Next Steps in Reduction of TRIZ Entry Barrier

Galina Malkin, Sergey Malkin, Gregory Frenklach, and Donald Coates

ABSTRACT

Five years of use in industry and education has led to development of an improved version of the Guided Brainstorming Toolkit™ TRIZ Methodology. The process was streamlined from six steps to four. This allows integration with other methods like Value Engineering, Six-Sigma, and Solutions Engine Methodology to name a few. The process was simplified for easy acceptance of beginners (complexity delegated to advanced TRIZ users/facilitators). The more universal set of inventive principles can be applied to each of the opportunities: improve function, counteract function, and resolve contradiction. The number of inventive principles was reduced from 55 to 30 and they became universal for all three opportunities. The texts of the inventive principles as well as the examples were improved for better understanding. The changes should make the method particularly friendly to beginning TRIZ users to solve well defined problems, should enhance the growth of TRIZ, and should motivate some into more advanced TRIZ methods for more complex problem solving. The enhancements were incorporated in new software to further aid the newcomers.

Introduction

Over the last decade several TRIZ experts[1,2,3,4] have promoted simpler TRIZ methodologies for solving average inventive problems, albeit these methods are not as extensive as the classical TRIZ methodology that have benefited beginners and students. This is supported by the student evaluations that Coates has seen in his classes on TRIZ[5]. The fact that the simple contradiction matrix using the 40 Inventive Principles is still very popular with beginning students points to the continued need for simpler approaches that reduce the entry barrier for students.

Specific barriers to entry are:

1. Advanced and complex structures of classical TRIZ are challenging for new students;
2. Confusion due to multiple versions due to advances being made;
3. A long time is needed for students in industry and universities to become capable;

1Malkin, Sergey, Guided Brainstorming LLC, Guided Innovation Toolkit V2.0 and other versions, http://www.gbtriz.com/Index.htm, (accessed 11/2/2011)
2Ideation International, http://www.ideationtriz.com/home.asp (accessed 3/11/2007)
3Malkin, Sergey, Donald Coates, and Galena Malkin, , "An Improved Method for Teaching the Theory of Inventive Problem Solving to Students", Conference Proceedings TRIZCON2007, Louisville, KY
4Domb, Ellen and Kalevi Rantanen, Simplified TRIZ, Auerbach Publications, Boca Raton, Fl 2008
5Coates, Donald, "Tech 61095/33095, TRIZ: Theory of Inventive Problem Solving", Kent State University, Spring of 2007 through 2011,

4. Disparate collection of tools which complicates teaching further;
5. Difficult to apply manually without mentored guidance;
6. Classical TRIZ is difficult to use in team environment due to non-uniformity of methodologies.
7. A simpler process to solve problems of intermediate complexity.
8. Need for less costly software approaches for students and companies.

Software was introduced by Ideation[6], Invention Machine[7], Pretium[8], and others to guide and assist the user through the methodology. Each system was tailored to their idea of simpler and/or better methods. Improvements to all of these approaches have been made but an epidemic growth in TRIZ is still yet to occur.

In response to the above barriers, the method proposed by Malkin et al in Guided Brainstorming Toolkit™[9] has been further evolved into an improved methodology called Guided Brainstorming Companion™[10] for beginners. A future professional version generation methodology further removes barriers from complex structures. These changes are summarized here and will be explained in more detail in the rest of this paper.

1. The method is simplified to a four step process. This makes the method less complex to follow and to remember for the beginner.
2. The software acts as one integrated method and constant guide to help the unfamiliar through the process.
3. With software the student can receive faster clarification of the method for problems in general.
4. The tools used are integrated into the process steps. This relieves the student from deciding when and where to use them.
5. An improved e-book is an additional mentor that is immediately available to the student.
6. The process was simplified by the reduction of inventive principles from 55 in the previous version to 30 in the Guided Brainstorming Companion software. In addition, the inventive principles have been sequenced in an order of increasing application complexity.
7. The new set of principles has mnemonic icons associated with them for easier recollection.
8. The method is practical for students, especially, with a low cost entry barrier.

6Ideation International, "Innovation Workbench" software and other programs, http://www.ideationtriz.com/software.asp (accessed 11/2/2011).
7Invention Machine, "Goldfire Software",http://inventionmachine.com/ (accessed 11/2/2011)
8Guided Brainstorming LLC, Guided Innovation Toolkit V2.0 and other versions, http://www.gbtriz.com/Index.htm, (accessed 11/2/2011)
9Ibid.
10Id.

