CLAIMS

1. An additive manufacturing apparatus, comprising:

(i) a printer that additively manufactures structures for a vehicle;

(ii) a plurality of analysis components, each analysis component being configured to receive information based on a design model of the vehicle and to analyze the information based on an analysis factor, wherein each analysis component analyzes the information based on a different analysis factor than the other analysis components; and

(iii) an integrator that receives the analyzed information from the analysis components, updates the design model based on the analyzed information, and determines whether the updated design model satisfies criteria,

(iv) wherein, if the updated design model satisfies the criteria, the integrator determines printing instructions for the printer to print the one or more structures of the vehicle based on the updated design model and wherein the printer receives the printing instructions from the integrator and prints the one or more structures using the received printing instructions;

(v) and if the updated design model does not satisfy the criteria,

(a) the integrator sends information based on the updated design model to the analysis components,

(b) the analysis components analyze the information based on the updated design model,

(c) the integrator receives the analyzed information, updates the design model based on the analyzed information, and determines whether the updated design model satisfies criteria,

(d) wherein steps (a)-(c) are performed one or more times until the updated design model satisfies the criteria,

(e) when the updated design model satisfies the criteria, the integrator determines other printing instructions and sends the other printing instructions to the printer and the printer prints the one or more structures using the other printing instructions.

2. The apparatus of claim 1, wherein one or more of the analysis components includes a computer aided engineering (CAE) component.

3. The apparatus of claim 1, wherein the analysis components include a first analysis component and a second analysis component,

the first analysis component including at least an aerodynamic component, a thermal component, a stiffness component, a noise, vibration, and harshness (NVH) component, an environmental impact component, an additive manufacturing component, a crashworthiness component, a vehicle dynamics component, a composite materials component, a node location component, a commercial off-the-shelf (COTS) parts component, a durability component, or a cost component, and

the second analysis component including at least a different one of the aerodynamic component, the thermal component, the stiffness component, the NVH component, the environmental impact component, the additive manufacturing component, the crashworthiness component, the vehicle dynamics component, the composite materials component, the node location component, the COTS parts component, the durability component, or the cost component.

4. The apparatus of claim 1, wherein the printer includes a powder-bed fusion system.

5. The apparatus of claim 1, wherein the analysis components are arranged in hierarchical levels of topology of the design model.

6. The apparatus of claim 5, wherein a first one of the hierarchical levels includes analyzing a material composition of a node structure, a second one of the hierarchical levels includes analyzing a shape the node structure, and a third one of the hierarchical levels includes analyzing a placement of the node structure relative to one or more other node structures.

7. The apparatus of claim 1, wherein analyzing the information by the analysis components is performed in parallel.

8. The apparatus of claim 1, further comprising:

a user input component that receives input from a user, wherein the criteria are based on the user input.

9. The apparatus of claim 8, wherein the input includes a performance characteristic of the vehicle.

10. The apparatus of claim 8, wherein the input includes a vehicle type of the vehicle.

11. The apparatus of claim 1, wherein the criteria are based on a government regulated standard of the vehicle.

12. The apparatus of claim 1, further comprising:

a database of COTS parts, wherein the updated design model includes one or more COTS parts from the database, such that the printing instructions exclude instructions for printing the one or more COTS parts.

13. A method of additive manufacturing, comprising:

(i) sending information based on a design model of a vehicle to a plurality of analysis components;

(ii) receiving analyzed information from the analysis components, wherein each analysis component analyzes the information based on a different analysis factor than the other analysis components;

(iii) updating the design model based on the analyzed information;

(iv) determining whether the updated design model satisfies criteria;

(v) if the updated design model does not satisfy the criteria, sending information based on the updated design model to the analysis components and repeating (ii)-(iv) one or more times until the updated design model satisfies the criteria; and

(vi) determining printing instructions for a printer to additively manufacture one or more structures of the vehicle based on the updated design model and printing the one or more structures based on the printing instructions when the updated design model satisfies the criteria.

14. The method of claim 13, wherein analyzing the information includes analyzing the information based on a computer aided engineering (CAE) model.

15. The method of claim 13, wherein the analysis components include a first analysis component and a second analysis component,

the first analysis component including at least an aerodynamic component, a thermal component, a stiffness component, a noise, vibration, and harshness (NVH) component, an environmental impact component, an additive manufacturing component, a crashworthiness component, a vehicle dynamics component, a composite materials component, a node location component, a commercial off-the-shelf (COTS) parts component, a durability component, or a cost component, and

the second analysis component including at least a different one of the aerodynamic component, the thermal component, the stiffness component, the NVH component, the environmental impact component, the additive manufacturing component, the crashworthiness component, the vehicle dynamics component, the composite materials component, the node location component, the COTS parts component, the durability component, or the cost component.

