We claim:

1. A system for data collection, data analysis and tribal knowledge identification, and deployment of tribal knowledge in a manufacturing system comprising:

a. Manufacturing system sensor inputs for the capture of operational data from a manufacturing system in the course of the execution of an operation upon an artifact by a manufacturing equipment operator

b. Operator sensor inputs for the capture of data inputted by a manufacturing equipment operator

c. Metrology equipment for the capture of data relating to the artifact being processed by the manufacturing equipment

d. A means for the communication of a broad execution plan for the execution of the operation to the operator

e. Display Unit for the communication of information to the manufacturing equipment operator

f. An Input interface for the manufacturing equipment operator to input commands to the manufacturing equipment

g. A data collection unit for the collection of operational data from the manufacturing equipment sensor inputs, data inputted by the manufacturing equipment operator from the operator sensor inputs, data retrieved from the metrology equipment relating to the artefact being processed and data relating to the broad execution plan.

h. A first data transmission unit for the transmission of such collected data

i. A server for the collection of transmitted data from the first data transmission unit

j. A first data storage unit located on the server for the short term storage of the transmitted data from the first data transmission unit

k. An analysis unit located on the server for the determination of manufacturing performance parameters based on the transmitted data

l. A historical data repository unit located on the server for the long term storage of the transmitted data and corresponding operational data parameters as well as historical data transmitted from previous manufacturing equipment executions and corresponding

manufacturing performance parameters, including historical operational data, historical operator input data and historical artefact data.

m. An evaluation unit located on the server for comparison of transmitted data pertaining to operational data, operator input data and artifact data against corresponding historical data in the historical data repository

n. A first logic unit located on the server for the determination of deviations in operator input data from corresponding historical data relating to the same or similar manufacturing equipment and/or from the broad execution plan

o. A second logic unit located on the server for the determination of deviations in operational data and artifact data from corresponding historical data relating to the same or similar manufacturing equipment and/or from the specifications of the broad execution plan

p. A third logic unit located on the server for the identification and analysis of relationships between determined deviations in operator input data and determined deviations in in operational data and artifact data

q. A learning unit located on the server for the determination of improvements in operational parameters of the manufacturing equipment, manufacturing performance parameters and/or the artifact based on the relationships determined by the third logic unit

r. A fourth logic unit located on the server for the comparison of operator input data against historical operator input data relating to the same or similar manufacturing equipment that has resulted in improvements in operational parameters of the manufacturing equipment, manufacturing performance parameters and/or the artifact

s. A fifth logic unit located on the server for the determination of alternative operator inputs that would result in improvements in the parameters relating to manufacturing performance.

t. A teaching unit located on the server for the creation of recommendations corresponding to alternative operator inputs that would result in improvements in the parameters relating to manufacturing performance.

u. A second data storage unit located on the server for the storage of such determined improvements in operational parameters of the manufacturing equipment,

manufacturing performance parameters and/or the artifact along with all transmitted data at the time of operation of the manufacturing equipment as well as such recommendations corresponding to alternative operator inputs that would result in improvements in the parameters relating to manufacturing performance.

v. A data transmission unit for the transmission of such recommendations corresponding to alternative operator inputs that would result in improvements in the manufacturing performance parameters to the manufacturing equipment operator or any other person, whether in real time or at any subsequent point.

2. The system as claimed in claim 1 wherein the manufacturing equipment sensor inputs may include all or any of the following instruments: computerised numeric controller (CNC), numeric controller (NC) and programmable logic controller (PLC, accelerometers, gyroscopes, thermistors, thermocouples, vibration sensors, optical gauges, eddy current sensors, capacitive sensors, power meters, energy meters, current meters, voltage meters, generic analog-to-digital sensors, generic digital sensors.

