CLAIMS

What is claimed is:

1. An autonomous biologically based learning system, comprising:

a manufacturing tool that produces an asset;

a drift component that modifies a manufacturing recipe processed by the manufacturing tool to generate a set of one or more adjusted manufacturing recipes to produce the asset;

an objective autonomous learning engine that infers one or more functions among asset output metrics and at least one of input material measurements, recipe parameters, or state records for the manufacturing tool based on the modified recipe processed by the manufacturing tool, wherein the one or more functions predict asset output metrics for the produced asset; and

an autonomous optimization engine that extracts a set of recipe parameters from a set of input measurements and the one or more inferred functions to generate an adjusted manufacturing recipe with predicted output within a tolerance of target asset output metrics.

2. The system of claim 1, wherein the asset includes one or more of semiconductor devices, the semiconductor devices comprising semiconductor substrates possessing integrated circuits (ICs), plasma-discharge based flat panel displays (FPDs), organic light emitting diode (OLED)-based FPDs, liquid crystal display (LCD)-based FPDs, or elements thereof which comprise one or more of thin-film-transistor active matrix arrays, color filters, or polarizers.

3. The system of claim 1, wherein the drift component modifies the manufacturing recipe via an update component that randomizes the manufacturing recipe in accordance at least in part with at least one of a set of driving variables or a predetermined probability density function.

4. The system of claim 3, wherein the drift component includes a formatter component that generates a recipe genealogy that includes at least one of the set of one or more adjusted manufacturing recipes, input material data linked to respective adjusted manufacturing recipes, output data related to respective adjusted manufacturing recipes, or a set of operational conditions for the manufacturing tool associated with respective adjusted manufacturing recipes.

5. The system of claim 4, wherein the set of operational conditions for the manufacturing tool associated with respective adjusted manufacturing recipes includes at least one of elapsed active duty, preventive maintenance (PM) records, or repair records.

6. The system of claim 1, wherein, to infer the one or more functions, the objective autonomous learning engine relaxes one or more constraints for the asset output metrics when at least one of the one or more functions predict output outside specific bounds.

7. The system of claim 6, wherein the relaxation of the one or more constraints is dictated at least in part by at least a ranking of asset output metric weights.

8. The system of claim 1, wherein the autonomous optimization engine solves an inverse problem to extract the set of recipe parameters, the inverse problem solved through at least one of genetic algorithm, Monte Carlo simulation, simulated annealing, or Tabu search.

9. The system of claim 1, when the extracted set of recipe parameters yields asset output metrics that are each outside a predetermined tolerance, the autonomous optimization engine performs at least one of the following: (a) configures preventive maintenance parameters or (b) repair procedures.

10. The system of claim 3, further comprising a component that renders a user interface to configure at least one of the set of driving variables or the predetermined probability density function.

11. The system of claim 6, further comprising a component that delivers the one or more functions to at least one disparate manufacturing tool to learn at least one function in the disparate manufacturing tool.

12. A method, comprising:

employing at least one processor to execute code instructions retained in a memory, the code instructions when executed by at least the one processor carry out the following acts:

drifting an initial recipe to fabricate a product that fulfills target product output;

learning a set of relationships associated with product output through the drifting of the initial recipe;

generating an adjusted recipe to accomplish the target product output based at least in part on the set of learned relationships; and

when generation of the adjusted recipe is successful, evaluating whether the target product output is fulfilled; and

when the evaluation yields a negative outcome, continue drifting the initial recipe to fabricate a product that fulfills the target product output.

13. The method of claim 12, further comprising, when generation of the adjusted recipe is unsuccessful, effecting a maintenance procedure.

14. The method of claim 12, wherein drifting an initial recipe to fabricate a product that fulfills the target product output includes:

setting the initial recipe as a current recipe;

randomizing one or more parameters in the current recipe;

processing via the manufacturing tool an adjusted recipe obtained through the randomizing act;

when the adjusted recipe is to be randomized, adding the adjusted recipe to a genealogy of recipes created through randomizing, and setting the adjusted recipe as a current recipe; and

when the adjusted recipe is not to be randomized, supplying the genealogy of recipes created through the randomizing, and data associated with the genealogy.