16. The method of claim 13, wherein the printing instructions include powder-bed fusion printing instructions.

17. The method of claim 13, wherein analyzing the information is based on hierarchical levels of topology of the design model.

18. The method of claim 17, wherein a first one of the hierarchical levels includes analyzing a material composition of a node structure, a second one of the hierarchical levels

includes analyzing a shape the node structure, and a third one of the hierarchical levels includes analyzing a placement of the node structure relative to one or more other node structures.

19. The method of claim 13, wherein analyzing the information by the analysis components is performed in parallel.

20. The method of claim 13, further comprising:

receiving input from a user, wherein the criteria are based on the user input.

21. The method of claim 20, wherein the input includes a performance characteristic of the vehicle.

22. The method of claim 20, wherein the input includes a vehicle type of the vehicle.

23. The method of claim 13, wherein the criteria are based on a government regulated standard of the vehicle.

24. The method of claim 13, further comprising:

selecting one or more COTS parts from a database of COTS parts, wherein the updated design model includes the one or more COTS parts from the database, such that the printing instructions exclude instructions for printing the one or more COTS parts.

25. A non-transitory computer-readable medium storing computer-executable instructions for additive manufacturing, the instructions executable to perform:

(i) sending information based on a design model of a vehicle to a plurality of analysis components;

(ii) receiving analyzed information from the analysis components, wherein each analysis component analyzes the information based on a different analysis factor than the other analysis components;

(iii) updating the design model based on the analyzed information;

(iv) determining whether the updated design model satisfies criteria;

(v) if the updated design model does not satisfy the criteria, sending information based on the updated design model to the analysis components and repeating (ii)-(iv) one or more times until the updated design model satisfies the criteria; and

(vi) determining printing instructions for a printer to additively manufacture one or more structures of the vehicle based on the updated design model and printing the one or more structures based on the printing instructions when the updated design model satisfies the criteria.

26. The non-transitory computer-readable medium of claim 25, wherein analyzing the information includes analyzing the information based on a computer aided engineering (CAE) model.

27. The non-transitory computer-readable medium of claim 25, wherein the analysis components include a first analysis component and a second analysis component,

the first analysis component including at least an aerodynamic component, a thermal component, a stiffness component, a noise, vibration, and harshness (NVH) component, an environmental impact component, an additive manufacturing component, a crashworthiness component, a vehicle dynamics component, a composite materials component, a node location component, a commercial off-the-shelf (COTS) parts component, a durability component, or a cost component, and

the second analysis component including at least a different one of the aerodynamic component, the thermal component, the stiffness component, the NVH component, the environmental impact component, the additive manufacturing component, the crashworthiness component, the vehicle dynamics component, the composite materials component, the node location component, the COTS parts component, the durability component, or the cost component.

28. The non-transitory computer-readable medium of claim 25, wherein the printing instructions include powder-bed fusion printing instructions.

29. The non-transitory computer-readable medium of claim 25, wherein analyzing the information is based on hierarchical levels of topology of the design model.

30. The non-transitory computer-readable medium of claim 29, wherein a first one of the hierarchical levels includes analyzing a material composition of a node structure, a second one of the hierarchical levels includes analyzing a shape the node structure, and a third one of the hierarchical levels includes analyzing a placement of the node structure relative to one or more other node structures.

31. The non-transitory computer-readable medium of claim 25, wherein analyzing the information by the analysis components is performed in parallel.

32. The non-transitory computer-readable medium of claim 25, the instructions executable further to perform:

receiving input from a user, wherein the criteria are based on the user input.

33. The non-transitory computer-readable medium of claim 32, wherein the input includes a performance characteristic of the vehicle.

34. The non-transitory computer-readable medium of claim 32, wherein the input includes a vehicle type of the vehicle.

35. The non-transitory computer-readable medium of claim 25, wherein the criteria are based on a government regulated standard of the vehicle.

36. The non-transitory computer-readable medium of claim 25, the instructions executable further to perform:

selecting one or more COTS parts from a database of COTS parts, wherein the updated design model includes the one or more COTS parts from the database, such that the printing instructions exclude instructions for printing the one or more COTS parts.