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# Examination of Altshuller's Trends of Technical System Evolution as a Method to Forecast the Future of Automotive Passenger Vehicles

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# Agenda

Historical Evolution of  
Passenger Vehicles Through  
the Lens of Altshuller's Trends

Altshuller's Trends and  
the System Context

Final Thoughts



Introduction

Case Studies of Automotive  
Successes and Failures

Recommended Application  
of Altshuller's Trends to  
Forecast Future Systems





# 01 Introduction & Definition of Altshuller's Eight Trends



# How's our track record at predicting trends of technical system evolution?



**1876:** *"This 'telephone' has too many shortcomings to be seriously considered as a means of communication."* — William Orton, President of Western Union.

**1889:** *"Fooling around with alternating current (AC) is just a waste of time. Nobody will use it, ever."* — Thomas Edison

**1903:** *"The horse is here to stay but the automobile is only a novelty – a fad."* — President of the Michigan Savings Bank advising Henry Ford's lawyer, Horace Rackham, not to invest in the Ford Motor Company

**1959:** *"Before man reaches the moon, your mail will be delivered within hours from New York to Australia by guided missiles. We stand on the threshold of rocket mail."* — Arthur Summerfield, U.S. Postmaster General.



# Maybe we've gotten much better at it more recently?

**1995:** *"I predict the Internet will soon go spectacularly supernova and in 1996 catastrophically collapse."* — Robert Metcalfe, founder of 3Com.

**2005:** *"There's just not that many videos I want to watch."* — Steve Chen, CTO and co-founder of YouTube expressing concerns about his company's long term viability

**2006:** *"Everyone's always asking me when Apple will come out with a cell phone. My answer is, 'Probably never.'"* — David Pogue, The New York Times.

**2007:** *"There's no chance that the iPhone is going to get any significant market share."* — Steve Ballmer, Microsoft CEO.

# Why is it important to understand trends of System Evolution?



To explain the events of nature in a reproducible way and to use these reproductions to make valuable predictions



To enrich qualitative predictions by quantitative analysis



Understand how systems were invented, developed, and improved over time



To improve consensual vision of decision-makers





# Examples of Forecasting Methods



Delphi  
method



Nine  
Windows



Heuristics  
as a Tool for  
Prediction



Altshuller's  
Trends of  
Technical  
System  
Evolution

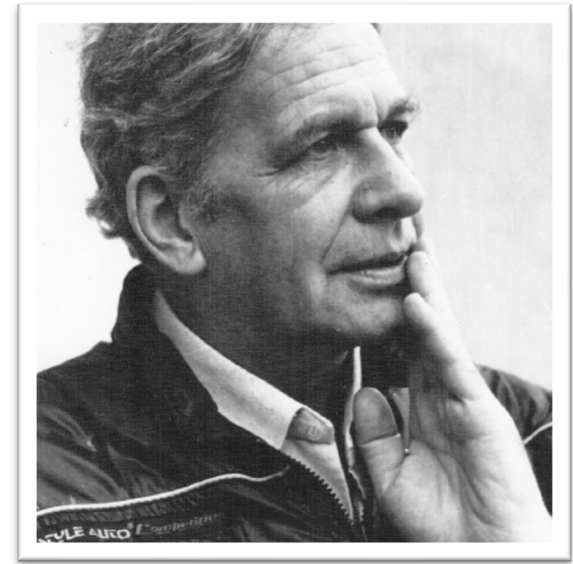




# Who was Altshuller?

**Genrikh Saulovich Altshuller**, was a Soviet engineer, inventor, and writer. He is most notable for the creation of the ***Theory of Inventive Problem Solving***, better known by its Russian acronym **TRIZ**.

- The evolution of any objects of material world, nature, different areas of knowledge, activity and thinking evolves according to certain regularities (trends).
- The trends are of objective nature, expressing actual relationships of things as well as their reflection in the human conscience.
- Trends of system evolution is the basis of TRIZ.
- The first system of trends of technical system evolution was developed by G. Altshuller.
- In 1969 Altshuller published his findings with all 40 TRIZ principles.