15. The method of claim 12, wherein generating an adjusted recipe to accomplish the target product output based at least in part on the set of learned relationships includes:

receiving the set of learned relationships that predict product output for a set of recipes;

receiving input material measurements;

for a current state of the manufacturing tool, extracting recipe parameters for the adjusted recipe based at least in part on the received set of learned functions or the received input material measurements;

when the predicted product output for each learned relationship in the set of learned relationships satisfies output constraints, supplying the adjusted recipe in accordance at least in part with the extracted recipe parameters.

16. The method of claim 15, when the predicted product output for each learned relationship in the set of learned relationships does not satisfy output constraints, further comprising:

relaxing a set of output constraints; and

when a current number of relaxed constraints is below a predetermined threshold, extracting recipe parameters for the adjusted recipe based at least in part on the received set of learned functions or the received input material measurements.

17. The method of claim 15, when the current number of relaxed constraints is below a predetermined threshold, configuring a maintenance procedure, wherein the maintenance procedure includes at least one of preventive maintenance or a repair procedure.

18. The method of claim 12, wherein learning a set of relationships associated with product output through the drifting act includes:

receiving production data generated through execution of one or more drifted recipes;

based on the received production data, learning a functional relationship among a product and material input measurements and recipe parameters of the manufacturing tool; and

when the predictions of the product output are within a specified quality, accepting the learning functional relationship.

19. The method of claim 15, wherein extracting recipe parameters for the adjusted recipe based at least in part on the received set of learned functions or the received input material measurements includes solving an inverse problem through at least one of genetic algorithm, Monte Carlo simulation, simulated annealing, or Tabu search.

20. The method of claim 18, wherein accepting the learning functional relationship includes at least one of delivering the learned functional relationship or storing the learned functional relationship.

21. A computer-readable storage medium comprising a set of code instruction retained therein that, when executed by a processor, perform the following acts:

employing at least one processor to execute code instructions retained in a memory, the code instructions when executed by at least the one processor carry out the following acts:

drifting an initial recipe to fabricate a product that fulfills target product output;

learning a set of relationships associated with product output through the drifting of the initial recipe;

generating an adjusted recipe to accomplish the target product output based at least in part on the set of learned relationships; and

when generation of the adjusted recipe is successful, evaluating whether the target product output is fulfilled; and

when the evaluation yields a negative outcome, continue drifting the initial recipe to fabricate a product that fulfills the target product output.

CLAIMS

1. An autonomous biologically based learning system, comprising:

a manufacturing tool that produces an asset;

a drift component that modifies a manufacturing recipe processed by the manufacturing tool at least in part using a set of driving variables and a predetermined probability distribution function to generate one or more adjusted manufacturing recipes for the asset, wherein the set of driving variables determine a particular sequence to modify a set of recipe parameters associated with the manufacturing recipe;

an objective autonomous learning engine that infers one or more functions for the manufacturing tool based on the modified manufacturing recipe processed by the manufacturing tool, wherein the one or more functions predict asset output metrics for the produced asset; and

an autonomous optimization engine that extracts a set of updated recipe parameters from a set of input measurements and the one or more inferred functions to generate an adjusted recipe within a predefined tolerance of a target value for the asset output metrics.

2. The system of claim 1, wherein the asset includes one or more of semiconductor devices, the semiconductor devices comprising semiconductor substrates possessing integrated circuits (ICs), plasma-discharge based flat panel displays (FPDs), organic light emitting diode (OLED)-based FPDs, liquid crystal display (LCD)-based FPDs, or elements thereof which comprise one or more of thin-film-transistor active matrix arrays, color filters, or polarizers.

3. The system of claim 1, wherein the drift component randomly modifies the manufacturing recipe at least in part using the set of driving variables and the predetermined probability distribution function.

4. The system of claim 1, wherein the drift component includes a formatter component that generates a recipe genealogy that includes at least one of the one or more adjusted manufacturing recipes, input material data linked to respective adjusted manufacturing recipes, output data related to respective adjusted manufacturing recipes, or a set of operational conditions for the manufacturing tool associated with respective adjusted manufacturing recipes.

5. The system of claim 4, wherein the set of operational conditions for the manufacturing tool associated with respective adjusted manufacturing recipes includes at least one of elapsed active duty, preventive maintenance (PM) records, or repair records.

6. The system of claim 1, wherein, to infer the one or more functions, the objective autonomous learning engine relaxes one or more constraints for the asset output metrics.