3. The system as claimed in claim 1 wherein the operational data may include data relating to all or any of the following operational parameters: acceleration, vibration, temperature, position, energy usage, current drawn, voltage, power factor, magnetic field, distance, position, capacitance; and data reported by a CNC and/or PLC controller including: axes positions, axes feedrate, surface speed, path feedrate, axes acceleration, axes jerk, spindle speed, axis loads, spindle loads, program block being executed, program line being executed, current macro variables in CNC memory, alarms, messages, other notifications

4. The system as claimed in claim 1 wherein the metrology equipment may include all or any of the following instruments: gage blocks, coordinate measurement machines (stationary and portable), go/no-go gages, capacitance probes, laser-based systems, interferometry, microscopy, profilometry, air gages, LVDT probes and articulating arms

5. The system as claimed in claim 1 wherein the server is a remote server located at a different location from the manufacturing system

6. The system as claimed in claim 1 wherein the manufacturing performance parameters may include all or any of the following parameters: productivity, efficiency, utilization, failure rate, rejection rate, first-time quality, overall equipment effectiveness, operating cost, product cost, production efficiency, rejection rate, rejection rate parts per million, rework rate, availability, in-cycle time, cycle time, available time, repair time, planned downtime, unplanned downtime, total downtime

7. The system as claimed in claim 1 wherein the historical data repository unit and the second data storage unit are the same unit

8. The system as claimed in claim 1 wherein the historical data repository is a data warehouse that performs any or all of the following functions:

a. Long term storage of all data transmitted during a given process step and/or broad execution plan;

b. Long term Storage of all determined improvements in operational parameters of the manufacturing equipment, manufacturing performance parameters and/or the artefact;

c. Long term Storage of all recommendations corresponding to alternative operator inputs that would result in improvements in the parameters relating to manufacturing performance;

d. Long term Storage of all analytic operations performed upon such stored data;

e. Long term Storage of all data and resulting information collected by the system as claimed in Claim1;

9. The system, as claimed in claim 1 where such recommendations are transmitted to the manufacturing equipment operator or any other person in real time during the course of execution of the manufacturing equipment operation.

10. The system as claimed in claim 1 where said data transmission unit is capable of transmitting at least one of the following to any person at any point of time:

a. operational data from the manufacturing equipment sensor inputs, data inputted by the manufacturing equipment operator from the operator sensor inputs, data

retrieved from the metrology equipment relating to the artefact being processed and data relating to the broad execution plan

b. manufacturing performance parameters based on such transmitted operational data

c. historical data transmitted from previous manufacturing equipment executions and corresponding manufacturing performance parameters

d. determined deviations in operator input data from corresponding historical data relating to the same

e. determined deviations in operational data and artifact data from corresponding historical data and/or from the specifications of the broad execution plan

f. relationships between determined deviations in operator input data and determined deviations in in operational data and artifact data

g. improvements in operational parameters of the manufacturing equipment, manufacturing performance parameters and/or the artefact

h. alternative operator inputs that would result in improvements in the parameters relating to manufacturing performance

i. recommendations corresponding to alternative operator inputs that would result in improvements in the parameters relating to manufacturing performance

11. A method of data collection, data analysis and tribal knowledge identification, and deployment of tribal knowledge in a manufacturing system comprising:

a. Collecting, by means of the data collecting unit, of operational data from the manufacturing equipment sensor inputs, data inputted by the manufacturing equipment operator from the operator sensor inputs, data retrieved from the metrology equipment relating to the artifact being processed and data relating to the broad execution plan

b. Transmitting, by means of the first data transmission unit, of such collected data, to the server

c. Storing such transmitted data on the first data storage unit

d. Analysing such transmitted data, by means of the analysis unit, for the determination of manufacturing performance parameters based on the transmitted data

e. Comparing, by means of the evaluation unit, the transmitted data pertaining to operational data, operator input data and artifact data against corresponding historical data in a historical data repository

f. Determining, by means of the first logic unit ,of deviations in operator input data from corresponding historical data relating to the same or similar manufacturing equipment and/or from the broad execution plan