# Altshuller's Trends of Technical System Evolution



# Altshuller's Trends of Evolution (*Trends 1-4*)



## TREND 1: Increasing Ideality

Ideality is defined as *"the quality or state of being ideal,"* and Altshuller defined this trend as *"All systems evolve in the direction of increasing ideality"*.



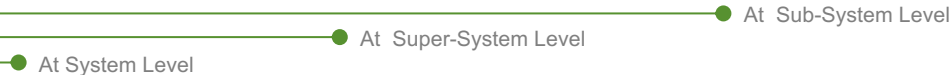
## TREND 2: Following S-Curves

System evolution occurs through different stages, from birth to retirement represented by an "S" Shape. The S-curve can provide details on whether a new system is required because the old system is no longer marketable or maintainable.



## TREND 3: Less Human Involvement

All systems evolve requiring less and less of the human variable, thus freeing humans from repetitive tasks. The essence of this trend is to reduce human labor and errors by introducing a self-dependent system.



## TREND 4: Non-Uniform Evolution of Parts

The parts that make up the system(s) evolve differently and follow their own development patterns and independent S-curves. As each component follows its independent line of development, each one manages to reach its development limits at different times.



# Altshuller's Trends of Evolution (Trends 5-8)



## TREND 5: Simplicity, Complexity, Simplicity

A cyclic repeating pattern of starting simple, increasing complications, and simplifying again. This can apply to systems, subsystems or parts.

- Combining Similar Elements
- Combining Dissimilar Elements
- Transition To Super-System
- Trimming Components While Keeping Functionality

## TREND 6: Increasing Dynamism, Flexibility, and Controllability

Increasing the dynamic capability and flexibility of the system not only allows functions to be performed with greater variability and degrees of freedom but can also improve the system's performance as it becomes more dynamic, adaptive, and adjustable.

- Increasing Controllability
- Increasing Flexibility
- Increasing States

## TREND 7: Increasing Segmentation and Use of Fields

Segmentation refers to dividing a monolithic object or system into separate parts or sections. Eventually, when an object is segmented enough times, its discrete elements will appear so small next to each other that they will generate a field effect as the number of segmentations approaches infinity.

- Object/System Segmentation
- Surface Segmentation
- Space Segmentation
- Actions Segmentation

## TREND 8: Matching and Mismatching of Parts

**Matching** : A product developer changes the system aligning the system outputs with consumer wants to deliver all required functions more effectively. **Mismatching**: The developer does not do what the customer says to improve product performance.

- Geometric Evolution (Line)
- Actions Coordination
- Shortening of Energy Flows
- Geometric Evolution (Volume)

More information on the trends with examples can be found here





02

# Historical Evolution of Passenger Vehicles Through the Lens of Altshuller's Trends





# The process leveraged a local museum

- Visit Henry Ford museum to gather initial dataset and study the architecture and design of vehicles. Over 90 vehicles were studied for the 160-year history of the automotive industry.
- Investigate each decade to see which trends were, and were not observed
- Further investigate decades where trends were not initially observed using other resources



