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Role of Digital Twin in Manufacturing Motor Vehicles

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***Abstract*: Digital twin simulation has many applications, but one of the most important applications is in automotive industry. It helps in fleet management, cost management and most importantly increases the operational efficiency of the physical asset. The data from the previous asset's life cycle is also important for the current asset to be efficient. There are many challenges faced by the automotive industry for which digital twinning might be a solution.**

***Keywords*: Simulation, Artificial Intelligence, Data, IoT**

1. Introduction

A digital twin is basically the virtual counterpart of a physical asset. It increases the operational efficiency of its physical counterpart by using real-time data. To develop a digital twin, the modeling basically includes data-driven analytics along with multi-physics knowledge.

The automotive industry involves all the organizations that manufacture a variety of motor vehicles from automobile to rockets. The lines between the physical and digital world is blurred by advanced technology extending the life of fleet of vehicles, aircraft and rocket operators mainly using digital twin to determine the life of the structural components. By creating a digital twin, insights about how to improve operations, increase efficiency or discover an issue are all possible before it happens to whatever it's duplicating in the real world. The data which we get from the digital twin can then be applied to the physical asset with much more return on investment and much less risk.

[2] doesn't talk about the challenges faced by the automotive industry and the use of digital twin simulation in resolving the issues. This paper focuses on the challenges that can be resolved using digital twin technology. This technology is appropriate in today's world because demand for vehicle is increasing and using digital twin to simulate the asset before the production will not only increase its operation value but will also increase its cost efficiency.

This paper contains various sections that cover different topics concerning Digital Twin in the automotive industry. Section I talks about the Introduction which provides basic introduction to Digital Twin and basic information of how it is used in automotive industry while Section II talks about the role of Digital twin in automobile, aviation and in rocket science. Section III talks about the challenges faced by the automotive industries and how it can be resolved using Digital Twin and Section IV talks in depth about what the future holds for Digital Twin simulation in the automotive industry and how it can be improved in the future.

2. Role of digital twin in automotive industry

A. *Digital twin application in automobile sector*

In a world where AI is taking more control in human decision making, systems supported by digital twins can prove game-changing for the automotive industry [1]. Digital Twins are key to the long-term success of autonomous vehicles in the future.

Automobile sector uses digital twin for simulation of vehicles. They can capture the behavioral and operational data of the vehicle and analyze the overall vehicle performance, delivering a personalized service for customers.

B. *Digital twin application in aviation sector*

Aviation sector uses digital twin for the virtual replication of airplane parts which holds an important value. Boeing, for instance, achieved up to a 40% improvement in first-time quality of the parts and systems it uses to manufacture commercial and military airplanes, while GE Aviation brought 15 years' worth of data to life as a result of digital twin technology [2]. IFS customer TEST-FUCHS is already seeing the real benefits. The data that is generated from each asset's life cycle is quite useful. This enables the company to build an enterprise-wide picture of their business processes to put the digital twin strategy into action.

Aircraft maintaining cost is quite high and is one of the highest among the aircraft operating costs. It is also critical to maintain aircrafts in order to deliver a good customer experience – customer satisfaction nosedives when flights need to be delayed or canceled owing to unplanned maintenance.

C. *Digital twin application in rocket science*

NASA used what it then called pairing technology to replicate the rockets in places which is out-of-reach for us.

These were one of the first uses of digital twin simulation. This complete 360° digital representation of a physical asset is mostly used in the industrial space. Soon, they will be more widespread in verticals from food and beverage to retail and healthcare.

As a virtual instantiation of a flying vehicle, the Digital Twin is expected to be able to experience every event that its flying twin experiences. Because of its ability to mirror the life of a specific vehicle in an as-built state, the Digital Twin will necessarily revolutionize certification, fleet management and sustainment [3]. It will also decrease system weight by reducing reliance on statistical distributions of material properties, heuristic design philosophies, physical testing and assumed similitude between testing and operational conditions. Once the vehicle is launched, the Digital Twin will increase the reliability of the flying vehicle because of its ability to continuously monitor and mitigate degradation and anomalous events. Additionally, it will enable mission managers to make knowledgeable decisions regarding the consequences of possible in-flight changes to a vehicle's mission [4].

3. Discussion

A. *Challenges faced by Automotive Industry*

Table 1
Challenges faced by automotive industry

S. No.	Challenges	Solutions for Digital Twin
1.	Designers need to deal with the variety of data which is scattered across the organization. Integration of information from previous generation vehicles (customer usage of features, feedback, failures) is missing.	Digital twin can potentially integrate all the data between previous generation vehicles and current vehicle concept in its digital model.
2.	Refinement of product design involves multiple iterations of simulation tests which is time consuming and often lacks comprehensive coverage of real environment conditions.	Digital twin is expected to hold the complete data of product lifecycle.
3.	It is too late a stage for the company to work retrospectively, if they need to accommodate any major change in the design.	Digital twin can potentially integrate all the data between previous generation vehicles and current vehicle concept in its digital model.
4.	There is a skilled labor shortage in manufacturing sector.	Digital twin is already seeing large deployments in training the workforce by providing real-time, on-site, step-by- step visual guidance on tasks such as product assembly, component design, machine operation, etc.

B. ***Future Scope***

The next step would be setting up a system for the data to automatically be transmitted back to the manufacturer. The manufacturer can analyze the data and perform predictive analysis to help make driving experiences smarter and safer for car owners. Engineers are also able to predict performances of products within large systems such as; an individual wing on a plane, a rocket engine launching, an office building maintaining energy through the day, A race car engine which is about to burn, or even a driverless car navigating the road during rush hour can create a digital twin of every single autonomous vehicle it sells, enabling them to analyze how a car performs in its physical environment, and track the vehicle from its creation to the day it goes to the junkyard. Much of the sensor infrastructure is already in place in newly released vehicles with them containing up to 100 sensors monitoring critical systems. This data can be combined with design information so predictive analysis can be implemented. An example of where this could be useful is for the modeling and monitoring of airbag systems. Defects would be spotted far sooner, and many potential injuries would be avoided.

While being highly intelligent, digital twins are not fully autonomous and will require human intervention – we have come to this conclusion after executing a few studies at Challenge Advisory that helped us realize this. The manual testing of new features and modifications of physical assets through virtual replicas are a example. AI, while not necessarily providing more intelligence than humans, is certain to boost skills by implementing more efficient and productive analysis. While the automotive industry has the relevant processes to move towards further implementing digital twins, they will still need the ability to include individually derived data.

4. Conclusion

Digital twins can offer improvements to fleet life management of civil aircraft and vehicles and rockets used by NASA, ISRO, etc., but the cost-to-benefit ratio is an important consideration. Understanding the end-goal is useful to help define the steppingstones to achieve this and generate value in the process.

With the advancement in the technologies and features used in automotive, the vehicles are becoming more and more vulnerable to failures and high cost development and maintenance is required by the manufacturer to bear. Digital twin simulation before the manufacturing greatly reduces the cost and increases the operational and life management efficiency.

Even though the use of digital twin simulation for vehicle manufacturing is at its peak, more developments and advancements must be made to implement all the functions that the vehicle performs in the real life. Digital twin must be well integrated with IoT, AI and machine learning technology for error-free simulation.

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