

Using TRIZ to resolve conflicts between Public Educational Institutions and private Cyber-Charter School Initiatives in Pennsylvania

Dana G. Marsh / Heidelberg Digital L.L.C.

Darrell L. Mann / Director, Systematic Innovation

Abstract

Public education in the U.S. is now facing competition from private educational initiatives in the virtual domain. Pennsylvania public education at the high school level is funded by the State, based upon enrollment and attendance. However, many parents are choosing to home-school their children rather than educate them in public schools. Home-schooled students are a subset of homebound students that also includes the subset of students that are homebound due to medical reasons and the subset of students who are homebound having been expelled from the public school system due to inappropriate social behavior. The school districts do not receive state aid for home-schooled students and find educating the other two subsets to be extremely expensive. To make matters worse, Cyber-Charter Schools that provide educational curricula on the Internet are attracting the home-schooled students. In addition, the school districts lose a portion of their state funding because the State mandates that districts subsidize the Cyber-Charter Schools for the expenses of these students.

A group of 20 doctoral students in educational leadership at East Stroudsburg University of Pennsylvania were introduced to TRIZ and the use of a new Contradiction Matrix for Business and Management. These students and the professor, together with the authors, have rewritten the 31 features in the language of educators in order to modify this matrix to create a version appropriate for educational problems.

The doctoral students have addressed the technical contradiction faced by the parents of the home-schooled students, that is, the tradeoff between the quality of education at the public schools versus the system generated harmful effects (exposure to drugs, violence, etc.) at public schools.

This paper will report the 31 features written in educational terms and their relationships to the business and management features. This paper will also discuss potential solution concepts generated by the doctoral students in education, using the Contradiction Matrix for Business and Management modified to be used to resolve education related technical conflicts including an extension of the cyber-school concept for a second student population.

1.0 General Introduction

School districts across Pennsylvania are seeking technology-enhanced solutions to various educational challenges. This year, Monroe County school districts are spending over \$200,000 to ensure adequate training for their “homebound” students. Based upon projections, these numbers will drastically increase in coming years. Additionally, school districts hope to enhance the complete training experience for all students by offering web-based learning alternatives for students within the Commonwealth. Ultimately, district owned and operated cyber-schools will ensure educational excellence for all students receiving cyber education, while funds will return to local districts to be used by all students. This paper reports the work of the authors, and Dr. Faith Waters and her graduate studies class of twenty doctoral students. The paper includes “educational equivalents” for the 31 features of a Contradiction Matrix for Business and Management developed by Mann (1) and, results for resolving contradictions associated with “homebound” students using the Contradiction Matrix for Business and Management.

2.0 Technical and Physical Contradictions – Educational Examples

In order to test the relevance of the TRIZ process, the doctoral students identified unresolved, complex problems with the following contradictions facing administrators, teachers, and staff in Kindergarten through 12th grade levels in public schools in the US today.

2.1 Teacher Release Time

Full time teachers have contractual release time for professional development that takes them out of the classroom. In some cases as many as twelve full-time teachers may be absent at one time. Full-time teachers while in the classroom provide excellent quality of instruction. Substitute teachers replace full-time teachers when they are absent; however, the quality of instruction suffers, busy work is the norm, and general chaos often occurs. There is a technical contradiction between Teacher Release and Quality of Education. In addition, there are associated physical contradictions, the full-time teachers must be present and absent, and the substitute teachers are present but should be absent.

2.2 Teachers and Community Morale

Teacher morale is an issue in empowered schools. School districts invest significant resources in public relations; however, teachers and the community complain that it is not possible to teach more students with less teacher aid, support, etc. In addition, there is enormous pressure to manage the district’s financial resources tightly and to curb spending in order to stay within the budget.

2.3 Standardized Test Scores

Teachers are expected to improve their classes’ Pennsylvania State Standardized Assessment (PSSA) scores each year. Co-incidentally, classrooms are becoming more diverse racially, ethnically, by socio-economic status, etc. This situation results in several technical contradictions; namely, Product Quality vs. Communication Flow, Product Quality vs. Support Interface, and Product Quality vs. Supply Interface.

2.4 Time Resources

Administrators require more time to discuss curricula and instructional issues with teachers. Teachers have no time available during “contract” hours, and are unwilling to stay overtime. A physical contradiction exists, that is, time is needed, but there is no time.