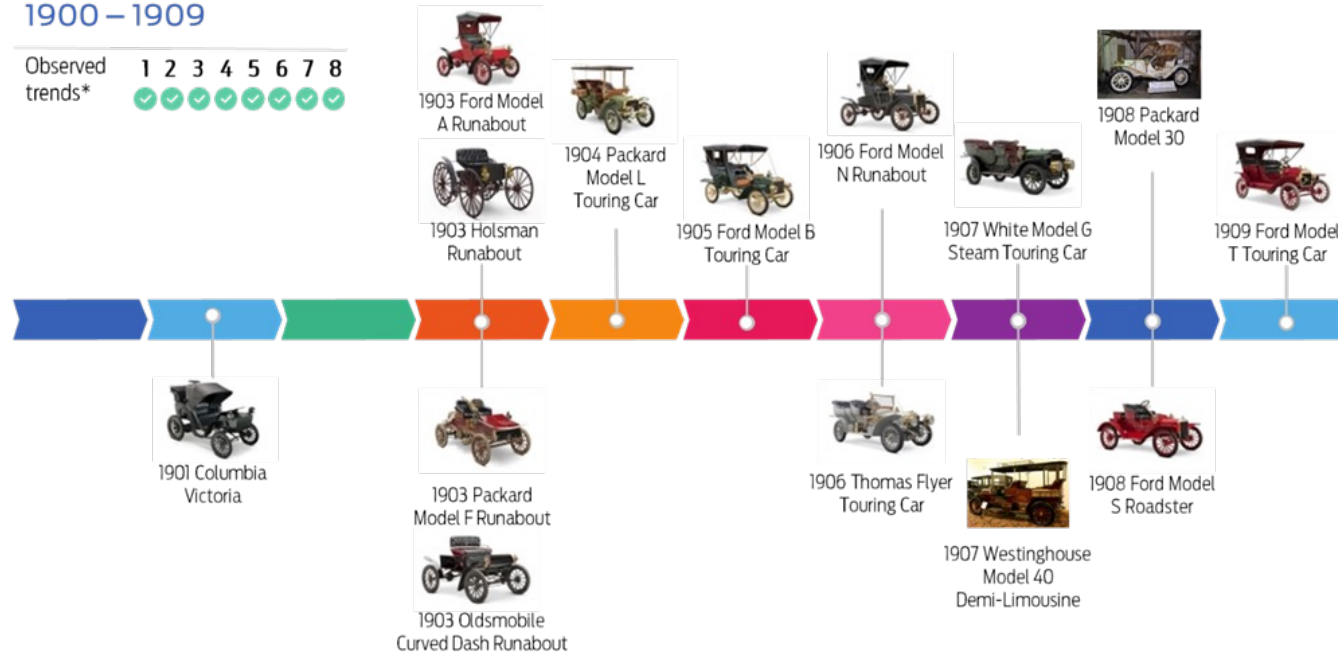
# Example of Historical Evolution Research



1900 – 1909

Observed trends\*

1 2 3 4 5 6 7 8  
 ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓



## \* Trends of Technical System Evolution

✓ Observed

⚪ Partially observed

✗ Not observed

|                                       |                                                       |                                            |                                   |
|---------------------------------------|-------------------------------------------------------|--------------------------------------------|-----------------------------------|
| 1. Increasing Ideality                | 2. Follows S-Curves                                   | 3. Less Human Involvement                  | 4. Non-Uniform Evolution of Parts |
| 5. Simplicity, Complexity, Simplicity | 6. Increasing Dynamism, Flexibility & Controllability | 7. Increasing Segmentation & Use of Fields | 8. Matching and Mismatching       |

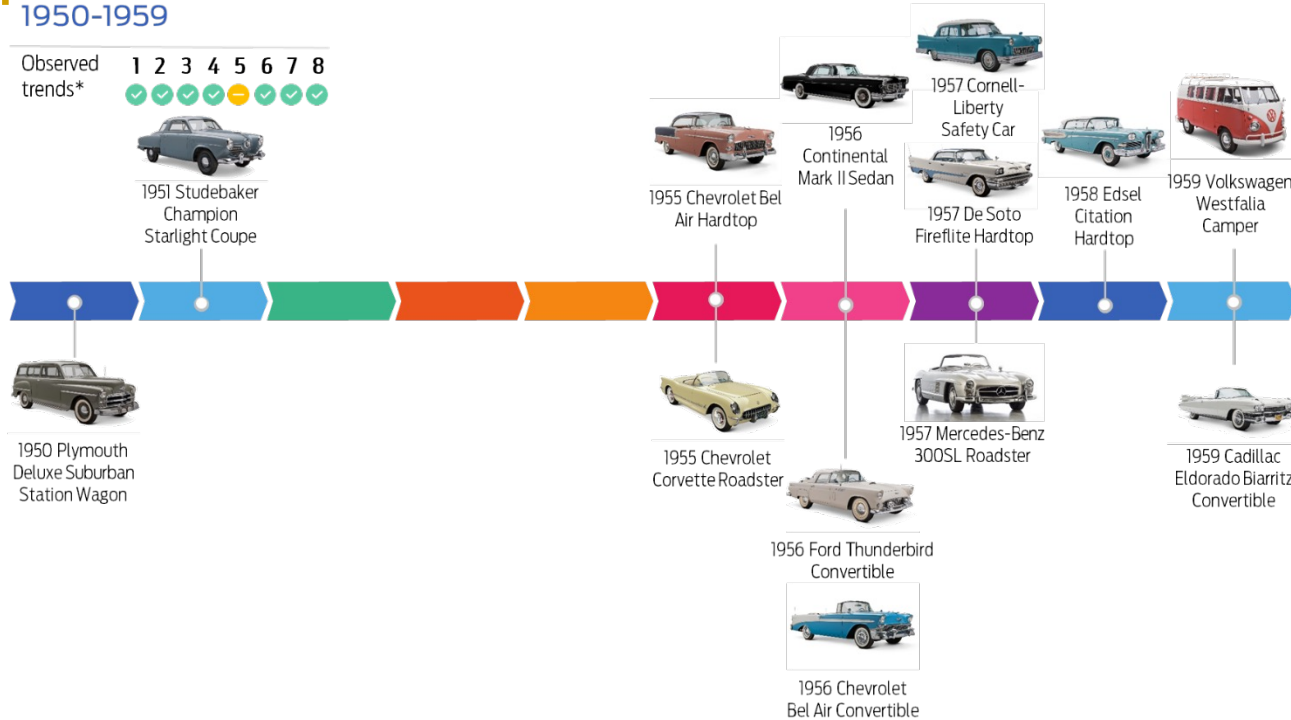
# Example of Historical Evolution Research



