

WEEK 1: What is a Model? Project Template

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Write a ~ 500-word response on the role that models played during the STS-107 mission and in the post-accident investigation. Word count suggestions have been included, but you do not need to feel constrained by them. Although you will input your replies into the course page, the course team recommends drafting your responses in this document.

In your response, please address the following questions:

- A.** How would you categorize the model(s) used in the report section assigned with respect to what you have learned about the taxonomy of models (physical, mathematical, etc.)? (100 words)

- B.** Based on what you have learned about model credibility and fidelity, where do you think the various models used for the STS-107 should reside in the 2x2 matrix of model confidence and model fidelity? (100 words)

- C.** How do you think the models affected the decision to continue flying the Space Shuttle after Columbia? (100 words)

- D.** How does this relate to the situation in your firm? In particular, how do models affect the decision-making process in your organization? Be sure to mention a model, its taxonomy, and how the model was used in a decision-making process in your organization. (100 words)

- E.** Choose a specific model you have seen within your firm. How does your organization perceive the model in terms of credibility and fidelity? Grade the model on the 2x2 matrix. (50 words)

Essay: The Role that Models Played During the STS-107 Mission and in the Post-accident Investigation

The purpose of this essay is to describe how models influenced the decisions taken during the STS-107 Mission and in the post-accident investigation. The essay will concentrate in the Accident Investigation Report, Section 3.4: Image and Transport Analyses for the discussion.

A. How would you categorize the model(s) used in the report section assigned with respect to what you have learned about the taxonomy of models (physical, mathematical, etc.)? (100 words)

The first thing to point out are the models used in the report section. The models listed below aided in determine the cause of the accident:

- *Computer-Aided Design (CAD) model* to define the potential impact area. This mathematical model based on simulation used still and motion images to determine the area of impact on the Columbia's left wing as well as the possible trajectory of the foam that impacted with the wing.
- *Foam Speed and Volume model* to determine the speed and volume of the foam piece. This mathematical model based on computer simulations detailed the speed and volume estimations of the foam before and after the impact.
- *Computational Fluid Dynamics (CFD) model* used to determine the foam path. This mathematical simulation model uses fluid equations (in a program called CART-3D), to determine the possible path that the foam piece took after becoming detached.
- *Ballistic model* was used to determine the foam ballistic coefficient. Computer analysis was used to determine the appropriate ballistic properties of the foam piece.

B. Based on what you have learned about model credibility and fidelity, where do you think the various models used for the STS-107 should reside in the 2x2 matrix of model confidence and model fidelity? (100 words)

Now that the models have been identified, it is necessary to determine how credibly and the level of fidelity of some of these models:

- *Computer-Aided Design (CAD) model*: This is a low fidelity, high confidence model. This model was developed in combination with images captured during the event. Even though the model image were not of high resolution and with the knowledge of uncertainty in the data, the team deemed this model adequate and trusted the results.
- *Foam Speed and Volume model*: This is a high fidelity, low confidence model. The team's calculations during the mission and after the investigation for speed and volume were relatively close. However, the team didn't fully believe this data due to a lack of high-quality visual evidence.
- *Transport CFD & Ballistic model*: This is a low fidelity, low confidence model. The reason for this is twofold: (1) the low fidelity low trust on the data and the evidence used – it was difficult to determine the size and shape of the foam piece; and (2) the need for independent ballistic analysis to corroborate the results of the ballistic coefficients.

C. How do you think the models affected the decision to continue flying the Space Shuttle after Columbia? (100 words)

It is noticeable that some of the models used to determine the state of the Space Shuttle were of low confidence, this is due because the data relied on low-resolution images and computational analysis that couldn't be guaranteed because of the size characteristics of the foam piece. The uncertainty in quantifying the damage is evident in the report. For instance, the relative velocity of the foam debris

was in a range from 625 ft/s to 849 ft/s. Similarly, the foam size and ballistic information were almost impossible to determine with a high level of confidence. In addition, the models did not confidently describe which areas of the wing were damaged leading the team to make decisions based on Engineering judgment alone.

Based on the provided recommendations, it is obvious that the investigation team want to obtain high-resolution images when providing input to their models. This suggests that the models in future missions would have a higher degree of fidelity and trust.

D. How does this relate to the situation in your firm? In particular, how do models affect the decision-making process in your organization? Be sure to mention a model, its taxonomy, and how the model was used in a decision-making process in your organization. (100 words)

In the automotive industry, there are several models that influence architectural decisions and provide a large amount on flexibility when making decision. Vehicle dynamic mathematical models are a great example of this. My company runs software-based simulations to determine the correct chassis architecture for a vehicle. For a given vehicle architecture; these models typically simulate loads under different conditions that help the Engineers understand how the vehicle will ride and how comfortable the vehicle would be for a passenger.

The models used at my company also help to reduce the cost of validation testing. We use models and simulations to test several software features before they go into a real vehicle. This allow us the opportunity to test different parameters in a safe environment.

E. Choose a specific model you have seen within your firm. How does your organization perceive the model in terms of credibility and fidelity? Grade the model on the 2x2 matrix. (50 words)

One of the most utilized models in my company are Chassis Control Systems models. These are a combination of mathematical and simulation models that generate the right vehicle response when an operator simulates an input on the steering wheel or the accelerator or brake pedals. These models are of high fidelity and high credibility because they follow the laws of physics and they have been fully verified and validated using real vehicle data.