I voltage drop the power source or the starter instead of doing the voltage drop somewhere else…

14: Or start from a more basic point of view, does the engine mechanically turn over.

15: So that is why I guess I like that part and disagree some of the scenarios in the system we are using… students struggle all the time because they miss something… they don't necessarily miss a step… they do a step out of order, which in some cases I think is critical and in other cases I don't think it is critical

15: The computer based training we are using doesn't allow for the student to think out of the box… you know what I mean… to say, alright I know all this but let me give um, this is a shortcut for me as a technician…

14: That's a lot of them [commercially available computer based scenarios]

15: I can test all these things by doing this one instead of doing these ones methodically… it doesn't allow for thinking out of the box…

M: And so you feel that this simulator does that better?

15: I do… because I have an option, I can pick any test that I want it doesn't… if I do one that they thought I should have done another one first it doesn't say too late you have to start all over again because of that… I think this flexibility is fine, it allows a student to think out of the box and think about a better test or think of a test that best suits… I don't care which one they use… if they've got one that they understand and they can use it to diagnose the problem I think that's fine… I think

14: Yeah, because a lot of people are going to come up with the same answer in different ways, for example I'm not… you know I don't always jump to the meters the scopes but a lot of times I get the same results because I had the experience and that's what it comes down to… I have the experience and know what to look for or where to look first and that you know nine times out of ten that's where I have gone and after I have looked there if that is not the answer you move on from there

[Discussion on a mistake in the scan tool data in one of the scenarios]

M: This simulator currently uses a factory scan tool as the default scan tool. Not all shops will have access to such a tool. Many of the aftermarket scan tools will not access

the data that is needed. Should it be pointed out that this data would likely only be accessible with the factory scan tool?

15: I think that… my answer to you is that I don't know. My question would be that somehow we need to… I don't necessarily think that a student should just be given that and then walk away… you know…

14: Or maybe even give them options…

15: Absolutely…

14: You know give them an option of scan tools…

15: Maybe give them another scan tool on that… I think you need something to drive that point home

14: For example where I work, just in my class alone we have the OTC Genysis and the MODIS and they are both good and they both do a lot of good stuff… I am more familiar with the MODIS but there are some things I can do with the OTC that I can't do with the MODIS and there is a lot I can do with the MODIS that I can't do with the OTC and they all have their advantages and disadvantage and sometime s the kids don't know that… they are used to using the Snap On Scanner and you offer that option they are going to grab the Snap On scanner and say, ah I already know how to use this.

15: I had the opportunity to do some drivability last spring and in lab the kids were constantly go for the MODIS… MODIS… MODIS…. every time… every time… you give them the opportunity

14: You go with what you know…

15: But, we've got, uh.. the Volkswagen scan tool now, we've got the Tech II [GM], we've got the Starscan [Chrysler], we've got IDS [Ford]… you know… and I just don't understand it… I'm trying to get across to them that I am going to use the best tool that I have available to me… that's the point to drive home… to use the best tool that we have available…

14: Yeah… and maybe you know for this option I don't know if all the screens are the same for all the cars… you could have a generic screen like this – these are the tools you can pick from… you know… which tool are you picking for this job? It could snowball into a huge thing…

M: So, with this the suggestion would be to add… expand this tool list and have rather than just scan tool have DRBIII and Solus Pro and maybe even throw a Tech II in so that they don't just have to choose a scan tool but have to choose an appropriate scan tool.

14: If you get a GM Tech they would be familiar with the Tech II and would go to it every time.

15: I would love to see students click on one of the other ones… a MODIS or something like that to see that it comes up and you've got nothing...I think that is important… I used to tell a shop owner I know that all the time… you are so limited with the aftermarket scan tool… it is a great tool… I wouldn't want to do this without it, but there are better ones out there…

14: To even navigate the tool itself… I've used the DRB III and there is a learning curve to it because I am not that familiar with it and it takes me a little bit longer… I can hook up a MODIS and it doesn't have what I want so I go to the DRB III… it takes me a little while to hook it up… it takes a while to figure out which button to push things like that… where as this unit they just click on a button and see exactly what they are looking for…

M: Right… it is simplified. And a question off of this would be: Do you think that the scan tool should stay simplified or would it be better if the navigation is set up so that you have to push the buttons like you are using the actual scan tool?

14: But then you end up with other problems… It depends on what you are going for…

15: Is this for basics… is this for an introductory course?

14: I would say leave it simple… because if you are looking for just a basic teaching tool this is an excellent teaching tool. Eventually they are going to have to put there hands on an actual car and they can get into to specific tool then…

14: For teaching this is excellent…

15: Then if they click on the scan tool you could have, 'oh sorry hothead, uh or Tech A or whatever is using that tool right now, it is not an option for you right now. And that happens, I'm serious… I try to tell those guys I still use the older scan tool some times because there may not be enough of the newer tools to go around… and so that is your only option. Or you get some of those guys who are so set in there ways they won't touch the newer tools…

M: Would you use this type of teaching tool and if so why? And if not why not?

15: I would use it definitely

M: Why? What do you see in it specifically that is useful?

15: Can I think about that?

M: Sure… we can come back to that later or you can catch me after the session.