g. Determining, by means of the second logic unit, deviations in operational data and artifact data from corresponding historical data relating to the same or similar manufacturing equipment and/or from the specifications of the broad execution plan

h. Identification and analysis of relationships, by means of the third logic unit, between the determined deviations in operator input data against determined deviations in in operational data and artifact data

i. Determining, by means of the learning unit , improvements in operational parameters of the manufacturing equipment, manufacturing performance parameters and/or the artifact based on the relationships determined by the third logic unit

j. Storing, by means of the second data storage unit, of such determined improvements in operational parameters of the manufacturing equipment, manufacturing performance parameters and/or the artifact along with all transmitted data at the time of operation of the manufacturing equipment

k. Comparing, by means of the fourth logic unit, operator input data against historical operator input data relating to the same or similar manufacturing equipment that has resulted in improvements in operational parameters of the manufacturing equipment, manufacturing performance parameters and/or the artifact

l. Determining, by means of the fifth logic unit, alternative operator inputs that would result in improvements in the operational parameters of the manufacturing equipment and/or the artifact

m. Creating recommendations corresponding to alternative operator inputs that would result in improvements in the operational parameters of the manufacturing equipment and/or the artifact, by means of the teaching unit

n. Storing, by means of the second data storage unit, of such recommendations corresponding to alternative operator inputs that would result in improvements in the operational parameters of the manufacturing equipment and/or the artifact

o. Transmitting such recommendations to the manufacturing equipment operator

12. The method as claimed in claim 11 wherein the collecting, by means of the data collecting unit of operational data from the manufacturing equipment sensor inputs, data inputted by the manufacturing equipment operator from the operator sensor inputs, data retrieved from the metrology equipment relating to the artifact being processed and data relating to the broad execution plan is conducted in real time during the course of execution of the manufacturing equipment operation

13. The method, as claimed in claim 11 wherein the server is a remote server located at a different location from the manufacturing system

14. The method, as claimed in claim 11, wherein the historical data repository unit and the second data storage unit are the same unit

15. The method as claimed in claim 11 wherein the historical data repository is a data warehouse that performs any or all of the following functions:

a. Long term storage of all data transmitted during a given process step and/or broad execution plan;

b. Long term Storage of all determined improvements in operational parameters of the manufacturing equipment, manufacturing performance parameters and/or the artefact;

c. Long term Storage of all recommendations corresponding to alternative operator inputs that would result in improvements in the parameters relating to manufacturing performance;

d. Long term Storage of all analytic operations performed upon such stored data;

e. Long term Storage of all data and resulting information collected by the system as claimed in Claim1;

16. The method as claimed in claim 11 wherein the such recommendations corresponding to alternative operator inputs that would result in improvements in the operational parameters of the manufacturing equipment and/or the artifact are transmitted to the manufacturing equipment operator or any other person.

17. The method, as claimed in claim 11 wherein such recommendations are transmitted to the manufacturing equipment operator or any other person in real time during the course of execution of the manufacturing equipment operation.

18. The method as claimed in claim 11 where at least one of the following may be transmitted to any person at any point of time:

a. operational data from the manufacturing equipment sensor inputs, data inputted by the manufacturing equipment operator from the operator sensor inputs, data retrieved from the metrology equipment relating to the artefact being processed and data relating to the broad execution plan

b. manufacturing performance parameters based on such transmitted operational data

c. historical data transmitted from previous manufacturing equipment executions and corresponding manufacturing performance parameters

d. determined deviations in operator input data from corresponding historical data relating to the same

e. determined deviations in operational data and artifact data from corresponding historical data and/or from the specifications of the broad execution plan

f. relationships between determined deviations in operator input data and determined deviations in in operational data and artifact data

g. improvements in operational parameters of the manufacturing equipment, manufacturing performance parameters and/or the artefact

h. alternative operator inputs that would result in improvements in the parameters relating to manufacturing performance

i. recommendations corresponding to alternative operator inputs that would result in improvements in the parameters relating to manufacturing performance

