

A Digital Twin in Aviation: The Creator Paradox

1.1 Introduction: The Beginning of The End

A digital twin, DT, is a virtual model of any physical entity. The virtual and physical entities are connected to each other through data exchange in real time. The DT mimics the physical system hence why it is sometimes referred to as a virtual twin, Singh et al. [1]. The PhD sits within the AVATAR project, which is a European Union, EU, led initiative. The funding is provided by the European Climate, Infrastructure and Environment Executive Agency, CINEA, and by the United Kingdom Research and Innovation, UKRI [2]. The overall objective of the PhD is to develop a DT model that is capable of predicting the structural response of an aeroplane wing due to aerodynamic loading, SIHM Imperial [3] [4]. The main novelty of the work is that AI-driven methods will be used. The narrative of this essay begins from scripture in the book of Genesis and concludes in the book of Revelation. The essay follows a two-fold mission approach: from Christ to our studies. This framework was developed by the International Fellowship of Evangelical Students, IFES [5], based in Europe. The remainder of this essay follows a similar structure to that of creation as proposed by Roberts in God's Big Picture: A Bible Overview [6].

1.2 Scripture-based Narrative

1.2.1 The Creator: God

The AVATAR project looks to create a DT model to be used for the design of future and greener aviation, AVATAR [2]. This is the main project aim, and in scripture we start from the book of Genesis. In the beginning God created the heavens and the earth. The earth was without form, and void; and darkness was on the face of the deep. And the Spirit of God was hovering over the face of the waters. Then God said, "Let there be light"; and there was light (Genesis 1:1-3, NKJV). This DT will involve the continuous monitoring of, Transformative Air Vehicle, TAVs, during the entire operational lifetime and this will be done through an innovative smart, Internet of Things, IoT, sensing skin. The TAVs are provided by the industrial partners; Evektor, EVE, and Nordic Wing, NW; AVATAR [2]. EVE's Cobra is a small and conventional propeller-powered aeroplane [7]. On the other hand, NW's Astero is less conventional, electric and unmanned [8]. The key, or rather light, is that this DT will be informed by accurate physics-based models derived from both experimental and computational work, AVATAR [2]. This work will be similar to that conducted by Makuni et al. and Kalsi et al. at the University of Cambridge from 2014, [9] [10] and [11] respectively. The advanced analytics will make use of big data, Cyber-Physical Systems, CPS; machine learning, ML; and artificial intelligence, AI, AVATAR [2]. In many ways this is applying a methodology that has successfully worked in a previous project to this project. This parallels with John in the New Testament, NT, who restates what was written in the Old Testament, OT, in the book of Genesis when he says: In the beginning was the Word, and the Word was with God, and the Word was God. All things were made through Him, and without Him nothing was made that was made. In Him was life, and the life was the light of men. And the light shines in the darkness, and the darkness did not comprehend it (John 1:1-5, NKJV). This methodology has already produced light, or rather has bore fruit in the past; hence the same methodology can bear fruit again, but only if applied correctly.

1.2.2 Mankind and The Fall

We are all made in the image of God; Lennox [12] and Helms [13]. Following the creation of the heavens and the earth, God created mankind. Then God created man in His own image; in the image of God He created him; male and female He created them. Then God blessed them, and God said to them, "Be fruitful and multiply; fill the earth and subdue it; have dominion over the fish of the sea, over the birds of the air, and over every living thing that moves on the earth." (Genesis 1:27-28, NKJV). The outputs of AVATAR are synonymous

to the project bearing fruitful. The primary outputs of the AVATAR project are as follows. First, reduced direct operative costs. Second, extended service life of TAVs. Third, an increase in safety of urban skies. The secondary outputs of the AVATAR project are as follows. First, the development of predictive maintenance concepts. Second, early-stage warning of behaviour that deviates from expected operating behaviour. Both will contribute significantly towards sustainable air mobility; AVATAR [2]. There are, however, caveats to these outputs that are deceiving, that if not correctly identified, will ultimately lead to failure. Here, failure could be described as darkness that is referred to in John 1:5, NKJV. The deceptive nature of these caveats could be seen as analogous to the serpent that is first introduced in the book Genesis, and that later reappears in the book of Revelation. Now the serpent was more cunning than any beast of the field which the Lord God had made (Genesis 3:1, NKJV). That serpent of old, called the Devil and Satan, who deceives the whole world (Revelation 12:7, NKJV), deceived Adam and Eve, resulting in the original sin and the reason for the broken and suffering world we live in. The caveats for the project outputs as stated in the AVATAR [2] proposal will now be explained. By recording the actual load spectrum that each TAV experiences during every flight, the individual service life can be optimised. However, if this is not conducted correctly, the service life predictions will be incorrect which can lead to unexpected failure of the TAV during service. Further still, although there is potential to optimise the design and performance of each individual TAV by using this real load data; again, if incorrect, the calculations can lead to in service TAV failure. The final caveats present themselves in the two capabilities of AVATAR's IoT sensing skin. The first capability being the development of a real-time data acquisition system for the TAV during live operation. The second capability being reliable connectivity between the physical TAV, and its virtual counterpart. This connectivity can be achieved using a combination of wired and wireless data communication and transmission. If conducted correctly, the project could see the seamless integration of recent digital revolutions. These digital revolutions are namely new concepts such as IoT, CPS, ML and AI. However, the way this large data is collected and processed is subject to, General Data Protection Regulation, GDPR rules. The rationale behind processing and using this data should not be negatively biased, else the prediction of the TAVs health could lead to unrealistic results and unwelcome consequences, again potentially leading to failure.