14: I think it would be a useful tool, but in its current state I don't know if would just let the kids… I don't know how much the kids would actually get from it in its current state just because it still is kind of limited… I work with a group of younger kids and we are still in basic electrical… we are still going over the basics… I would probably walk them through it and show them and maybe for some of my more advanced students it would be great for… especially if it is internet based, they could play with it on their own time. That's a nice thing…

15: I will add to that seeing that he [1] is seeing them in BOCES that would be their first exposure whereas we are seeing them in college after BOCES so it is the second time round and I can see where it would be more applicable and they can do it as an assignment on their own… Since the group I work with already has to do computer based scenarios this is just another set of scenarios… which is fine… but, like I said before it has flexibility it has the option that if I want to think out of the box and I want to skip this step because if I do this other one I do both or all three at the same time then I can do that… I like that. As a technician when I was working as a technician if I took the wiring diagram and I dissected and figured out that diagram I realized that I've got an open in the circuit because I voltage dropped the load… I know I have to check the fuse or the switch… let me do this and I do all of them at once rather than this one and then this one and then this one… I just do all of them… that's my thinking… right or wrong. So those are reasons why…

M: If you could change anything what are some changes you would like to see done to improve the simulator?

14: Well, like I said the instant gratification kind of thing… you know, I think kids want to know if they were right or wrong and they want to know right away. 'Did I get it right? How'd I do?' So that would be definitely… because sometimes when they do something like this and then have to wait two or three days for the results they don't want to deal with it… they don't even want to look at it. So that is a big one. Um… you know maybe… I would like to see more cases, even for a typical starter problem that you or I would see as a simple problem. To them it doesn't make any sense… We do simple things… in September we start with how to change a tire…

15: That's not simple anymore [laughter]…

14: Oh no it's not [more laughter]…

15: It could have a tire pressure monitor system that could be one of two different types and they have got to re do that thing… they can't just put it back on…

14: Oh yeah definitely…

15: There are shops that have quite their businesses because of things like this… that is how set in the ways some are that they can't adapt and be flexible… you know…

14: Oh, absolutely… when like that NYS inspection computer thing came along how many guys stopped doing inspections.

15: Yeah, but that is just such an excellent job justification… to justify why a particular repair has to be done I think… especially the '96 and older ones.

14: I think this is a really nice tool and I think even to have some simpler scenarios.

M: Yes, and that is a goal to have more scenarios and a variety of scenarios. While on the topic of the degree of difficulty of scenarios… Should the scenarios be grouped be degree of difficulty or should they be all in one pile like in the real world?

14: If you show them that they are rated on a degree of difficulty they might benefit from that because you could assign it as a homework assignment and then see how much it would have cost the customer based on the invoicing idea suggested earlier.

15: I agree with him there… their grade or evaluation on that thing should be based on the time, the thoroughness of the diagnosis, the expense… some sort of quantification at the end… this is how much time you spent, this is the expense… rather than just rating whether they got it right or wrong. Just throwing ideas out there… does that make sense?

M: Yes, and to put those two ideas together… going back to the instant feedback, the invoicing idea, and then the kind of graduated problem and the whole grading thing. Maybe to say have a class of faults that are easier and they are give a certain amount of sold diagnostic money… so an easy diagnosis is maybe $100 and a hard diagnosis is $250 diagnosis

14: Or even as they progress throughout the year you could have countless number of these.. who knows…

M: Right so different grades on diagnostic level and as they go through if they sell a part that is not needed it reduces their pay and if they sell a part that is needed it increases the pay. So an easier diagnosis it would be easier to get the pay, but a harder diagnosis if done correctly they could get more pay unless they just threw parts at it, in which case they would end up with little pay.

14: Yeah, and maybe they couldn't even fix it because they didn't have enough to throw at it…

15: The only other down thing that I see with scenarios is you get one or two students… the good ones… who want to solve them and then all the rest… especially when they get back to their dorm rooms ask 'how did you solve that one'… because all they wanted to do is get it done… that's all they want to do… they don't care about learning or anything… they just want to get through the assignment… I don't know if that's human nature or… I don't know what to do about that.

M: Well, two questions I have on that… because that is a really valid problem. Two different possible solutions that I see that I would like to throw at you to see if they make sense. One is going back to the discussion forum thing, because there is no instant feedback there is a problem, but would it address the issue of how can you find out from your friend if your friend doesn't know either?

14: Yeah that is true…

15: I… my answer to you is that anything that you could do to deter that or delay that is a plus…

14: Yeah, maybe the instant feedback isn't a good idea for this situation.

M: Or would it makes sense to do both… a practice scenario that has instant feedback and a homework that doesn't?

15: I like that… I think it is one of those things that you just have to try… trial and error.

14: Yeah… you might go either way. If you have a good student who is not going to cheat and does everything the way they are supposed to do it is nice to give them the option to find out if they did it right or wrong without having to wait… I don't know if you guys have once a week classes sometimes right?

M: It depends… yes.

14: So, they may have to wait that entire time going nuts… or you have the kid who hangs out with the kid that figured it out… 'which way did you go… well I'm going to do that'

M: Right…

14: Without doing any of the tests without doing anything he gets the same grade… so, there are a lot of different ways to do it… it is hard to say one way is better than the other way…

M: An additional thought that I just came up with listening to you guys… was… if the scenarios were randomized… what I mean by that is when you choose scenario one that one student chooses might not be the scenario one that some other student chooses… and when you get done to the selling part the simulator generates a unique number that the instructor can match up… if there were enough scenarios they might have the same vehicle but they would get different measurements… same type of vehicle, but different one

14: Yeah…

15: Anything that you can do to deter or delay the students taking the guessing or copying approach might help that something sinks in… which is the goal… to teach them something… even if they only learn one thing going through this process I think that it is worth it