CLAIMS

WHAT IS CLAIMED:

1. A method of calibrating an additive manufacturing system (100), the method comprising:

comparing a digital representation of one or more calibration marks (1602) to a calibration-CAD model (1400) comprising one or more model calibration marks (1402), the digital representation of the one or more calibration marks (1602) having been obtained using a vision system (102), and the one or more calibration marks (~~1602~~1502) having been printed on a calibration surface (1500) according to the calibration-CAD model (1400) using an additive manufacturing machine (104); and

applying a calibration adjustment to one or more CAD models (800, 850) based at least in part on the comparison, the calibration adjustment configured to align the one or more CAD models (800, 850) with one or more coordinates of the additive manufacturing system (100).

2. The method of claim 1, comprising:

printing the one or more calibration marks (~~1602~~1502) on the calibration surface (1500) according to the calibration-CAD model (1400) using the additive manufacturing machine (104).

3. The method of claim 1 or 2, wherein the calibration surface (1500) comprises a calibration sheet applied to a build plate (118), the build plate (118) configured to be installed in the additive manufacturing machine (104) and configured to secure a plurality of workpieces (116) when additively printing respective ones of a plurality of extension segments (206) on respective ones of the plurality of workpieces (116) using the additive manufacturing machine (104).

4. The method of ~~any preceding~~ claim 3, wherein the additive manufacturing machine (104) comprises an energy source (142) configured to additively print the plurality of extension segments (206), and wherein printing the one or more calibration marks (1502) comprises marking the calibration surface (1500) using the energy source (142).

5. The method of any preceding claim, comprising:

printing a plurality of calibration marks (1502) on the calibration surface (1500) at a plurality of registration points (202) according to the calibration-CAD model (1400), the plurality of registration points (202) having CAD-model coordinates respectively corresponding to locations where respective ones of a plurality of workpieces (116) are to be situated when additively printing respective ones of a plurality of extension segments (206) onto the respective ones of the plurality of workpieces (116).

6. The method of any preceding claim, comprising:

obtaining the digital representation of the one or more calibration marks (1602) using the vision system (102).

7. The method of any preceding claim, comprising:

wherein the calibration-CAD model (1400) includes a model of a plurality of calibration marks (1402) respectively located at CAD model-coordinates corresponding to respective ones of a plurality of registration points (202), the model of the plurality of registration points (202) respectively corresponding to locations where respective ones of a plurality of workpieces (116) are to be situated when additively printing respective ones of a plurality of extension segments (206) onto the respective ones of the plurality of workpieces (116).

8. The method of any preceding claim, wherein the one or more calibration marks (1602) comprises:

a plurality of dots, wherein respective ones of the plurality of dots have CAD model-coordinates that correspond to respective ones of a plurality of registration points (202), the plurality of registration points (202) respectively corresponding to locations of respective ones of a plurality of workpieces (116) onto which respective ones of a plurality of extension segments (206) are to be additively printed; or

a plurality of geometric shapes or patterns, at least a portion of respective ones of the plurality of geometric shapes or patterns having CAD model-coordinates that correspond to respective ones of a plurality of registration points (202), the plurality of registration points (202) respectively corresponding to locations of respective ones of a plurality of workpieces (116) onto which respective ones of a plurality of extension segments (206) are to be additively printed; or

a plurality of contours respectively corresponding to a perimeter of a model of an extension segment (802), wherein respective ones of the plurality of contours have CAD model-coordinates respectively corresponding to locations of respective ones of a plurality of workpieces (116) onto which respective ones of a plurality of extension segments (206) are to be additively printed.

9. The method of any preceding claim, wherein comparing the digital representation of the one or more calibration marks (1602) to the calibration-CAD model (1400) comprises:

comparing one or more coordinates of the one or more calibration marks (1602) in the digital representation thereof with a corresponding one or more coordinates of the model calibration marks (1402) in the calibration-CAD model (1400) and determining one or more differences therebetween.

10. The method of any preceding claim, wherein the one or more coordinates comprise coordinates of respective ones of a plurality of registration points (202), the plurality of registration points (202) respectively corresponding to locations of respective ones of a plurality of workpieces (116) onto which respective ones of a plurality of extension segments (206) are to be additively printed using the additive manufacturing machine (104).

11. The method of any preceding claim, wherein comparing the digital representation of the one or more calibration marks (1602) to the calibration-CAD model (1400) comprises:

comparing one or more dimensions of the one or more calibration marks (1602) in the digital representation thereof with a corresponding one or more dimensions of the model calibration marks (1402) in the calibration-CAD model (1400) and determining one or more differences therebetween.

12. The method of any preceding claim, wherein applying a calibration adjustment to one or more CAD models (800, 850) based at least in part on the comparison comprises:

transforming at least a portion of the one or more CAD models (800, 850) based at least in part on the comparison, and wherein transforming comprises rotating, bending, twisting, shifting, scaling, smoothing, ~~aligning,~~ offsetting, and/or morphing at least a portion of the one or more CAD models (800, 850).

13. The method of any preceding claim, wherein the one or more CAD models (800, 850) comprises an extension segment-CAD model (800), the extension segment-CAD model (800) comprising a model of a plurality of extension segments (802) respectively located at CAD model-coordinates corresponding to respective ones of a plurality of registration points (202), the plurality of registration points (202) respectively corresponding to locations where respective ones of a plurality of workpieces (116) are to be situated when additively printing respective ones of a plurality of extension segments (206) onto the respective ones of the plurality of workpieces (116).

14. An additive manufacturing system (100), comprising:

a controller (2000) operably coupled to a vision system (102) and an additive manufacturing machine (104), the controller (2000) comprising one or more computer readable medium and one or more processors (2004), the one or more computer readable medium comprising computer-executable instructions (2008), which, when executed by the one or more processors (2004), cause the additive manufacturing system (100) to:

compare a digital representation of one or more calibration marks (1602) to a calibration-CAD model (1400) comprising one or more model calibration marks (1402), the digital representation of the one or more calibration marks (1602) having been obtained using a vision system (102), and the one or more calibration marks (~~1602~~1502) having been printed on a calibration surface (1500) according to the calibration-CAD model (1400) using an additive manufacturing machine (104); and

apply a calibration adjustment to one or more CAD models (800, 850) based at least in part on the comparison, the calibration adjustment configured to align the one or more CAD models (800, 850) with one or more coordinates of the additive manufacturing system (100).

15. A computer readable medium comprising computer-executable instructions (2008), which, when executed by one or more processors (2004) of an additive manufacturing system (100), cause the additive manufacturing system (100) to:

compare a digital representation of one or more calibration marks (1602) to a calibration-CAD model (1400) comprising one or more model calibration marks (1402), the digital representation of the one or more calibration marks (1602) having been obtained using a vision system (102), and the one or more calibration marks (~~1602~~1502) having been printed

on a calibration surface (1500) according to the calibration-CAD model (1400) using an additive manufacturing machine (104); and

apply a calibration adjustment to one or more CAD models (800, 850) based at least in part on the comparison, the calibration adjustment configured to align the one or more CAD models (800, 850) with one or more coordinates of the additive manufacturing system (100).