2.5 Teamwork

Administrators desire more teamwork between administrators and teachers. Teachers expect that administrators will deal with student behavior problems such as smoking, dress-code violations, and inappropriate behavior in hallways, etc. A technical contradiction between Support Interface and Feedback exists.

2.6 Cyber-Charter Schools

School districts are funded by the state based on student enrollment and attendance. Home-schooled students do not contribute to enrollment nor to attendance, and have recently begun receiving state-mandated funding from the school districts to attend approved charter schools, including cyber-schools, thereby diverting funds from the local school districts. Because of this funding process, independent cyber-schools are beginning to surface across the state.

A number of problems arise due to this action. Schools must deal with multi-layered communication, and state aid is being diverted from the school districts thereby impacting the education of the traditional students. The State pays 35% of Yearly Per Pupil Costs but is withholding 100% for home-schooled students. The school districts need to cut staff, but cannot cut staff due to contracts, and rapid growth from urban areas is increasing the number of students with behavioral problems.

3.0 Students Who Are Taught at Home

Homebound students fall into several populations or categories. Home-schooled students represent an important class. These are students whose parents have made the decision to keep them out of the public school system. The parents are required to provide an education consistent with the public school standards and curricula. The parents are making a tradeoff between the quality of education and exposing their children to an environment that does not meet their expectations for respect for authority, religious curricula, moral issues such as sex, drugs, and inappropriate behavior, and the safety of their children. The parents of students want control of the environment, and the schools want control over a consistent curriculum.

Another class of homebound students is students who have been expelled from the public school system due to behavior or discipline problems. This paper addresses this class of homebound student specifically. A final class of homebound students is those who are confined to their homes for medical reasons.

4.0 Ideal Final Result

An ideal solution is that all schools will be able to meet the needs of all students. This includes the general student population as well as the homebound population.

5.0 Results and Discussion

Dr. Faith Waters, Department Chair, Professional and Secondary Education, and a group of twenty doctoral students were introduced to TRIZ and the use of TRIZ principles to find a solution to the problems associated with homebound students. In particular, the group focused on the population of homebound students who had been expelled from the public schools. The group decided to use the Contradiction Matrix for Business and Management developed by Darrell Mann and reported at TRIZCon 2002, the 4th Annual Conference of the Altshuller Institute for TRIZ Studies, in St. Louis, April 30 – May 2, 2002. (1) The group was also encouraged to concentrate on the ideal final result and the optimal use of resources.

The Contradiction Matrix for Business and Management contains 31 parameters (see tables below). The new Matrix is intended to function in much the same way as the classical Matrix; the user is encouraged to think about what they are trying to improve and then what is stopping them from making the improvement.

5.1 Educational Equivalents for the Business Features

The team immediately recognized the need to identify some 'educational equivalents' to the parameters developed for business applications. The team decided to create equivalents for Kindergarten through 12th grade and an additional set of equivalents for higher education (Colleges and Universities). These equivalents are reported below in the tables. Table 1 suggests educational equivalents for the 31 features of the Contradiction Matrix for Business and Management for public education grades K – 12. For example, feature number 16 is labeled Product Reliability (or Support

Specification, Support Quality, or Support Means) for business and management. The K–12 educational equivalents are Remediation, Quality of Education, Quality of Supervision, and Student Test Scores.

Table 1: K – 12 Educational Equivalents of the 31 Features - Contradiction Matrix for Business

