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TRIZ Methods Applied to the Analysis of Disruption in the Marketplace

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Abstract

Since its conception by Everett Rogers (1962), the "S-curve" has been known and used for more than 50 years. The S-curve model has allowed for the prediction of market disruption but has consistently failed to predict the timing in which when disruption would occur. Adner and Kapoor (2016) provided a framework that links the evolution of an incumbent challenged by a new technology to the evolution of the ecosystem, which they claim provides a predictive model for the occurrence of disruption. According to the authors, the "mode" and timing of a disruption may now reasonably be predicted. From a practitioner's point of view, the question at hand is how to identify the right strategies and the subsequent tactics to respond to each of these disruption scenarios, for both the position of the incumbent and the new entrant. We propose these answers can be found within the body of knowledge offered by TRIZ. The utilization of these practices can guide incumbents and contenders to specific strategies that can be employed when engaging with each scenario of disruption. Policy-setting and regulation can also benefit from such analysis. We demonstrate the approach with a practical case study from the construction industry.

Keywords: Disruption, S-Curve, Technology Trends

1. Introduction

In the discussion of innovation and disruption, the "S-curve" is a well-known concept to describe the maturing of systems. Altshuller (1984) distinguishes between the four stages of "childhood", "growing up", "maturity" and "old days", which others have further expanded, for example by D. Mann (1999).

Better known among marketers is Everett Rogers' (1962) earlier use of the S-curve to describe the diffusion process of innovation. Rather than maturity or performance of the system, the degree of adoption is tracked, which is the mathematical integral of the rate of adoption (see Fig. 1). In this view, the S-curve is understood as a special case of a learning curve. Notice that also other learning curves are observed, for example hyperbolic ones (Thurstone, 1919), where learning is fast initially and then becoming more incremental.

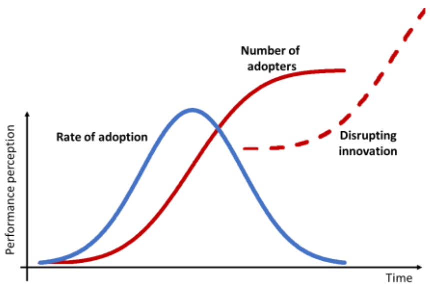

Fig. 1: R. Everett's model (1962) for the diffusion of innovation

One of the first things an innovation practitioner will want to determine is a system's position on the S-curve – be that with regards to maturity, performance, or stage of diffusion. Based on Altshuller's original work, evaluating the evolution over time of four metrics can be used to accomplish these assessments, including: the system's performance, the number of related inventions, the level of these inventions and profitability of each, as discussed in more detail by M. Slocum (1999). One can include Roger's view in such a study and add degree and rate of adoption (Fig 2). TRIZ practitioners would then validate the resulting findings through a technology trend analysis, either based on Altshuller's original 8 trends (1984), or on more granular formulations, as proposed by D. Mann (2002). Such analysis not only validates the system's position on the S-curve, it also further helps identify the evolutionary potential within the current system and predict developmental paths to increase the system's maturity.

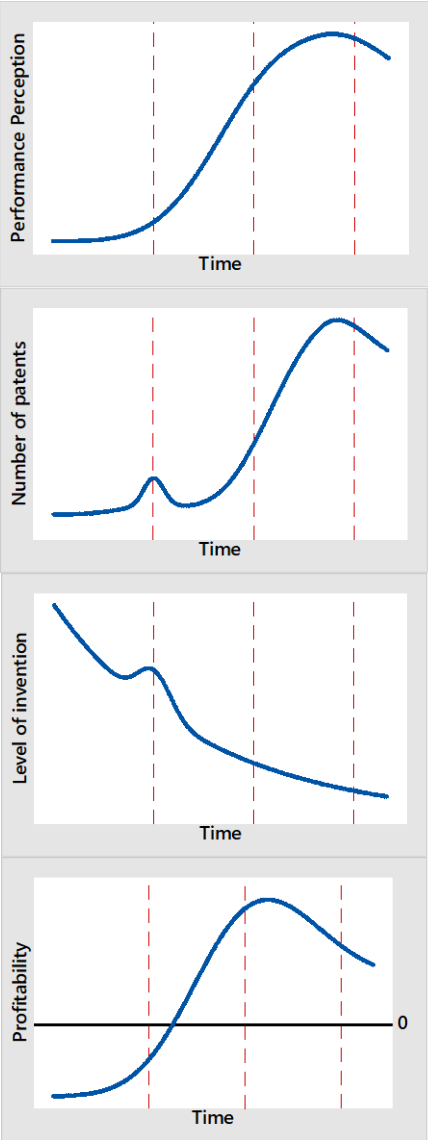

Fig. 2: Stages of technology evolution (adapted from Slocum, 1999). These four metrics along with Roger's two metrics from can be used to determine the position on the S-curve of a given system.