1.2.3 Jesus Christ and Salvation

For God so loved the world that He gave His only begotten Son, that whoever believes in Him should not perish but have everlasting life (John 3:16, NKJV). Jesus proclaimed, "I am the way, the truth, and the life. No one comes to the Father except through Me (John 14:6, NKJV). This is the good news, and in a similar way, AVATAR comes with some good news for all partners involved. AVATAR will validate the effectiveness of its innovative technologies through wind tunnel testing, computational modelling, and real flight test data. A key benefit for the industrial partners is that they will gain a deeper understanding of their TAVs. On a consortium level, the project contains a good balance between industrial partners, EVE and NW; research institutions, Nippon Telegraph and Telephone Corporation, NTT, and Danish Technological Institute, DTI; and leading European universities; Imperial College London, ICL, Loughborough University, LBORO, and University of Luxembourg, UL, AVATAR [2]. A key benefit of collaborating in a network this diverse is that it allows for diversity of thoughts and ideas. This then renders communication as paramount, especially in a multi-cultural European setting. An analogy can be made between effective communication and the importance of prayer. Prayer allows us direct communication with God our Father in heaven, the more we understand God's will, the more effective our prayers become; Pelser [14]. For this project to be successful, all partners must communicate effectively with one another. This will involve learning, but also teaching one another. Even in the Holy Bible Jesus Christ a great example of being a good teacher. A well-known example being that he taught His disciples how to pray. Now it came to pass, as He was praying in a certain place, when He ceased, that one of His disciples said to Him, "Lord, teach us to pray, as John also taught his disciples." (Luke 11:1, NKJV). Jesus taught them the Lord's prayer (Luke 11:2-4, NKJV and Matthew 6:9-13, NKJV). Here we can see the humbleness and confidence of Jesus Christ our

Saviour. Today there are numerous tools that we can use to aid us with confidence during evangelistic work. However, it is important to be humble and to stay true the good news of the gospel, Bannister [15] and Monks [16]. There was also a clarity in Jesus' teachings and His words, Ward [17]. A famous statement that demonstrates this can be found in the book of Revelation when He said: "I am the Alpha and the Omega, the Beginning and the End," says the Lord, "who is and who was and who is to come, the Almighty." (Revelation 1:8, NKJV).

1.2.4 Jesus Christ and Redemption

Through the birth, death and resurrection of his Son, Jesus Christ; the Bible also affirms our two corporate identities: We are 'in Adam', and we are 'in Christ'. This relationship is explained clearly in an article by Cornwell [18]. The summary is this: Adam was disobedient and sinned, and similar to Adam; we are sinful in nature. On the other hand, Jesus Christ was obedient, and He did not sin. Instead, He paid the debt for all of mankind's sin by His death on the cross. The death on the cross was justification for all sin, and the following this, sanctification is required by all believers. This calls to be followers of Jesus, and for us to live Christ-like lives. Within AVATAR, if the project is executed correctly and in moral alignment with the Holy Bible, there is the potential for substantial contributions to the development of sustainable future TAVs, AVATAR [2]. A significant consequence of the project is that it will conform to the modern approaches and methods for creating a DT during in this age of digital revolution. A powerful and important point regarding digital twinning, is that it removes the need to perfectly understand a system to obtain a meaningful output. It is feasible for one to only understand the inputs and outputs of the black box well, and not exactly what is happening inside the black box, Makuni [19]. This is because by using some of these new techniques – examples include IoTs, CPS, ML and AI – a virtual model that mimics the physical asset can be built, without the need to understand the system fully and deeply. Returning to our two-fold mission approach, from Christ to our studies. Therefore, as through one man's offense judgment came to all men, resulting in condemnation, even so through one Man's righteous act the free gift came to all men, resulting in justification of life. For as by one man's disobedience many were made sinners, so also by one Man's obedience many will be made righteous (Romans 5:18-19, NKJV). This means that through our work and studies, we can point to Christ. Even by simply producing good work, as Christians we can bear witness to Christ; IFES [5] and Hobday [20]. As the project is fully funded by CINEA and UKRI; the outputs of the project will present themselves as free gifts to the field of aviation and wider society in general through the discovery of new knowledge, information and wisdom.