No.	Business & Management	K-12 Education Equivalent
1	R&D Spec/Quality/Capability	Student Achievement; Teacher & Curriculum Quality; Instructional Practices
2	R&D Cost	Curriculum Development; Professional Development; Research
3	R&D Time	Professional Development; Collaboration; Summers
4	R&D Risk	Non-accredited School & Degree; Teacher Retention
5	R&D Interfaces	State Mandated Standards; Student Teaching
6	Production Spec/Quality/Means	Curriculum Development; Standards; Federal & State Mandates
7	Production Cost	Per Pupil Cost; Strategic Plan Costs; School Facilities and Infrastructures
8	Production Time	Differing Ability Levels; Efficiency in Use of Instructional Time; Scheduling
9	Production Risk	Student Failure & Drop-out Rates; State Take-over (Empowerment); Public Dissatisfaction
10	Production Interfaces	Stakeholders; Educators; Dept. of Education; PTA; PTO
11	Supply Spec/Quality/Means	Budgets; Bid Lists
12	Supply Cost	Salaries; Remediation; Materials; Technology
13	Supply Time	Instruction; Staff Hiring & Removal; Order Completion
14	Supply Risk	Student & Non-certified Teachers; Budgets; Substitute Teachers
15	Supply Interfaces	Budget Constraints; Line and Staff Relationships; Administration; Staff; School Board Priorities
16	Product Reliability Support Spec/Quality/Means	Remediation; Quality of Education & Supervision; Student Test Scores
17	Support Cost	Salaries (Administration; Aides; Counseling; Special Education); Remedial Programs; Support Staff
18	Support Time	Filling Unfilled and Understaffed Positions; Professional Development; Scheduling
19	Support Risk	Insufficient Staffing Pool; Special Education Programs; Retention of Qualified Personnel
20	Support Interfaces	Collective Bargaining Agreements; Department of Education; School Boards; Community Officials; Organizational Memberships; Teachers; Parents; Schools
21	Revenue/Demand/Feedback	Graduation Rates; School Placed under State Management; Department of Education; Employment Rates; Empowerment; College Acceptance; Parents
22	Amount of Information	Assessment Data; Educational Research; Special Education Data; Curricula
23	Communication Flow	Report Cards; Among (Administration; Teachers; Staff; Students; Parents; Community; State; Federal)
24	System Affected Harmful Effect	Societal Dysfunctions; Inadequate Funding; Alcohol; Drugs; Poor Test Scores; Poor Instructional Facilities; Poor Programs; Drop-out Rates; Budgets Voted Down

25	System Generated Harmful Effect	Disrespect; High Drop-out Rates; Exposure to Drugs; Violence; Sexual Behavior; Poor Test Scores; Exposure to Unsafe Environments
26	Convenience	School Calendar; Parental Involvement; School Holidays; Busing; Motivation; Community Support
27	Adaptability/Versatility	Schedules; Alternative Routes; Split Sessions; Time; Block Scheduling; Emergency Certification
28	System Complexity	School Funding; Alternative Education/Choice; Special Education; Private; Public; Charter; Homebound; Cyber; State & Federal Funding Regulations; Remediation
29	Control Complexity	State Department of Education; Educational Regulations; State Boards; School Boards; Special Interest Educational Groups
30	Tension/Stress	State & Federal High Stakes Testing; Teacher & Staff Morale; Community Expectations; Societal Dysfunctions
31	Stability	Personnel Retention; Disaffected Children; Enrollment; Attendance; Mobility Rates; Special Education; Foster Children

Table 2 suggests educational equivalents for the 31 features of the Contradiction Matrix for Business and Management for higher education (Colleges and Universities, Post-graduate Studies, etc.) The higher educational equivalents for Feature 16 Product Reliability or Support Spec/Quality/Means are Quality of Education, Graduate Employment Statistics, Certification Exams, Graduate School Enrollment, and GRE.

Table 2: Higher Educational Equivalents of the 31 Features - Contradiction Matrix for Business

No.	Business & Management	Higher Education Equivalent
1	R&D Spec/Quality/Capability	Degree/Diploma/Certificate/Honors; General Educational & Graduate Requirements; Professional Standards
2	R&D Cost	Accreditation; Professional Development
3	R&D Time	Scholarly Activities; Research Grants
4	R&D Risk	Tenure; Competition; Attrition; Promotion
5	R&D Interfaces	Collaboration; Partnerships; Research Facilities
6	Production Spec/Quality/Means	Licensing & Certification Requirements; Accreditation Requirements; School Facilities & Infrastructures
7	Production Cost	Faculty & Staff Salaries; Financial Aid; Graduate Student Assistantships; Tuition; Stipends
8	Production Time	50 Week Instruction; Continuing Education; Weekend & Evening Instruction
9	Production Risk	Declining Enrollment; Declining Funding Sources; Increased Competition from Online Venues; Endowments
10	Production Interfaces	Board of Trustees; Accreditation Bodies; State Boards; Alumni Groups
11	Supply Spec/Quality/Means	Curricula; Government Regulations; Books & Supplies; IT; LAN's; Technology
12	Supply Cost	Faculty & Staff Salaries; Recruitment & Retention; Cost of Supplies; Libraries; Medical
13	Supply Time	Purchasing; Faculty and Administrative Search Committees; Order Completion
14	Supply Risk	Faculty Grants; Budgets Constraints; Faculty Grievances