Adner and Kapoor (2016) provided a framework that links the evolution of an incumbent, challenged by a new technology, to the evolution of the ecosystem, which they claim provides a better predictive model for the occurrence of disruption. According to the authors, "mode" and timing of disruption may now be reasonably predicted.

From a practitioner's point of view, the question at hand is how to identify the right strategies and subsequent tactics to respond to each of these disruption scenarios, for both the position of the incumbent and for the new entrant. Based on our investigation, in this early phase still with a limited set of data, we propose searching the answers within the TRIZ body of knowledge, such as the analysis of trends, inventive and separation principles, and others. The utilization of these practices can then guide both the incumbent and the contender to specific strategies they can employ when engaging with each of the four scenarios of disruption described by Adner and Kapoor.

2. Analysis of disruption scenarios

When engaging in a maturity and diffusion analysis, disruption is observed as a possibility, when a new technology, initially inferior, over time supersedes a mature incumbent system. This phenomenon of disruption has been studied by G. Schmidt & C. Druehl (2008), C. Christensen, C. Raynor and M. McDonald (2015), G. Pisano (2015) and others.

Using concepts such as the "Sun Diagram" proposed by D. Cavallucci (2007), practitioners can also predict where disruption is likely to happen. In the practice of this tool, different technologies are compared using a function and contradiction analysis, and roadblocks are identified that hinder the technology from evolving towards the "ideal final result". Such an analysis helps predict which of the emerging technologies are most likely to challenge an incumbent.

Upon identifying how the incumbent will be challenged by competing systems, the strategic feat is the prediction of when disruption is likely to occur. R. Adner and R. Kapoor (2016) claim to have developed a model to address this problem. The authors link the evolution of an incumbent system, which is challenged by a new technology, to the evolution of the surrounding ecosystems. From a given starting position, shown as "Today" in Fig. 3, they identify four possible scenarios in which to perform this evaluation (also see Table 1). We will discuss selected known scenarios.

Mode A - The LED disrupts the incandescent and halogen lights

A well-known example for classical disruption is the replacement of the incandescent and fluorescent lightbulbs by LEDs. LEDs were present since the 1960's, yet they were constrained by their low power capabilities, producing light predominantly in the red frequencies of the spectrum. Development continued throughout the mid-1990's, at which point blue and brighter LEDs were created and introduced to the market, but the desire for a white LED light remained. In 2007, efforts were spurred on to achieve this through a competition set forth by the US-American Department of Energy, the "Bright Tomorrow Lighting Prize" (https://www.lightingprize.org/). And alas, in 2011, with four years of effort, this feat was achieved by Philips. Today, the incandescent and fluorescent light bulbs are replaced almost entirely with the white LED light. This was possible 1) thanks to its enhanced performance as a LED of 10 Watts that provides about the luminosity of a 60 Watts incandescent bulb and 2) thanks to its compatibility with the existing ecosystem as the new LED bulbs fit into the classical "Edison screw" socket. Both has resulted in a quick, easy substitution.

Table 1 Four disruption scenarios when considering the ecosystems of incumbent and new technology (adapted from Adner and Kapoor, 2016).