1950-1959

Observed trends\*

1 2 3 4 5 6 7 8  
 ✓ ✓ ✓ ✓ - ✓ ✓ ✓



## \* Trends of Technical System Evolution

✓ Observed

- Partially observed

✗ Not observed

|                                       |                                                       |                                            |                                   |
|---------------------------------------|-------------------------------------------------------|--------------------------------------------|-----------------------------------|
| 1. Increasing Ideality                | 2. Follows S-Curves                                   | 3. Less Human Involvement                  | 4. Non-Uniform Evolution of Parts |
| 5. Simplicity, Complexity, Simplicity | 6. Increasing Dynamism, Flexibility & Controllability | 7. Increasing Segmentation & Use of Fields | 8. Matching and Mismatching       |





# Key Takeaways

| Trends<br>Decades | Trend 1 | Trend 2 | Trend 3 | Trend 4 | Trend 5 | Trend 6 | Trend 7 | Trend 8 |
|-------------------|---------|---------|---------|---------|---------|---------|---------|---------|
| 19th Century      | ✓       | ✓       | ✓       | ✓       | ✓       | ✓       | ✓       | ✓       |
| 1900 - 1909       | ✓       | ✓       | ✓       | ✓       | ✓       | ✓       | ✓       | ✓       |
| 1910 - 1919       | ✓       | ✓       | ✓       | ✓       | ✓       | ✓       | ✓       | ✓       |
| 1920 - 1929       | ✓       | ✓       | ✓       | ✓       | ✓       | ✗       | ✓       | ✓       |
| 1930 - 1939       | ✓       | ✓       | ✓       | ✓       | ✓       | ✗       | ✓       | ✓       |
| 1940 - 1949       | ✓       | ⚡       | ✓       | ✓       | ⚡       | ✓       | ✓       | ✓       |
| 1950 - 1959       | ✓       | ✓       | ✓       | ✓       | ⚡       | ✓       | ✓       | ✓       |
| 1960 - 1969       | ✓       | ⚡       | ✓       | ✓       | ⚡       | ✓       | ✓       | ✓       |
| 1970 - 1979       | ✓       | ✓       | ✓       | ✓       | ✓       | ✓       | ✓       | ✓       |
| 1980 - 1989       | ✓       | ✓       | ✓       | ✓       | ✓       | ✓       | ✓       | ✓       |
| 1990 - 1999       | ✓       | ✓       | ✓       | ✓       | ✓       | ✓       | ✓       | ✓       |
| 2000 - 2009       | ✓       | ✓       | ✓       | ✓       | ⚡       | ✓       | ✓       | ✓       |
| 2010 - Today      | ✓       | ✓       | ✓       | ✓       | ✓       | ✓       | ✓       | ✓       |

✓ Observed
 ⚡ Partially Observed
 ✗ Not Observed

The eight trends contextualized with external factors answer the 'How to evolve' and 'Which system or subsystem is critical to evolve' questions.