We claim:

1. A system for data collection, data analysis and tribal knowledge identification, and deployment of tribal knowledge in a manufacturing system comprising:

a. Manufacturing system sensor inputs for the capture of operational data from a manufacturing system in the course of the execution of an operation upon an artifact by a manufacturing equipment operator

b. Operator sensor inputs for the capture of data inputted by a manufacturing equipment operator

c. Metrology equipment for the capture of data relating to the artifact being processed by the manufacturing equipment

d. A means for the communication of a broad execution plan for the execution of the operation to the operator

e. Display Unit for the communication of information to the manufacturing equipment operator

f. An Input interface for the manufacturing equipment operator to input commands to the manufacturing equipment

g. A data collection unit for the collection of operational data from the manufacturing equipment sensor inputs, data inputted by the manufacturing equipment operator from the operator sensor inputs, data retrieved from the metrology equipment relating to the artefact being processed and data relating to the broad execution plan.

h. A first data transmission unit for the transmission of such collected data

i. A server for the collection of transmitted data from the first data transmission unit

j. A first data storage unit located on the server for the short term storage of the transmitted data from the first data transmission unit

k. An analysis unit located on the server for the determination of manufacturing performance parameters based on the transmitted data

l. A historical data repository unit located on the server for the long term storage of the transmitted data and corresponding operational data parameters as well as historical data transmitted from previous manufacturing equipment executions and corresponding

manufacturing performance parameters, including historical operational data, historical operator input data and historical artefact data.

m. An evaluation unit located on the server for comparison of transmitted data pertaining to operational data, operator input data and artifact data against corresponding historical data in the historical data repository

n. A first logic unit located on the server for the determination of deviations in operator input data from corresponding historical data relating to the same or similar manufacturing equipment and/or from the broad execution plan

o. A second logic unit located on the server for the determination of deviations in operational data and artifact data from corresponding historical data relating to the same or similar manufacturing equipment and/or from the specifications of the broad execution plan

p. A third logic unit located on the server for the identification and analysis of relationships between determined deviations in operator input data and determined deviations in in operational data and artifact data

q. A learning unit located on the server for the determination of improvements in operational parameters of the manufacturing equipment, manufacturing performance parameters and/or the artifact based on the relationships determined by the third logic unit

r. A fourth logic unit located on the server for the comparison of operator input data against historical operator input data relating to the same or similar manufacturing equipment that has resulted in improvements in operational parameters of the manufacturing equipment, manufacturing performance parameters and/or the artifact

s. A fifth logic unit located on the server for the determination of alternative operator inputs that would result in improvements in the parameters relating to manufacturing performance.

t. A teaching unit located on the server for the creation of recommendations corresponding to alternative operator inputs that would result in improvements in the parameters relating to manufacturing performance.

u. A second data storage unit located on the server for the storage of such determined improvements in operational parameters of the manufacturing equipment,

manufacturing performance parameters and/or the artifact along with all transmitted data at the time of operation of the manufacturing equipment as well as such recommendations corresponding to alternative operator inputs that would result in improvements in the parameters relating to manufacturing performance.

v. A data transmission unit for the transmission of such recommendations corresponding to alternative operator inputs that would result in improvements in the manufacturing performance parameters to the manufacturing equipment operator or any other person, whether in real time or at any subsequent point.

2. The system as claimed in claim 1 wherein the manufacturing equipment sensor inputs may include all or any of the following instruments: computerised numeric controller (CNC), numeric controller (NC) and programmable logic controller (PLC, accelerometers, gyroscopes, thermistors, thermocouples, vibration sensors, optical gauges, eddy current sensors, capacitive sensors, power meters, energy meters, current meters, voltage meters, generic analog-to-digital sensors, generic digital sensors.