		New Entrant Ecosystem	
		Must be improved	**Is ready**
Incumbent Ecosystem	**Can be improved**	**Mode C:** Robust resilience of the old technology	**Mode B:** Robust coexistence between old and new technology
	Has reached maturity	**Mode D:** Illusion of resilience of the old technology	**Mode A** "Classical" creative disruption of the old by the new technology

Mode D - Paper maps become virtually extinct by GPS Navigators

Paper maps, in various forms, have prevailed as the go to method of navigation in unfamiliar territory. However, navigation using a map while driving is unsafe and error prone. As roads and infrastructure is updated, paper maps also become quickly out of date. Global positioning system (GPS)-based maps, in both dedicated GPS navigation units as well as smartphones. These applications mitigate the concerns around paper-maps by offering up to date maps, that also highlight immediate traffic conditions, road hazards, speed-control points and other information that is of interest to a driver. GPS-based navigation demonstrated an early win for the technology, but its widespread adoption was hampered by the lack of a supporting infrastructure or ecosystem. A functioning GPS navigation system depends on satellite-based positioning information, affordable GPS-capable devices, such as smartphones, affordable and fast data-services, as they are now provided by mobile network operators, interactive mapping software as well as easy-to-use interface, allowed for today with the ubiquitous touchscreen devices. Initial forays into the consumer GPS navigation market by providers such as Garmin, were viewed as a niche application from the perspective of map publishers. Only when reliable mobile network connectivity became available and affordable, coupled with freely available map information, such as was published by companies like Google & Apple, were traditional map publishers replaced in the market. The incumbent paper-based navigation maps were not initially threatened by GPS based market entrant solutions, because the latter initially found limited application. However, as the eco-system evolved, supporting technology developed and GPS navigation ultimately improved to outperform paper-based maps from the perspectives of convenience, accessibility, speed, accuracy and flexibility

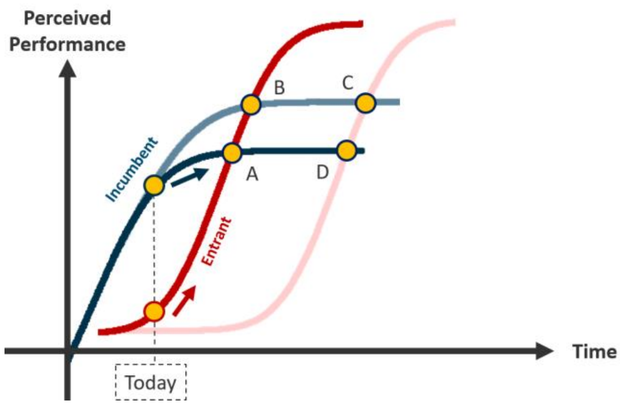

Fig. 3: Paths of disruption for four different scenarios, depending on the evolutionary potential in the incumbent's and the new technology's ecosystems (adapted from Adner and Kapoor, 2016).

Mode B- The snowboard fails to disrupt the ski

The ski appears to have been invented multiple times in different areas, and likely for the first time about 10,000 years ago in what is today's China (New York Times, 2017). Since creation, the design of the ski has continued to evolve, namely with the advent of new materials. Efforts to improve the design of the ski dwindled down through the 1980's.

As early as 1939, a patent was granted for a sled as "substitute for skis in jumping on snow or snow-covered ground" (US2181391A). In the mid-1960's, the first truly snowboard-like design emerged under the name of "snurfer" (US3378274A), which stands for "snow-surfer". Only in the late 1970s and early 1980s, after the release of the 1985 James Bond film, "A View to A Kill" did the idea of snow-surfing gain popularity in concept and experimentation. Snowboarding was distinguished for bringing the attractive elements of surfing on Californian beaches to the snow-covered mountains in America, Europe and elsewhere. The ease of learning this sport greatly increased its desirability, as demonstrated by daring snowboarders who were able to perform on terrain considered "impossible" by means of skiing.

With an attractiveness to extreme users and accessibility for the larger public, one could have expected the snowboard to take over an important share of the market for skis. What was unforeseen, was the span of development still available for the ski design to advance upon. Thus, after thousands of years of development and perfection, the ski evolved to include a carving feature, a design element borrowed from the curved shape of the snowboard. The new design featured a shorter ski length, which provided a social benefit and thus greater adoption for non-expert skiers, previously mocked for use of non-traditional short skis. The addition of the curved feature allowed greater comfort and a smoother ride, increasing its performance across moderate to tough territory. These enhancements made the experience of the sport more widely attractive, inviting even the un-experienced, occasional skier.

The ski exemplified the scenario of robust resilience, in which the ski evolved to compete against the snowboard, protect its market space, and gain more amidst the introduction of the snowboard. One can now expect the ski and the snowboard to co-exist at least for some time to come while incremental improvements occur, and debates persist over beneficial features such as easy step-in, advancement on flat sections of slopes, likelihood and nature of typical injuries, ease of use under spring-snow conditions and so forth.