# 03 Case Studies of Automotive Successes and Failures





# Are the Trends Enough?

Eight Trends



System Context

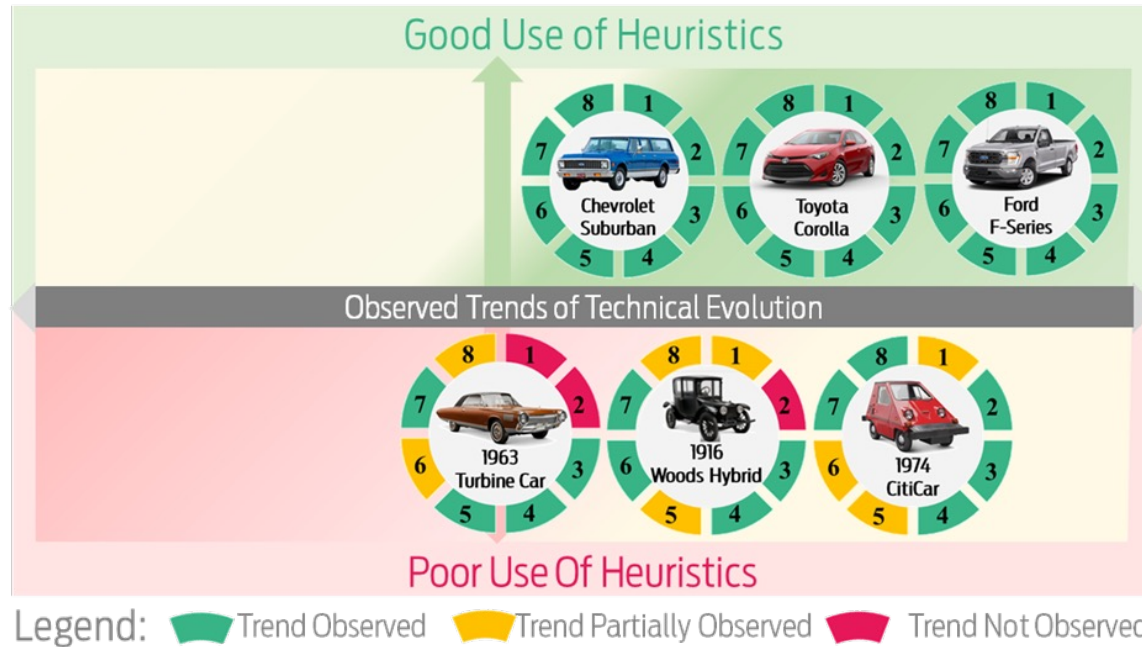


Architecting Heuristics

The goal was to answer this question: By themselves, are the eight laws of technical system evolution enough to predict the development of a successful system? And if not, what else is needed?



# Summary of Case Studies



The differentiators between success and failure appear to be the understanding of the system context, which is necessary to apply the key heuristics, and presenting designs consistent with many system architecting heuristics

# The Role of Heuristics



**Analysis of these six case studies suggest that following heuristics help differentiate success from failure, presuming multiple systems already appear to satisfy Altshuller's trends and appear compatible with the current system context.**

## Cost rules.

Change introduces new forms of failure. If there isn't understanding of the existing system, there can't be assurance of re-architecting a better one.

In introducing technological change, how you do it is often more important than what you do.

Complex systems will develop and evolve within an overall architecture much more rapidly if there are stable, intermediate forms than if there are not.

Build in and maintain options as long as possible in the design and implementation of complex systems. Always have a good plan B, and plan C.

Try to hit a solution that, at worst, won't put the business under.

Success is defined by the beholder, not the architect. The customer defines success. Build trust with your customers; it is a necessary prerequisite for innovation.

Listen closely to what the customer perceives as his requirements and to have the will and ability to be responsive.

It is sometimes more important to know who the customer is than what the customer wants.

The most dependable, highest quality, lowest cost subsystem is the one that does not exist.

A good design has benefits in more than one area.

The first line of defense against complexity is simplicity of design. The eye is a fine architect.