1. Discussion of New Simplified Process

The Guided Brainstorming™ Process is a systematic technique that can be used by individuals and teams to address problems that are well defined or that are somewhat complex. A well-defined inventive problem is one where the challenge is clear, cause of the problem is evident, and opportunities are well defined or easy to formulate. Thus the skills, experience, and tools in defining the problem are not needed. If it is a well-defined problem, the innovator can proceed to Step 1; however, if it is a complex problem and not well defined, the problem can be facilitated by a person trained in the Guide Brainstorming Professional version. The facilitator should assemble a team of experts with depth in the specific problem area and functional breadth spanning the major roles within a company, and then proceed to Step 1.

1. **Challenge:** The purpose of this step, shown in Figure 1, is to frame the well-defined problem. For complex projects, the use of the elements of Systems Approach[11], shown in Figure 2, to identify the system that contains the problem is excluded in the Guided Brainstorming Companion™ for beginners and is used in the professional version for complex problems.

Figure 1. New Methodology

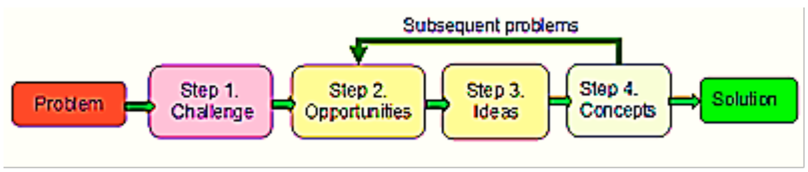
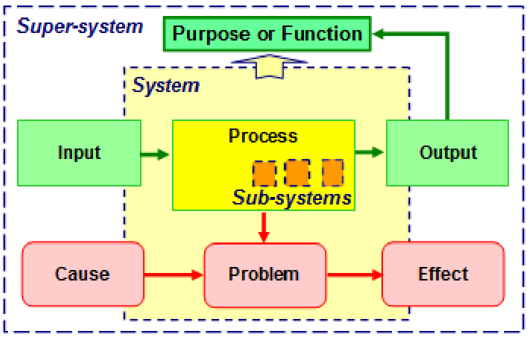


Figure 2. System Approach

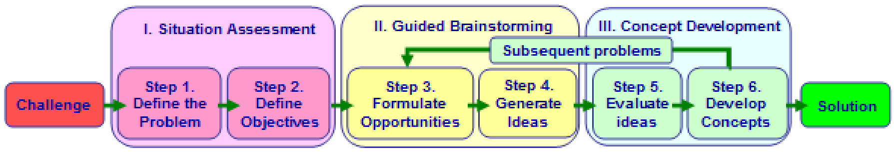


2. By comparing the simplified process in Figure 1 to the old process in Figure 3, the steps containing Objectives and Definition have been bundled into the Challenge to keep the method conceptually simple for the student.

---

11 "Systems Thinking", Wikipedia, http://en.wikipedia.org/wiki/Systems_thinking, (accessed 10/29/2011)

Figure 3. Old Methodology



2. Opportunity: The next critical step is identifying the best opportunities for brainstorming. System performance improvement opportunities can be enhanced in three ways:

1. Improving or performing useful functions.
2. Reducing or eliminating harmful functions.
3. Resolving contradictions between useful and harmful functions in the system.

One of the tools for complex problems is a Function Model[12] – which is a diagrammatic tool designed to understand cause-and-effects and relationships between useful and harmful functions. It is used in the professional version of this approach. Function modeling evolved from FAST (Function Analysis System Technique) diagramming by including the interactions of useful and harmful functions to identify contradictions. These are key areas on which to focus brainstorming efforts.

3. Ideas: In this step, conduct a Guided Brainstorming™ session. The key element of this process is a system of inventive principles, derived from the TRIZ methodology, to focus and energize idea generation activity. This is covered in more detail later in the paper.

4. Concepts and an Action Plan: The ideas generated in the Guided Brainstorming™ sessions can now be evaluated and combined into solution concepts that could solve the overall problem. The best of these can be selected for implementation. If the technical means to implement a selected concept require further development, these subsequent problems can be addressed with additional sessions. Comparing Figures 1 and Figures 3, one can see that the Evaluation and Subsequent Problems have been moved to the Concepts Step in the new method.