Mode C - Is the combustion engine resilient enough – or will the battery or hydrogen prevail?

A more complex situation is the ongoing debate around the internal combustion engine versus the battery- or fuel-cell-driven electric motor versus the hydrogen combustion engine. In the public debate, battery-driven electric vehicles are often presented as the obvious future of the industry. Yet, that view requires scrutiny: First, incumbent car manufacturers still see significant evolutionary potential in the "classical" combustion engine, through advances in fuel-efficiency and the reduction of harmful effects produced by NOx, CO_2, CO, and unburned hydrocarbons. The incumbent technology is also positioned with advantage as the existing ecosystem predominately caters to this solution with a vast presence of dealerships, gas stations and repair shops.

Further, when thinking "backwards from perfection", i.e., using the "ideal final result", as the TRIZ practitioner would do, one also examines the ideality of the energy-storage solution and compares the energy-density for gasoline, battery, and hydrogen, and this in terms of weight (Joule/kg) and volume (Joule/m^3). Hydrogen (whether used in the fuel cell or in a hydrogen combustion engine), outperforms any known battery concept and beats gasoline in terms of energy stored per weight, although not per volume (e.g. Wikipedia, https://en.wikipedia.org/wiki/Energy_density). Furthermore, the use of rare earth and other materials in electric motors, and the materials required for current designs of high-performance batteries, add considerable "harm" to the end-to-end lifecycles of electric motors. As a result, the automotive industry, incumbents and new entrants, explore all four options: the improved "classical" combustion engine, a hydrogen combustion engine and the battery and fuel-cell powered electric car. Predicting the evolution of the combustion engines alongside the rate of adoption for the other technologies is a scenario where TRIZ thinking and TRIZ practices provide guidance not only for inventors and strategists but also for regulation and policy-setting.

3. A strategist's TRIZ-based disruption analysis

TRIZ practitioners notice that Adner and Kapoor's re-formulation of the S-curve incorporates Altshuller's original analysis into aspects of the nine-screens method. Their methodology conceptually analyzes the technology in the past, present and future, for system and ecosystem (the super-system from a TRIZ perspective), but not for the sub-system. TRIZ practitioners may thus concede that Adner and Kapoor's model is not fundamentally new to the TRIZ community, and even incomplete. Yet, in our practical work with client teams, we find their four disruption and resilience scenarios highly useful, and this both for contenders and for incumbents in their respective situations. We also acknowledge that the framework provided by Adner and Kapoor allows for encompassing analysis and provides valuable insights.

As can be seen namely with the complex "mode C" example above, strategists can indeed further expand the concepts developed by Adner's and Kapoor when complementing them with TRIZ methods and understand what strategies incumbent and contenders may develop in the face of disruption. The general usefulness of TRIZ thinking for strategists has been explored in another of our articles (M. Ohler, P. Samuel, N. Shahani and D. Bennington, 2016). Here we see how TRIZ methods, combined with the observation of patent and research activities, help each party anticipate the others' next likely moves and plan their own strategy accordingly. TRIZ capabilities in an organization then turn into a tangible, strategic advantage.

The iPad may serve as an instructive example, as it is sufficiently well-documented in the public domain. Almost four decades ago, Steve Jobs (1983) formulated his vision:

"What we want to do is to put an incredibly great computer in a book that you can carry around with you and learn how to use in 20 minutes ... and we really want to do it with a radio link in it, so you don't have to

hook up to anything and you're in communication with all of these larger databases and other computers."

The system Jobs described, an amalgam of a computer and a book, did not only require the readiness of ecosystems such as the internet (the "larger databases and other computers") but also the readiness of sub-systems such as "radio links" (read: W-LAN) with high data transmission rates, small and low-power processor- and memory-units, a high energy-density battery and not least, suitable display technology to fit on the "book". It is known that strategist Steve Jobs actively monitored the evolution of relevant super- and sub-systems, as well as the successes and failures of pre-cursor products such as the Samsung's GRiDPad, Fujitsu's PoqetPad, Apple's own Newton and the Palm – which increased his chances to avoid the trap of "right product – wrong time"; the very title of Adner and Kapoor's article.