3. The system as claimed in claim 1 wherein the operational data may include data relating to all or any of the following operational parameters: acceleration, vibration, temperature, position, energy usage, current drawn, voltage, power factor, magnetic field, distance, position, capacitance; and data reported by a CNC and/or PLC controller including: axes positions, axes feedrate, surface speed, path feedrate, axes acceleration, axes jerk, spindle speed, axis loads, spindle loads, program block being executed, program line being executed, current macro variables in CNC memory, alarms, messages, other notifications

4. The system as claimed in claim 1 wherein the metrology equipment may include all or any of the following instruments: gage blocks, coordinate measurement machines (stationary and portable), go/no-go gages, capacitance probes, laser-based systems, interferometry, microscopy, profilometry, air gages, LVDT probes and articulating arms

5. The system as claimed in claim 1 wherein the server is a remote server located at a different location from the manufacturing system

6. The system as claimed in claim 1 wherein the manufacturing performance parameters may include all or any of the following parameters: productivity, efficiency, utilization, failure rate, rejection rate, first-time quality, overall equipment effectiveness, operating cost, product cost, production efficiency, rejection rate, rejection rate parts per million, rework rate, availability, in-cycle time, cycle time, available time, repair time, planned downtime, unplanned downtime, total downtime

7. The system as claimed in claim 1 wherein the historical data repository unit and the second data storage unit are the same unit

8. The system as claimed in claim 1 wherein the historical data repository is a data warehouse that performs any or all of the following functions:

a. Long term storage of all data transmitted during a given process step and/or broad execution plan;

b. Long term Storage of all determined improvements in operational parameters of the manufacturing equipment, manufacturing performance parameters and/or the artefact;

c. Long term Storage of all recommendations corresponding to alternative operator inputs that would result in improvements in the parameters relating to manufacturing performance;

d. Long term Storage of all analytic operations performed upon such stored data;

e. Long term Storage of all data and resulting information collected by the system as claimed in Claim1;

9. The system, as claimed in claim 1 where such recommendations are transmitted to the manufacturing equipment operator or any other person in real time during the course of execution of the manufacturing equipment operation.

10. The system as claimed in claim 1 where said data transmission unit is capable of transmitting at least one of the following to any person at any point of time:

a. operational data from the manufacturing equipment sensor inputs, data inputted by the manufacturing equipment operator from the operator sensor inputs, data

retrieved from the metrology equipment relating to the artefact being processed and data relating to the broad execution plan

b. manufacturing performance parameters based on such transmitted operational data

c. historical data transmitted from previous manufacturing equipment executions and corresponding manufacturing performance parameters

d. determined deviations in operator input data from corresponding historical data relating to the same

e. determined deviations in operational data and artifact data from corresponding historical data and/or from the specifications of the broad execution plan

f. relationships between determined deviations in operator input data and determined deviations in in operational data and artifact data

g. improvements in operational parameters of the manufacturing equipment, manufacturing performance parameters and/or the artefact

h. alternative operator inputs that would result in improvements in the parameters relating to manufacturing performance

i. recommendations corresponding to alternative operator inputs that would result in improvements in the parameters relating to manufacturing performance

11. A method of data collection, data analysis and tribal knowledge identification, and deployment of tribal knowledge in a manufacturing system comprising:

a. Collecting, by means of the data collecting unit, of operational data from the manufacturing equipment sensor inputs, data inputted by the manufacturing equipment operator from the operator sensor inputs, data retrieved from the metrology equipment relating to the artifact being processed and data relating to the broad execution plan

b. Transmitting, by means of the first data transmission unit, of such collected data, to the server

c. Storing such transmitted data on the first data storage unit

d. Analysing such transmitted data, by means of the analysis unit, for the determination of manufacturing performance parameters based on the transmitted data

e. Comparing, by means of the evaluation unit, the transmitted data pertaining to operational data, operator input data and artifact data against corresponding historical data in a historical data repository

f. Determining, by means of the first logic unit ,of deviations in operator input data from corresponding historical data relating to the same or similar manufacturing equipment and/or from the broad execution plan