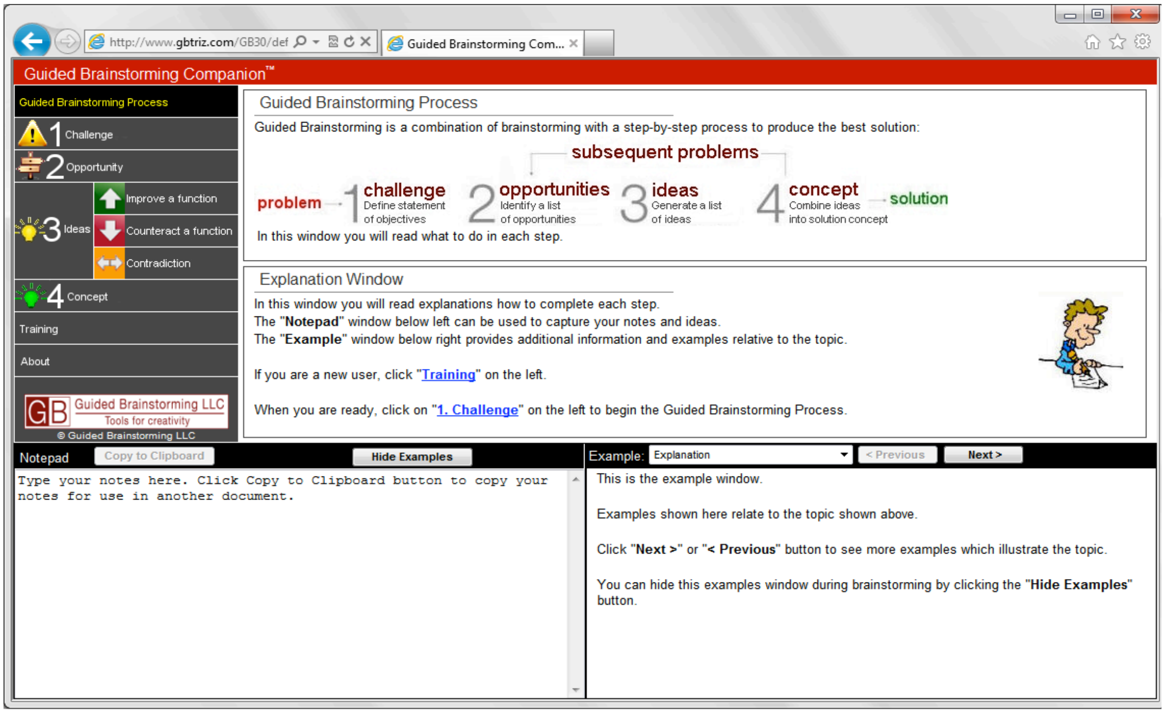
2. <u>Integrated Process.</u>

The software screen shot, show in Figure 4, identifies the main steps of the methodology imbedded in the software. The steps are clearly identified by the large number fonts both in the center of the screen and the side panel and are hyperlinked to instructions and examples for their respective step. These steps are further linked to their subsequent steps.

---

12 "Pretium Innovation LLC, "Function Analysis System Technique", http://www.pretiumllc.com/fast/ (accessed 10/29/2011)

Figure 4. Linked Steps in Software



3. Faster Reinforcement.

Students that go on to solve their own problems are left frustrated without a good mentor. The software answers many of these questions with the examples and wording of inventive principles.