The study of disruption scenarios helps the practitioner learn from both the perspective of the evolving system and eco-system, as well as the sub-systems. With that understanding, the next logical step is to not only include Altshuller's first, but rather all 8 trends in the analysis.

Another conclusion made by the TRIZ practitioner is to expand the study of disruption by employing a full ARIZ analysis (G. Altshuller, 1985). If that were done and skillfully so, then the "short-cut" method for analyzing scenarios of disruption, as discussed here, might not even be required. From our field-experience with clients we also learned that such an approach limits the study of disruption timing to the small number of highly experienced TRIZ practitioners, and to teams willing and capable to adopt the ARIZ framework. The question thus is: How can strategists, with an interest in the application of systematic methods, make their current practice more insightful by encompassing the application of TRIZ approaches? With a strategist's long to-do list, we see a simplified approach, such as shown in Fig. 4, as what can, and should, be integrated in such a strategic analysis. If, say, the betting of large sums of investor money on a hydrogen combustion engine were at stake, that turns into a key element of the "due diligence" investigation.

With an interest in experimentation, and with the constraint of often short time for the training of client teams, we have condensed the full ARIZ process into the subset of techniques shown in Figure 4. This figure represents the flow of analysis that we utilize in a standardized approach to the study of disruption situations.

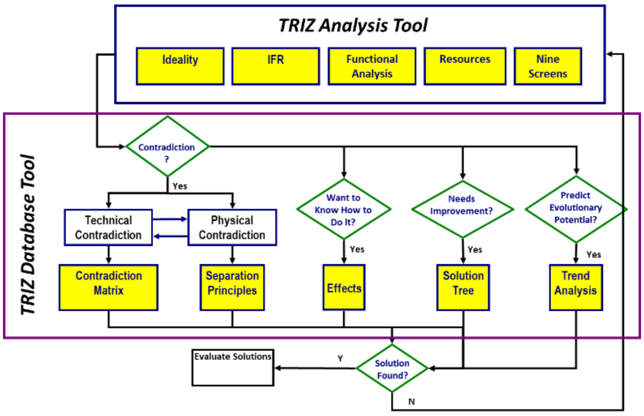

Fig. 4: A simplified approach for using TRIZ methods to derive strategic options from a disruption analysis.

This work is found to flow well when conducted during client workshops as described by M. Ohler, N. Shahani and S. Borde (2015). Once a team identifies entrant and incumbent systems, we supplement the common strategy analysis (Porter's Five Forces, SWOT, Capabilities, …) with this framework. In this phase of a strategy workshop, the teams review incumbent and entrant systems, their resources, and functions. A similar analysis is performed for the eco-systems with the help of the nine screens approach. We then continue to isolate useful and adequate functions, useful but insufficient functions and harmful functions of the incumbent and entrant systems, and this from the perspectives of product life-cycle and customer-journey. Then we formulate the Ideal Final Result and Ideality of the systems. Analysis of the position and distance of incumbents and entrants with reference to Ideal Final Result then helps formulating the contradictions that must be solved by the players for their respective technologies.

Armed with information thus gained, the teams then create strategic options for incumbents and entrants by applying inventive principles, separation principles, scientific effects, substance-field, and standard solutions. The resulting options then inform robust approaches towards handling a given scenario of disruption-mode and disruption-timing.

4. Case Study

With the following case study, we intend to illustrate how the approaches discussed here can be applied in practical terms.

A new structural framing system tool, known as Framefast®, has been recently introduced in the marketplace for attaching rafters and trusses with a single 6" fastener (see https://www.fastenmaster.com/products/framefast-system.html). This new entrant is trying to disrupt the incumbent system composed of various types of metal plates (such as a hurricane joint), fasteners, pneumatic nail guns, hoses, ladders, and scaffolding.

An essential step in providing structural integrity for buildings with wood framing against conditions such as wind, snow and storm include attaching of various rafters and trusses. The current method of attaching involves use of multiple metal joints with fasteners. For example, an H1 hurricane tie from Simpson Strong-Tie provides a positive connection between truss/rafter and the wall of the structure to resist wind and seismic forces (see https://www.strongtie.com/resources/product-installers-guide/h1-installation). Fig. 5 provides examples of trusses or rafters connected with such joints created with metal plates and fasteners.