7. The system of claim 6, wherein the relaxation of the one or more constraints is dictated at least in part by a ranking of weights for the asset output metrics.

8. The system of claim 1, wherein the autonomous optimization engine solves an inverse problem to extract the set of recipe parameters, the inverse problem solved through at least one of genetic algorithm, Monte Carlo simulation, simulated annealing, or Tabu search.

9. The system of claim 1, wherein the autonomous optimization engine configures repair procedures in response to a determination that the adjusted recipe is not generated within the predefined tolerance of the target value for the asset output metrics.

10. The system of claim 1, further comprising a component that renders a user interface to configure at least one of the set of driving variables.

11. The system of claim 6, further comprising a component that delivers the one or more functions to at least one disparate manufacturing tool to learn at least one function in the disparate manufacturing tool.

12. A method, comprising:

employing at least one processor to execute code instructions retained in a memory, the code instructions when executed by at least the one processor carry out acts, comprising:

determining a particular sequence for modifying one or more parameters associated with an initial recipe;

modifying the initial recipe at least in part using the particular sequence and a predetermined probability distribution function to fabricate a product that fulfills target product output;

learning a set of relationships associated with product output through the modifying of the initial recipe;

generating an adjusted recipe to accomplish the target product output based at least in part on the set of learned relationships;

evaluating whether the target product output is fulfilled in response to determining that generation of the adjusted recipe is successful; and

continuing the modifying in response to determining that the evaluation yields an unsuccessful outcome.

13. The method of claim 12, further comprising effecting a maintenance procedure in response to unsuccessfully generating the adjusted recipe.

14. The method of claim 12, wherein the modifying includes:

setting the initial recipe as a current recipe;

randomizing the one or more parameters in the current recipe;

processing via a manufacturing tool an adjusted recipe obtained in response to the randomizing;

adding the adjusted recipe to a genealogy of recipes created through randomizing, and setting the adjusted recipe as a current recipe in response to determining that the adjusted recipe is to be randomized; and

supplying the genealogy of recipes created through the randomizing, and data associated with the genealogy in response to determining that the adjusted recipe is not to be randomized.

15. The method of claim 12, wherein the generating includes:

receiving the set of learned relationships that predict product output for a set of recipes;

receiving input material measurements;

extracting recipe parameters for the adjusted recipe based at least in part on a set of learned functions or the received input material measurements;

supplying the adjusted recipe at least in part with the extracted recipe parameters in response to determining that the predicted product output for each learned relationship in the set of learned relationships satisfies output constraints.

16. The method of claim 15, in response to determining that the predicted product output for each learned relationship in the set of learned relationships does not satisfy output constraints, further comprising:

relaxing a set of output constraints; and

extracting recipe parameters for the adjusted recipe based at least in part on the received set of learned functions or the received input material measurements in response to determining that a current number of relaxed constraints is below a predetermined threshold.

17. The method of claim 16, further comprising configuring a maintenance repair procedure in response to determining that the current number of relaxed constraints is below the predetermined threshold.

18. The method of claim 14, wherein the learning includes:

receiving production data generated through execution of one or more modified recipes;

learning a functional relationship among a product output metric, material input measurements, and recipe parameters of the manufacturing tool based on the received production data; and

accepting the learning functional relationship in response to determining that predictions of the product output are within a specified quality.

19. The method of claim 15, wherein the extracting includes solving an inverse problem through at least one of genetic algorithm, Monte Carlo simulation, simulated annealing, or Tabu search.

20. The method of claim 18, wherein the accepting includes at least one of delivering the learned functional relationship or storing the learned functional relationship.

21. A non-transitory computer-readable storage medium comprising a set of code instruction retained therein that, in response to execution , cause a computing system including at least one processor to perform operations, comprising:

determining a particular sequence for modifying one or more parameters associated with an initial recipe;

modifying the initial recipe at least in part using the particular sequence and a predetermined probability distribution function to fabricate a product that fulfills target product output;

learning a set of relationships associated with product output through the modifying of the initial recipe;

generating an adjusted recipe to accomplish the target product output based at least in part on the set of learned relationships;

evaluating whether the target product output is fulfilled in response to determining that generation of the adjusted recipe is successful; and

continuing the modifying in response to determining that the evaluation results in an unsuccessful outcome.