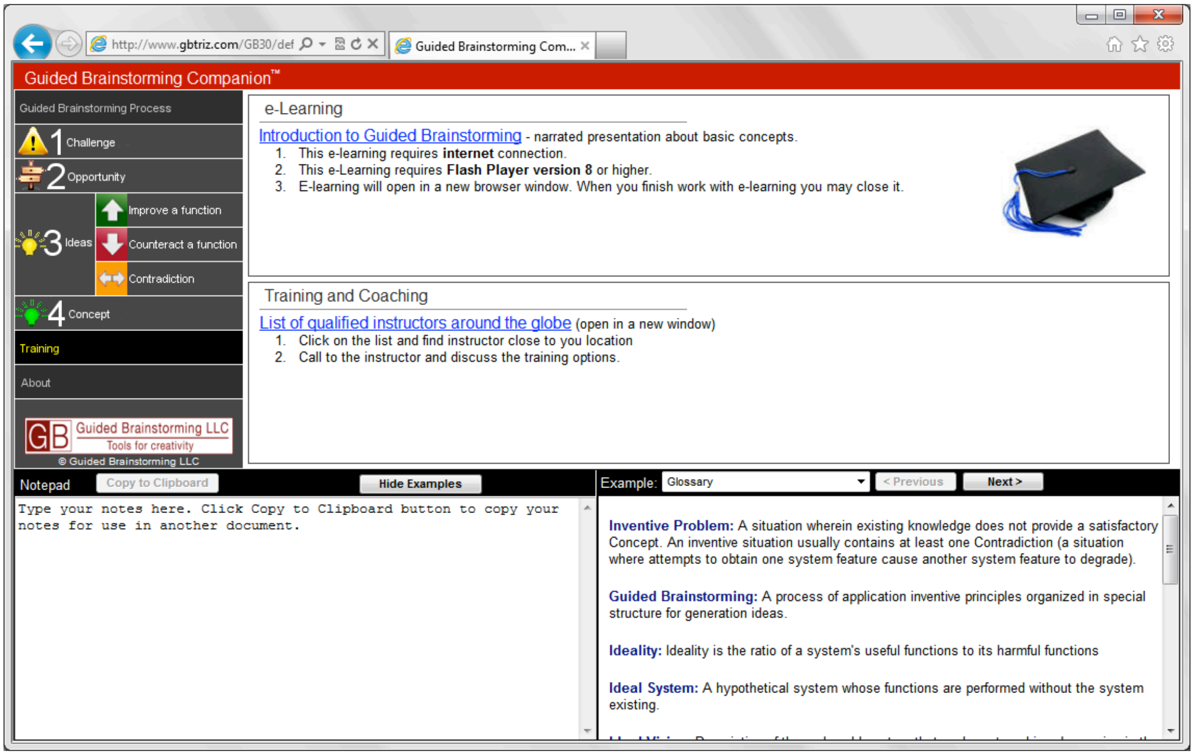
4. Tools Included in Software.

Functional Modeling is a important tool for deconstructing more complex problems and as mentioned is included in the professional version of this software.

5. Improved Mentoring.

Shown in Figure 5 is the improved e-book, with new examples and text. The e-book is further improved by narrated Power Point presentation that complements the e-book.

Figure 5. Improved e-book



6. <u>Simplified and Restructured Inventive Principle Table</u>.

Sergey Malkin, together with Gregory Frenklach, worked to reduce the entry barriers and make it easier to learn and apply the benefits of the TRIZ methodology. As a result a reformulated System of Inventive Principles was developed. The first system of 40 Inventive Principles and associated Contradiction Matrix were developed by Genrich Altshuller. Each principle captures an abstraction which embodies a creative approach to solving real world problems from diverse situations and industries, as evidenced in the patents.

These principles can be used to overcome "functional fixation," (or psychological inertia, as it is referred to in the TRIZ community) and stimulate new ways of thinking about the problem situation, functions that need to be performed or delivered, and to find and use hidden resources to address the problem.

The previous set of inventive principles, shown in Figure 6, were divided by the Vision, Function, Resources and further sub divided for the different opportunities: Improve Useful functions, Counteract Harmful Function, and Resolve or bypass Contradictions. Resolving contractions were further sorted by Separation on Condition/parameters, on Structure, on Space, and On Time(resource substance heading was converted to elements that is more general and relates to business situations better).For example, when resolving contradictions on Condition/Parameters, there were six inventive principles recommended to consider: Restoration, Isolation, Counteract, Dynamism, Excessive Action, and Partial Action. Under Vision-Counteracting Harmful Functions, the inventive principles range from Redirect to Counteract. These divisions produced a large number of inventive principles, 55 in total, which create an entry barrier for new students.

Thus the inventive principles from the old Guided Innovation Software method were reduced in number and improved in order to strengthen their utility and ease of use. This smaller set of inventive principles was defined and divided into the five new groups, as shown in Figure 7, producing 30 principles, as compared to 55 principles shown in Figure 6.