From an S-curve perspective, the incumbent system is a mature system. The eco-system includes pneumatic nail guns, hoses, ladders, scaffolding and human operator. The system and the ecosystem have evolved over the last decade and have reached a plateau in terms of its capabilities and functions. Typically, a human operator must climb the ladder, attach a variety of plates manually and then install the fasteners. It is sufficing to say that the incumbent method is cumbersome, labor intensive and unsafe. This provides the context for the innovation of the new entrant system called, Framefast®.

The new entrant system boasts eliminating the disadvantages of the incumbent system while providing additional advantages such as the elimination of the incumbent eco system composed of ladders, scaffolding, nail guns and hoses. It also eliminates all forms of metal plates used to join the structural members. This is achieved with the help of a newly designed tool, called Framefast® as shown in Fig. 6. The system allows for the elimination of the ladder and scaffolding as the installation is done on the deck level with the help of extendable tool. The tool holds a special fastener which can be directed and applied to join the structural elements without any special metal plates. It is claimed that the installation is done up to 8 times faster than the traditional method. The tool comes complete with a high torque drill and patented delivery system. The alignment wings can be folded back for girder trusses or harder to reach application. For vaulted ceilings or rafters, the backstabber feature can be raised to meet the bottom of the truss or rafter.

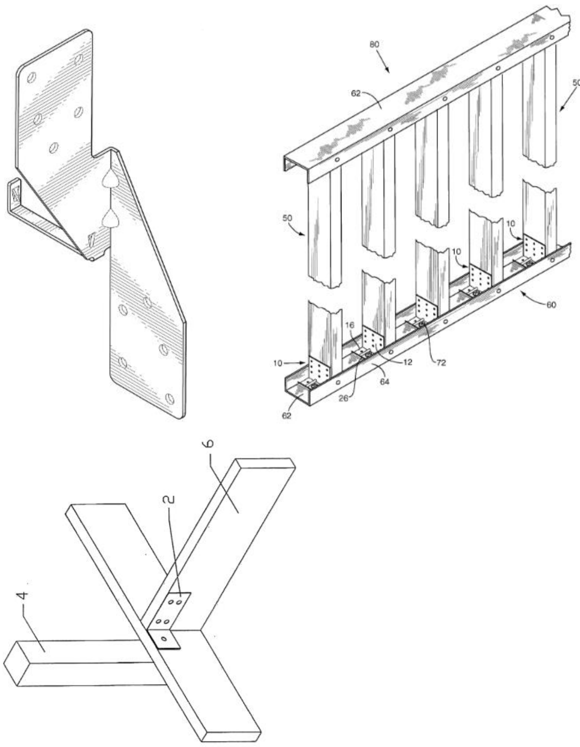

Fig. 5: Examples of incumbent systems to attach rafters and trusses [USD768470S1, US5467570, US20080115447A1].

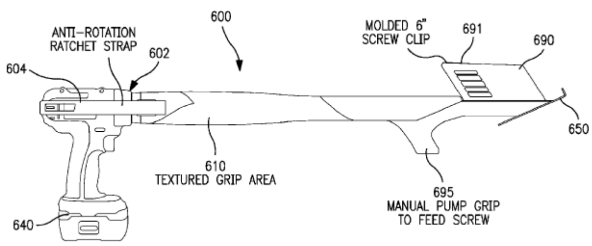

Fig. 6. Framefast® tool (new entrant) [US 20150101462].

We now evaluate the new system, using the framework provided by Adner and Kapoor, for its ability to disrupt the incumbent system. In this framework, there are four questions to be answered:
1) Is the new entrant ecosystem ready for wide acceptance by the stakeholders?
2) Must the new entrant ecosystem be improved before wide acceptance?
3) Has the incumbent ecosystem reached its maturity?
4) Can the incumbent ecosystem be improved against the attack from the new entrant?

Table 1 provides the framework to predict the mode of disruption based on the answers to these questions. The answers are then made robust by bringing additional analysis provided by TRIZ perspective.

