Luis E. Alvarado
Modeling and Simulation Experience plus some additional information.

1.- Developed a mathematical model for an Optical Scoring System named TRISS (Tactical Range Infra-Red Scoring System). TRISS integrates long-range infrared sensors and long-range laser spot images to produce a tactical scoring system with advanced day and night infrared, laser spot, and visible light cameras. The theoretical model was developed using a 4th generation data analysis tool named MATLAB. The theoretical model was used to predict the system scoring accuracy under different operational configurations such as number of optical cameras, position of cameras, target position and speed, and optical resolution.

2. Developed a theoretical model for the Distance Measuring Equipment (DME) Navigation Subsystem used by the Drone Formation Control System (DFCS) at White Sands Missile Range. DFCS uses the DME based navigation system to track the position of aerial and ground targets and estimate their velocity. The mathematical model was used to predict the accuracy of the system under different test configurations and mission scenarios. The variables were target position, velocity, acceleration; number of DME station and their locations; accuracy of DME equipment.

3.- Developed linear model for the QF-106 drone aircraft. The theoretical model included the development of a Small Perturbation model that represented the aircraft dynamics linearized about some operating condition or “flight regime”, in which it is assumed that the aircraft velocity and attitude are constant. The linear models were then used to evaluate the stability and controllability margins of different autopilot designs including an adaptive autopilot.

4.- Developed system identification algorithms (i.e. an intelligent agent) capable of estimating changes in aircraft dynamics in real time. A recursive Least-Squares system identification method was used for this purpose. This intelligent agent was used to rectify and correct available aircraft aerodynamic data and to develop and adaptive autopilot for the QF-106 drone aircraft.

5. Developed a real-time 6 degree of freedom simulation model for the QF-106 drone aircraft. I have also integrated other aircraft simulators into the Drone Formation Control system including simulations for the full scale QF-4 target and the subscale targets MQM-107 and BQM-34. The simulation models were coded using FORTRAN language.

ADDITIONAL NOTES:
System identification is one of the most important concepts in Simulation Modeling. It deals with the problem of building mathematical models based on the observed data from the system. The construction of a model from observed data involves three basic entities (1) The data, (2) A set of candidate models and (3) A rule by which candidate models can be assessed using the data. The system identification procedure picks the best model within the chosen model structured. The crucial question is whether this “best model” is “good enough”. This is the problem of model validation. The question has several aspects; (1) Does the model agree sufficiently with the observed data, (2) Is the model good enough for my purpose and (3) Does the model describe the “true” system.

The following lists describes some of the techniques that I have utilized for discarding parametric based models, as well as for developing confidence in them:

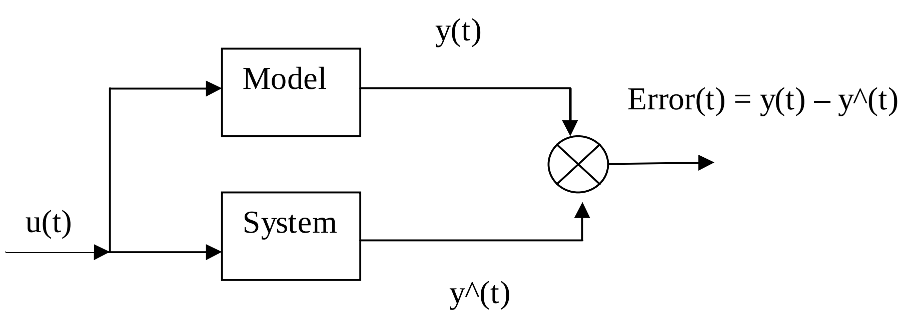
<u>(a) Model Validation with respect to the purpose of modeling</u>
Is the model god enough to satisfy its original purpose. A more reliable aircraft simulator is needed to develop and autopilot than one designed for pilot training.

<u>(b) Feasibility of Physical Parameters</u>
For a model structure that is parameterized in terms of physical parameters, a natural and important validation is to confront the estimated values with what is reasonable from apriori knowledge. It is also a good practice to evaluate the sensitivity of the input-output behavior with respect to these parameters to check their practical identifiability.

<u>(3) Model Reduction</u>
If the model can be reduced without affecting the input-output properties much, then the original model was unnecessarily complex.

<u>(4) Parameter Confidence</u>
This is done by computing standard deviation for each parameter. The larger the standard deviation is the lower its confidence level is. If the confidence level is close to zero the parameter should be removed.

<u>(5) Simulation</u>
A commonly applied procedure that can regarded as a test the model's validity is to simulate the system with the same input you provide to the real system and compare the simulated output with the output measured from the real system as depicted below:



6. Developed very simple theoretical models of small trucks, 5-ton trucks and some tracked vehicles such as the T-72 and BMP tanks. The models were developed using both MATLAB and SIMULINK. The models were used to develop a real-time 2-DOF simulations models for the WSMR Ground Vehicle Target Control Subsystem (GVTCS) . The SIMULINK models were also used to test GVTCS onboard control laws as well as the ground based navigation control system. The 2DOF simulation was developed in "C" language.