Figure 6. Old Table of Inventive Principles

Change Vision:		Change Functioning:	Mobilize Resources:				
Counteract harmful	Improve useful						
Redirect	Intensify	Exclude	**Space**	**Time**	**Energy/Forces**	**Elements**	**Information**
Conversion	Universality	Inversion	Different Location	Synchronization	In system	Inexpensive	Properties
Eliminate the cause	Specialization	Partitioning	Another dimension	Preliminary action	Flows	Raw materials	Output flows
Vaccination	Disposable	Integrate	Nesting	Parallel processing	Dissipated	Waste	Passing flows
Mismatch	Matching	Mediator	Passing through	Use pauses	Environmental	Environmental	Detection
Restoration	Dynamism	Use model	Take out the part	Accelerate	Transformed	Transformed	Additives
Isolate	Partial action	Controllability	Concentrate	Stretch out			
Counteract	Excessive action		Localize	Post-process time			
On condition or parameters		**In structure**	**In space**	**In time**			
Resolve the contradiction by separating contradictory requirements:							

Figure 7. New Table Universal Inventive Principles

Use Resources	Use Time	Use Space	Change Structure	Change Conditions or Parameters	
Power / Energy	Preliminary action	Another dimension	Exclude	Partial action	Vaccination
Elements	Post process time	Asymmetry	Integrate	Excessive action	Isolate
Information	Use pauses	Nesting	Partitioning	Matching	Counteract
Derived	Accelerate	Take out the part	Mediator	Dynamism	Disposable
Intensify	Stretch out	Localize	Copy	Controllability	Inversion

There is a powerful methodology associated with the order of the new inventive principle table. There are five groups, arranged according to increasing application complexity - from the simple to complex. The various inventive principles are recommendations to use and change resources. For each challenge situation, the user should partition it into objects, add their action-reactions, and add the environment. This creates opportunities to solve the challenge (improve useful, counteract harmful, or resolve the contradiction for the situation). Then consider the first main line column heading in Figure 6 and ask: "What are the general ready ideas that create resources that solve the opportunity?" If none come to mind, then the inventive principles below the heading are arranged in the order of ideas for latent and then created or derived resources. In all cases, user must look for the coincidence of the inventive principle with the partitioned challenge.

The next four columns are the separation principles arranged according to increasing complexity. Starting with the column heading, the same methodology applies for the subsequent columns. For instance for Space, user should ask what resources are readily available for creating space. If none come to mind then proceed to the more detailed inventive principles to find ready or derived resources such as another dimension, nesting, taking out a part, or asymmetry.

In general, the first group is looking for latent, concentration, accumulation, deriving, or combining existing resources. The second group is usage or creating of time resources – it is more complicated. The third group is usage or creating of space resources. The fourth group is usage or changing a structure of the system to use this as a resource. The fifth group is related to more complex principles that are connected to changing parameters or conditions. These are similar to patterns of technological evolution, such as example matching, controllability, dynamism.

In addition, some of the 76 standards have been incorporated in this reformulated set of principles. The principle Isolate includes part of the standard for Su-Field destroying S1.2.1 & S1.2.2. The principle Controllability includes the additives Standard S2.2.1, S1.1.3, S1.1.5... Mediator also includes part of standard for Su-Field destroying (buffer)S1.2.1, S1.2.2… and part of standard for Su-Field building/development (inserting of transitory element)S1.1.1, S1.1.2. Integrate includes parts of standards of group S3.1, S3.1.2… Dynamism includes parts of S2.2.4. Matching includes parts of group S2.3. But the language differs from language of standards to make it easier for a TRIZ introduction. Only some of the 76 standards were used.

The directions: change Vision, change Functioning, and mobilize Resources from the old method were moved to brainstorming. VFR is used now rather as an idea and concept development approach. For example, if a change was made to the system-by incorporating something-this may give additional resources that can be "mobilized" to improve the idea. This also might somehow improve the system's functioning and result in additional outputs/outcomes/results from the system (aka vision).

All of these changes allow the method to be more easily learned and used in a team environment. For instance, a technical specialist can be brought into a team problem solving project and quickly oriented on the new methodology in about two hours. He can contribute ideas and then leave the group without enduring many hours of TRIZ training.

7. Icons Added

As can be seen from Figure 6, icons have been developed and incorporated to make the principles easier to remember. Words can sometimes be misleading and the icons help to reinforce the meaning of the inventive principle.