From TRIZ perspective the insufficient functions of the incumbent systems include positioning and holding metal plates, such as hurricane tie in place, pre-drilling the location, and driving the fastener into the joints. The harmful functions for the incumbent system include safety hazards for humans while using the ladder, scaffolding and nail gun. The insufficient function of the fastener penetration is traditionally improved with the help of pneumatic nail gun with compressed air hose. However, this creates a technical contradiction resulting in additional harm, cost and inconvenience. Another technical contradiction is that the use of scaffolding and ladder improves the ability to position and attach the metal plates, but it lowers productivity and increases safety risk.

The ideal system to join trusses and membrane would have very limited resources in it, with perfect joining capabilities while providing no harm or cost. Such a system should eliminate most of the elements contained in the incumbent ecosystem. Therefore, it makes sense for the new entrant to find ways to eliminate harmful and cumbersome steps of using ladder, scaffolding, variety of metal plates for different types of joints and pneumatic accessories needed to drive the fastener, and the need of pre-drilling. From this perspective, we believe that the incumbent ecosystem has reached its maturity.

While the new entrant has eliminated the metal plates, at present, regulatory codes require its use in various locations of USA. Before it can be adopted, the new entrant must find ways to influence the code, although they have verified that the joints installed by the new system exceed the structural requirements. In addition, the new ecosystem still has many harmful functions and costs to be overcome. For example, there is a significant cost associated with the acquisition of the Framefast® tool. It requires storing, transportation, maintenance, and repair. While it has eliminated the ladder, scaffolding and pre-drilling, it still requires pneumatic or electric accessories to provide power to the drill. While the new system has considerably improved the productivity of installation, the system at present only allows one fastener to be loaded at a time for installation. As such the operator must load the tool with a new fastener each before installing it. Considering these facts, we conclude that the incumbent ecosystem must still be improved before it can be widely accepted. Hence, we believe that the mode of disruption is one of "illusion of resilience" (mode D) as Framefast® must improve its ecosystem on many of the dimensions described above before it is capable of disrupting the incumbent system.

5. Concluding Remarks

The model developed by Adner and Kapoor provides easily accessible explanatory and predictive power for timing and mode of disruption. The model gains its power from including in the analysis the ecosystem rather than considering only the innovation itself. We find useful to also include the evolution of sub-systems in such an analysis to better predict mode and timing of future disruption events.

The practitioner's concern in that is not only to anticipate future disruption but also how to best use the resulting insights and how to deal with a given competitive situation, and this both from the position of incumbents and new entrants. As we have seen with the automobile motor and source of energy, this can be a setup with multiple technologies, and in most cases, it will also include multiple agents both on the side of the incumbent and of the contender.

In situations as complex as these, we see the full TRIZ body of knowledge as highly relevant: Is the new solution currently held back by a contradiction at system, super-system, or subsystem level? Will scientific effects help improving insufficient or neutralize harmful functions along product life-cycle and customer journey? What evolutionary trends are most applicable to the situation? Given what a strategist sees on a trade fare, or finds published or patented by competitors, suppliers or customers: what road is incumbent A or contender B likely to follow?

In our work we see how thorough TRIZ work helps organizations break down such complex setups into manageable pieces of study that can then be used to develop specific strategic options.

We see this article as a first step that provides the practitioner with methods, a roadmap how to proceed, and with practical examples. From a scientific point of view, this article exposes our own informed hypothesis. As one possible next step, the proposed expansion with TRIZ-methods of the disruption model by Adner and Kapoor can be validated with a larger number of case studies, including our own still unpublished work, as they are already or become available in the public domain. We are convinced that the results of such scientific work, based on a large enough sample size, will also allow practitioners to sharpen their own methods, make these more approachable for teams with less TRIZ expertise, and allow for the definition of specific strategies how to deal with multi-technology-multi-agent disruption situations.

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Dr. Phil Samuel is a trusted advisor to C-Level leadership, providing strategic direction to clients across multiple industries on their business transformation journey. Through a portfolio of Strategy, Innovation, Operational Excellence, and Digital Transformation approaches, Phil and his team help solve clients' toughest problems of today while building client teams' capabilities so that they can sustain success and drive change tomorrow. Phil is also dynamic speaker having presented worldwide and an accomplished author whose credits include two books: Design for Lean Six Sigma: A Holistic Approach to Design and Innovation and The Innovator's Toolkit: 50+ Techniques for Predictable and Sustainable Organic Growth. Phil and his team have driven the development of services for identifying growth strategies, facilitating rapid innovation sprints, and bullet-proofing patents.