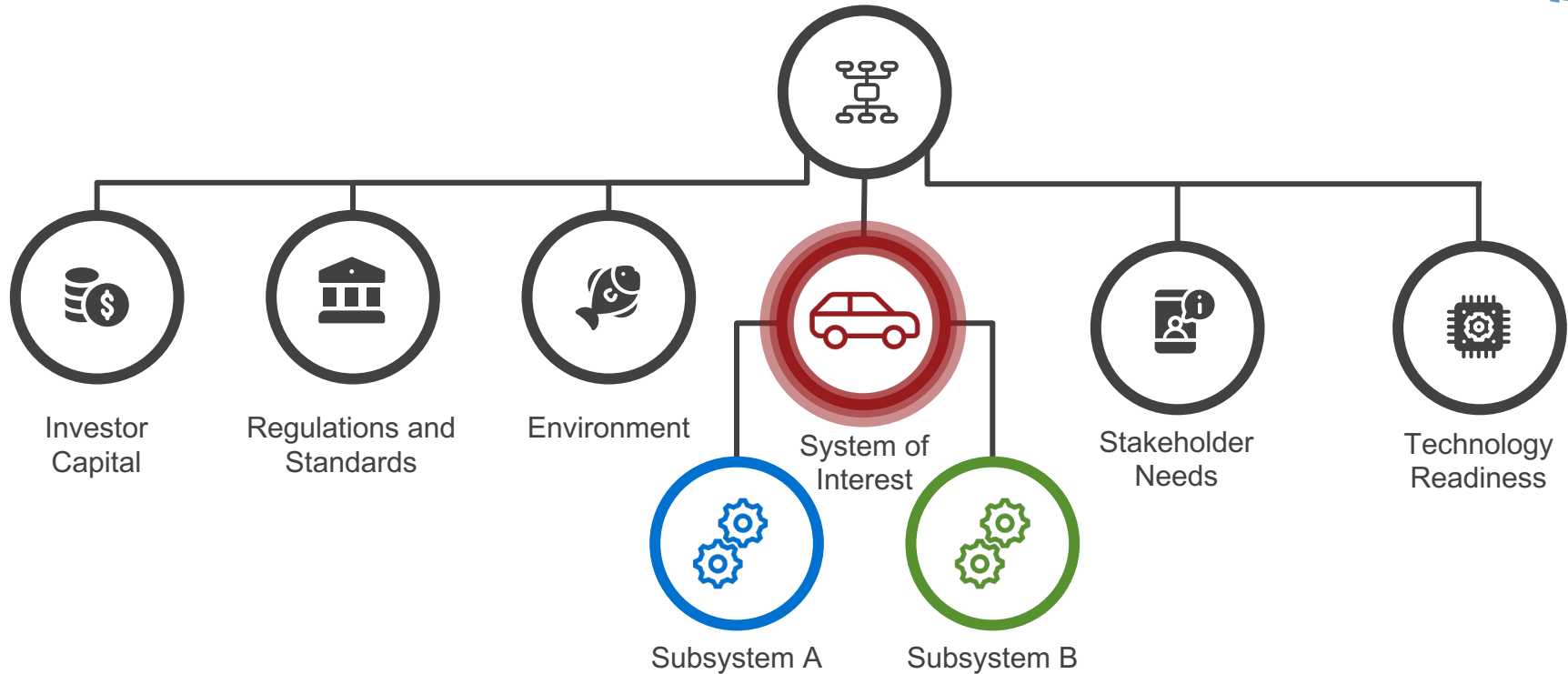
No complex system can be optimal to all parties concerned, nor all functions optimized.



# 04 Altshuller's Trends and the System Context



# System Context



The system context describes the portion of the environment that directly influences the system of interest, but is distinctly outside of the system's boundary



# 06 Final Thoughts



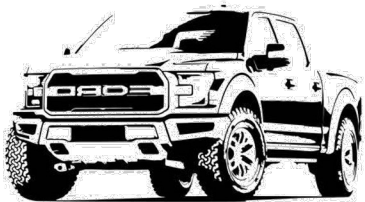




If you want to make better trend predictions, we recommend three key aspects to your approach

**Altshuller's Eight Trends of Technical System Evolution**  
*which are necessary conditions for system evolution*

1



2

**Prescriptive Architecting Heuristics**  
*that meet Eberhardt Rechtin's five characteristics of good heuristics*

3

**A Keen Understanding of the System Context**  
*and a thorough definition of external interfaces with the product or system of interest*



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