g. Determining, by means of the second logic unit, deviations in operational data and artifact data from corresponding historical data relating to the same or similar manufacturing equipment and/or from the specifications of the broad execution plan

h. Identification and analysis of relationships, by means of the third logic unit, between the determined deviations in operator input data against determined deviations in in operational data and artifact data

i. Determining, by means of the learning unit , improvements in operational parameters of the manufacturing equipment, manufacturing performance parameters and/or the artifact based on the relationships determined by the third logic unit

j. Storing, by means of the second data storage unit, of such determined improvements in operational parameters of the manufacturing equipment, manufacturing performance parameters and/or the artifact along with all transmitted data at the time of operation of the manufacturing equipment

k. Comparing, by means of the fourth logic unit, operator input data against historical operator input data relating to the same or similar manufacturing equipment that has resulted in improvements in operational parameters of the manufacturing equipment, manufacturing performance parameters and/or the artifact

l. Determining, by means of the fifth logic unit, alternative operator inputs that would result in improvements in the operational parameters of the manufacturing equipment and/or the artifact

m. Creating recommendations corresponding to alternative operator inputs that would result in improvements in the operational parameters of the manufacturing equipment and/or the artifact, by means of the teaching unit

n. Storing, by means of the second data storage unit, of such recommendations corresponding to alternative operator inputs that would result in improvements in the operational parameters of the manufacturing equipment and/or the artifact

o. Transmitting such recommendations to the manufacturing equipment operator

12. The method as claimed in claim 11 wherein the collecting, by means of the data collecting unit of operational data from the manufacturing equipment sensor inputs, data inputted by the manufacturing equipment operator from the operator sensor inputs, data retrieved from the metrology equipment relating to the artifact being processed and data relating to the broad execution plan is conducted in real time during the course of execution of the manufacturing equipment operation

13. The method, as claimed in claim 11 wherein the server is a remote server located at a different location from the manufacturing system

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15. The method as claimed in claim 11 wherein the historical data repository is a data warehouse that performs any or all of the following functions:

a. Long term storage of all data transmitted during a given process step and/or broad execution plan;

b. Long term Storage of all determined improvements in operational parameters of the manufacturing equipment, manufacturing performance parameters and/or the artefact;

c. Long term Storage of all recommendations corresponding to alternative operator inputs that would result in improvements in the parameters relating to manufacturing performance;

d. Long term Storage of all analytic operations performed upon such stored data;

e. Long term Storage of all data and resulting information collected by the system as claimed in Claim1;

16. The method as claimed in claim 11 wherein the such recommendations corresponding to alternative operator inputs that would result in improvements in the operational parameters of the manufacturing equipment and/or the artifact are transmitted to the manufacturing equipment operator or any other person.

17. The method, as claimed in claim 11 wherein such recommendations are transmitted to the manufacturing equipment operator or any other person in real time during the course of execution of the manufacturing equipment operation.

18. The method as claimed in claim 11 where at least one of the following may be transmitted to any person at any point of time:

a. operational data from the manufacturing equipment sensor inputs, data inputted by the manufacturing equipment operator from the operator sensor inputs, data retrieved from the metrology equipment relating to the artefact being processed and data relating to the broad execution plan

b. manufacturing performance parameters based on such transmitted operational data

c. historical data transmitted from previous manufacturing equipment executions and corresponding manufacturing performance parameters

d. determined deviations in operator input data from corresponding historical data relating to the same

e. determined deviations in operational data and artifact data from corresponding historical data and/or from the specifications of the broad execution plan

f. relationships between determined deviations in operator input data and determined deviations in in operational data and artifact data

g. improvements in operational parameters of the manufacturing equipment, manufacturing performance parameters and/or the artefact

h. alternative operator inputs that would result in improvements in the parameters relating to manufacturing performance

i. recommendations corresponding to alternative operator inputs that would result in improvements in the parameters relating to manufacturing performance