8. More Practical Tool for Beginners.

The simplicity of the tool makes it easier to learn and apply for a beginner. With success, this should encourage additional study of the professional version with function modeling and classical TRIZ and an opportunity for higher levels of certification. Details on how to acquire the Guided Brainstorming software and training opportunities must be obtained from the manufacturer[13] and are not part of the paper.

13Guided Brainstorming LLC, http://www.gbtriz.com/ (accessed 10/26/2011)

Conclusion and Summary

This newer methodology reduces the entrance barriers for students and further approaches a more ideal TRIZ tool.

The differences in this method in comparison with the previous one are:

1. The idea of resource usage is a basic change and foundation that the new system is based on by using ready resources, finding latent resources, or creating (deriving or combining) additional resources by using inventive principles to generate the ideas to solve the problem.
2. Inventive Principles are divided into groups according to the criteria of increasing complexity of change that applied to system when we transit from group to group.
3. Organizing of Inventive Principles into groups associated with separation principles - time, space, structure, condition - after considering apparent resources is also fundamental to this approach.
4. Reducing the number of inventive principles makes it easier for the students to learn and apply.
5. Reducing and clarifying the steps should make it easier for students to following the method.
6. Improving the learning tutorials will help the students and act as a readily available mentor.
7. The system enables the user to get results (to generate new concepts) without forcing a user to change his/her natural way of thinking and thus it is more user friendly than previous versions.
8. While preserving the playful and fun state of mind that characterizes brainstorming the low entry learning system directs users to the area of strong solutions.

Next Steps in Reduction of TRIZ Entry Barrier

Sergey Malkin, Vice President, Guided Brainstorming LLC is a well-know TRIZ Expert, trained by the method's founder, Genrich Altshuller and has more than 25 years' experience of TRIZ applications. He has held positions of Vice President, Pretium Innovation LLC, Director of Software Development, Ideation International Inc.; CEO, Private Enterprise Eurotecton; VP TRIZ&VE, Foton Corp. Sergey holds a MSEE from Sevastopol University and an MBA from Simferopol Business School.

Galina V. Malkin, President, Guided Brainstorming LLC, TRIZ Specialist, has been working with TRIZ for more than 23 years. Mrs. Malkin has taught TRIZ to students of different ages, including engineers, college students and schoolchildren. She has taught the adapted elements of TRIZ to preschool children. Based on her experience working with younger children, she developed an educational program to teach TRIZ to elementary school students in Lithuania. Mrs. Malkin has also worked as a TRIZ specialist on numerous industrial projects. In 2006, she began her collaboration with Pretium Consulting Services. Mrs. Malkin's subject matter expertise is in biological research. She has worked in various industrial and academic labs and for the last 5 years, she worked at Wayne State University. Galina holds an MS degree in biology from Simferopol State University.

Gregory Frenklach is a TRIZ expert with more than twenty years of problem solving experience in various fields of technology like microelectronics, medical devices, precise mechanics and robotics etc.
Mr. Frenklach has developed a number of TRIZ based innovation methods, a TRIZ based software ("Inventor Assistant"), and various training materials for managers, engineers and students. He is the creator of M.U.S.T (multilevel universal system thinking).
He is author of six patents and has published about thirty articles in the fields of TRIZ and Value Engineering. He holds a M.S. degree in mechanical engineering from P. Sukhoi State Technical University of Gomel.

Prof. Donald Coates, Ph.D., P.E. In 2011 Professor Coates retired from Kent State University's College of Applied Engineering, Sustainability, and Technology, but still teaches innovation courses, consults, and invents. Previously he taught courses on innovation, energy power and industrial controls; was V.P. of Engineering at a Division of Raytheon, Dir. of Primary Development and Dir. of Dishwasher Engineering at the Frigidaire Company of AB Electrolux, Dir. of Research for the Hoover Company of the Maytag Corporation and Mgr. of Whirlpool Automatic Washers at the Whirlpool Corporation. He received a Ph.D. and MSME for Purdue University and a BSME from the State University of New York at Buffalo. He also received the Distinguished Engineering Alumnus and Outstanding Mechanical Engineer awards from Purdue University. He holds 21 patents with another 8 pending and has authored 17 papers. He is member of the ASQ and the NSPE.