15	Supply Interfaces	Government & Industry Grants; Faculty; Administration; Staff; Publishers
16	Product Reliability Support Spec/Quality/Means	Quality of Education; Graduate Employment Statistics; Certification Exams; Graduate School Enrollment; GRE's
17	Support Cost	Salaries; Facilities & Grounds; Remedial Programs; Administration; Counseling; Psychological Services
18	Support Time	Unfilled Administration/Faculty/Staff Positions; Adjunct Professors
19	Support Risk	Retention of Qualified Personnel; Special Education & Remedial Programs; Administrators Resign & Retire
20	Support Interfaces	Board of Trustees; Faculty Governance Committees; External Interfaces; Program Boards; Faculty; Staff; Administration
21	Revenue/Demand/Feedback	Students; Legislators; Parents; Alumni; Faculty; Community; Industry
22	Amount of Information	Curricula; Accreditation Processes; Tenure & Promotion Processes; Institutional Research
23	Communication Flow	Among (Administration; Faculty; Staff; Students; Parents; Community; Alumni; State; Federal); Recruitment; Institutional Review Board
24	System Affected Harmful Effect	Legislative Mandates; Alcohol; Drugs; Unsafe Environment; Censorship; Balancing Freedom & State Policies
25	System Generated Harmful Effect	Exposure to Alcohol & Other Drugs; Violence; Sexual Harassment
26	Convenience	Course Availability; Calendar; Evening & Weekend Instruction
27	Adaptability/Versatility	Multiple Instructional Delivery Systems; Articulation Agreements
28	System Complexity	Private/Public/Virtual Universities; Trade & Technical Schools; Community Colleges; Affirmative Action; Sororities & Fraternities; Sports & Extracurricular Activities
29	Control Complexity	Multiple Constituencies; State Boards; Interdepartmental Competition; Alumni; State & Federal Government; Funding Sources
30	Tension/Stress	Academic Freedom; Accreditation; Collective Bargaining; Tenure & Promotion; State Exams & Expectations; Community Expectations; Assessment; Reductions in Force
31	Stability	Funding; Enrollment; Retention; Facilities; Endowments; Grants

5.2 Contradictions Associated with the Homebound Student

We considered some of the contradictions inherent to the problem of the homebound students who were expelled from the traditional public school environment for behavior or discipline reasons. These students receive the least adequate schooling and are the largest financial drain on the school districts. On the other hand, their parents are the least resistant to changes to their child's programming, as they have to be compliant based on the expulsion dilemma. Teachers are often threatened by these students in the public school venue. In some districts, teachers refuse to go to the students' homes fearing for their safety. Students are required to be educated by law, yet no one wants to do it. It is very expensive to educate them off-site, and the increasing numbers of expelled students are diverting large sums of money from budget-distressed schools.

These students are often oppositional and need structured support to develop morally and emotionally. However; few curricula have been developed to meet this need and are rarely if ever included in a homebound program, as the limited instructional time is devoted to basic skills. These students frequently return to the general student population, but there will be dim hope for modification of their previous behavior if there is no consistent intervention while they are homebound.

These homebound students are assessed from time to time to determine progress and ensure compliance. However, almost always the teacher or teachers who work with them are not certified in the subjects the students must take. They must then rely on worksheets and texts to deliver the content. Several contradictions are summarized in Table 3 below.

Table 3. Contradiction Worksheet

	Factor List	Improve	Worsen
1	R&D Spec/Quality/Capability/Means		
2	R&D Cost		
3	R&D Time		
4	R&D Risk		
5	R&D Interfaces		
6	Production Spec/Quality/Means		
7	Production Cost		
8	Production Time		
9	Production Risk		
10	Production Interfaces		
11	Supply Spec/Quality/Means		
12	Supply Cost		*
13	Supply Time		
14	Supply Risk		
15	Supply Interfaces		
16	Product Reliability	*	
17	Support Spec/Quality/Means		*
18	Support Cost	*	*
19	Support Time		*
20	Support Risk		
21	Support Interfaces		
22	Revenue/Demand/Feedback from		
23	Amount of Information		
24	Communication Flow		
25	System Affected Harmful Effects		
26	System Generated Harmful Effects		
27	Convenience		
28	Adaptability/Versatility		
29	System Complexity		
30	Control Complexity		
31	Tension/Stress		*
	Stability		

CONTRADICTIONS

16 vs. 12

16 vs. 17

16 vs. 18

17 vs. 30

IDEAL FINAL RESULT

All schools will be able to meet the needs of all students.