1.3 Conclusion: The End of the Beginning

As it is written in the book of Matthew. And you will hear of wars and rumors of wars. See that you are not troubled; for all these things must come to pass, but the end is not yet (Matthew 24:6, NKJV). And as it was revealed in the book of Revelation. And I saw the dead, small and great, standing before God, and books were opened. And another book was opened, which is the Book of Life. And the dead were judged according to their works, by the things which were written in the books (Revelation 20:12, NKJV). But now having been set free from sin, and having become slaves of God, you have your fruit to holiness, and the end, everlasting life (Romans 6:22, NKJV). The creation of a DT that looks to mimic the structural response to realistic aerodynamic loading on an aeroplane wing, will not result in a never-ending and eternally-lasting product. Instead, it will increase the lifetime of this product, in new and innovative ways. Leveraging the use of AI-based techniques in this current digital revolution could effectively lead to significant market growth and dominance. For example, if executed appropriately, this PhD could see similar levels of success to that of the Rolls-Royce rig used to study jet engine intakes at incidence designed Makuni et al. [9] [10] and Kalsi et al. [11] as mentioned earlier. However, if executed inappropriately, AVATAR could see the failure of TAVs in service, potentially leading to the loss of human life, such as EVE's crash in 2021 [21], and that is far more detrimental.

References

- [1] M. Singh, E. Fuenmayor, E. Hinchy, Y. Qiao, N. Murray and D. Devine, "Digital twin: Origin to future," *Applied System Innovation*, vol. 4, no. 2, p. 36, 2021.
- [2] AVATAR, [Online]. Available: www.avatar-project.eu/consortium.
- [3] SIHM Imperial, [Online]. Available: www.imperial.ac.uk/structural-integrity-health-monitoring/research-projects/avatar-project.
- [4] SIHM Imperial, [Online]. Available: www.imperial.ac.uk/structural-integrity-health-monitoring/people.
- [5] IFES, [Online]. Available: www.goodnewsfortheuniversity.org.
- [6] V. Roberts, "God's big picture: Tracing the storyline of the Bible," InterVarsity Press, 2012.
- [7] Evektor, [Online]. Available: <https://www.evektor.com/aircraft/aircraft>. [Accessed 08 01 2025].
- [8] Nordic Wing, [Online]. Available: <https://nordic-wing.com/product>. [Accessed 08 01 2025].
- [9] T. Makuni, H. Kalsi, P. Tucker and H. Babinsky, "Transitional Shock-Wave/Boundary-Layer Interactions in Intakes at Incidence," in *Symposium on Field of the Research Unit 1066*, 2014.
- [10] T. Makuni, H. Babinsky, M. Slaby and C. Sheaf, "Shock Wave-Boundary-Layer Interactions in Subsonic Intakes at High Incidence," in *53rd AIAA Aerospace Sciences Meeting (0067)*, 2015.
- [11] H. Kalsi and P. Tucker, "Numerical modelling of shock wave boundary layer interactions in aero-engine intakes at incidence," vol. 50985, American Society of Mechanical Engineers (ASME), 2018, p. V001T01A019.
- [12] J. Lennox, "Seven days that divide the world: The beginning according to Genesis and science," Zondervan, 2021.
- [13] W. Helms, "Blowing Clover, Falling Rain: A Theological Commentary on the Poetic Canon of the American Religion," Wipf and Stock Publishers, 2020.
- [14] J. Pelser, "Silencio: The Inner Journey," Google Books, 2023.
- [15] A. Bannister, *How to Talk about Jesus Without Looking Like an Idiot: A Panic-free Guide to Having Natural Conversations about Your Faith*, Inter-Varsity Press, 2023.
- [16] A. Monks, *The Now Generation: "Empowering people to lead and have influence today*, InterVarsity Press, 2023.
- [17] T. Ward, *Words of life: Scripture as the living and active word of God*, InterVarsity Press, 2009.
- [18] S. Cornwall, "Identity and Personhood "in Adam" and in Christ: Sexuality, Agency, Choice, Sin and Desire," 2024.
- [19] T. Makuni. [Online]. Available: www.eyecoonline.medium.com/exploring-lean-frontiers-380fc179faa2.
- [20] P. Hobday, "Richard Hooker and Mission and Ministry in Covenant," *Journal of Anglican Studies*, vol. 18, no. 2, pp. 215-234, 2020.
- [21] Aviation Safety Network, "An Exclusive Service of Flight Safety Foundation," [Online]. Available: <https://asn.flightsafety.org/wikibase/267138>.