#3 2, 25

#4 22, 25

#1 35, 24

#2 35, 24, 10, 2

5.3 TRIZ Solutions for Four Contradictions

The first contradiction in Table 3 is the trade off between Feature 17, Support Cost (Salaries, Remedial Programs, Support Staff) and Feature 30, Tension and Stress (State and Federal High Stakes Testing, Teacher and Staff Morale, Community Expectations, Societal Dysfunctions). As stated above, homebound students are instructed at home by special teachers. This requires costs associated with the remedial programs, teacher certification, and teacher salaries. The teachers' morale is adversely affected because they do not want to enter the hostile environments that exist in some of these student's homes and because they recognize that they are not certified to teach some of the subjects. Therefore a trade-off exists between costs and tension and stress.

The Contradiction Matrix directs us to look at Principles 35 (Parameter Change), 24 (Intermediary), 10 (Prior Action), and 2 (Take Out). We considered examples from two TRIZ Journal articles; namely, '40 Inventive (Business) Principles' (2) and '40 Inventive Principles with Social Examples' (3). Mann, *et al.*, have suggested that the same 40 Principles used for technical problem solving, may be used for resolution of business problems. The team now proposes that these same 40 Principles may be used to resolve contradictions and generate solution concepts for educational problems.

For Principle 35 (Parameter Change) Part a., Change an object's physical state (e.g. to a gas, liquid, or solid), the suggestion is made to use virtual prototyping. Part b., Change the concentration or consistency, suggests to change the team structure. Part c., Change the degree of flexibility, suggests software with options for 'beginner' to 'expert' usage. Part d., Change the temperature, suggests getting the customer or team fired up or 'hot' about the product.

These ideas prompted us to consider a "Virtual Educational Component" for every school. The "Virtual Educational Component" would utilize the existing teaching staff, but in a different way. The "Virtual" curricula would support teaching levels from beginning to expert and the ability to deliver instruction at a variety of appropriate levels. The "Virtual Educational Component" would provide a high level of educational quality for the homebound students, and also eliminate or reduce the tension and stress of teachers having to go to the students' homes. The existing teaching staff may be enthusiastic about developing the "Virtual Educational Component," an innovative way to deliver instruction.

In Principle 24 (Intermediary) Part a., Use an intermediary carrier article or intermediary process, the idea of introducing a "Virtual Educational Component" as an interface between the teaching staff and the homebound students emerges.

In Principle 10 Prior or Preliminary Action, Part a., Perform, before it is needed, the required change of an object (either fully or partially), changing the delivery system for learning is consistent with the development of a "Virtual" curricula.

For Principle 2 Take Out Part a., Separate an interfering part or property from an object, or single out the only necessary part (or property) of an object, suggests that it is the educational product that needs to be delivered to the homebound student, and this may be done without the teacher physically present. Thus the real teacher can be replaced with a virtual teacher. This principle also suggests separating the disruption of the behavior problems from the learning process.

The second contradiction associated with homebound students is the tradeoff between a quality education for the homebound students and the cost of providing this education. In Table 3, this contradiction is represented by Feature 16, Product Reliability or Support Spec/Quality/Means (Quality of Education & Supervision; Test Scores) and Feature 12, Supply Costs (Salaries; Remediation; Materials; Technology). The contradiction matrix directs us to Principles 35 and 24. These have been discussed above.

The third contradiction is the tradeoff between quality of education and support costs. These are related to Features 16 and 17. The contradiction matrix directs us to consider Principles 2 (Take Out), and 25 (Self-service). We have discussed Principle 2 above. The Principle 25 Self-service, Part a., Make an event serve itself by performing auxiliary helpful functions, suggests that the customer of the educational system (homebound student) could take flexible advantage of the “Virtual Education Component” in a manner that is adapted to their own circumstances, learning styles, time of day needs, etc. Benefits of asynchronous delivery match the needs of this population. The “virtual” curricula may also be developed to address the moral and emotional challenges of the homebound student, to develop their character while they are learning.

The fourth and final contradiction is the tradeoff between quality of education and support time, Features 16 and 18 respectively. Feature 16 has been discussed. Feature 18 Support Time has educational Equivalents: Filling Unfilled and understaffed Positions; Professional Development; Scheduling. The Contradiction matrix directs us to Principle 22 (Blessing in Disguise) and Principle 25 (Self-service). The latter has been addressed above. Principle 22 Blessing in Disguise, Part b., Eliminate the primary harmful action by adding it to another harmful action to resolve the problem, suggests to eliminate fear of change by introducing fear of competition. The establishment of a “Virtual Education Component” to the traditional educational system deals effectively with the challenges of the homebound student but also threatens and challenges teachers and staff. However this may be preferable to the recent challenges of the private Cyber-Charter School initiatives in Pennsylvania that represents an even greater competitive threat as well as the threat of loss of resources as the budget must accommodate increasing costs for homebound students.

6.0 General Notes on Application of the Business Matrix

This paper records some pioneering application of the new Business Contradiction Matrix. It is still early days as far as validating the tool as a useful addition to the creative process is concerned. This case plus a variety of others taken from a range of other industry sectors - from legal, to finance to business model design to organisation structure re-definition - have highlighted a number of points that appear to be applicable generally:

- 1) Different industries appear to generate very distinct terms and expressions to describe different aspects of their business (e.g. 'teacher release', 'SAT scores' in this paper). No generic set of parameters seems capable of mapping even a small proportion of the different terms and expressions used. In many senses, this should be viewed as a benefit rather than a problem - especially since one of the main aims of the Matrix is to facilitate the transfer of 'good' solutions from one sector to others. On the other hand, however, users of the Matrix should be able to focus on their problem rather than the mechanics of the tool. This is a definition of another contradiction; one that, like in other sectors, the team involved in the work described here solved by preparing the tables of generic-to-specific translations before sitting down to actually use the Matrix in earnest (i.e. Inventive Principle 10 - Preliminary Action - was employed).
- 2) Technical situations and 'people' situations are often distinguished by the presence of significantly higher degrees of 'fuzziness' in the latter. The Matrix has been constructed in a manner that tries to 'manage' this fuzziness. With the technical contradiction matrix of classical TRIZ, there is often a debate over whether A or B represents the 'right' contradiction to a given problem situation. The new Matrix has been constructed in a manner that encourages users to examine A and B.
- 3) The fuzziness of people-type problem situations also makes it likely that solutions will be generated from a wider range of Inventive Principles than would be expected in technical situations. It also means that there is often considerable benefit in inserting an additional step into the 'generate solutions' part of the problem solving process; a step that examines the possibilities of combining the

solutions derived from the different Inventive Principle suggestions. Individual Inventive Principles, in other words, offer useful solution generating triggers, but unlike what often happens in technical situations, the ultimately best business solutions will emerge through combination rather than selection of the ideas generated.

7.0 Conclusions

The team has endeavored to use TRIZ principles to resolve contradictions associated with public school education in the US. In school districts in Pennsylvania, homebound students, in particular, students that have been expelled from the public school environment, represent significant challenges for these budget-distressed school districts.

A solution for resolving four contradictions associated with these homebound students has been identified. The introduction of a “Virtual Educational Component” in conjunction with the traditional educational venues effectively resolves the identified contradictions. In addition, the solution also addresses an associated challenge regarding the emergence of “Cyber Charter Schools” in Pennsylvania. These schools further challenge the already budget distressed school districts.

The TRIZ experience at East Stroudsburg University of Pennsylvania has enabled the administration to react quickly to a 2 million dollar grant opportunity from the United States federal government. East Stroudsburg University of Pennsylvania in collaboration with Right Reason Technologies have submitted a proposal for a “Virtual Education Academy – A Cyberschool Alternative” with the mission of “Assuring Student Achievement so that No Student is Left Behind.”

References

1. Darrell Mann (2002) ‘Systematic Win-Win Problem Solving in a Business Environment’, Conference Proceedings, TRIZcon 2002, St. Louis.
2. Mann, D., Domb, E., ‘40 Inventive (Business) Principles with Examples’, The TRIZ Journal, www.triz-journal.com, September 1999.
3. Terninko, J., ‘Inventive Principles with Social Examples’, The TRIZ Journal, www.triz-journal.com, June 2001.