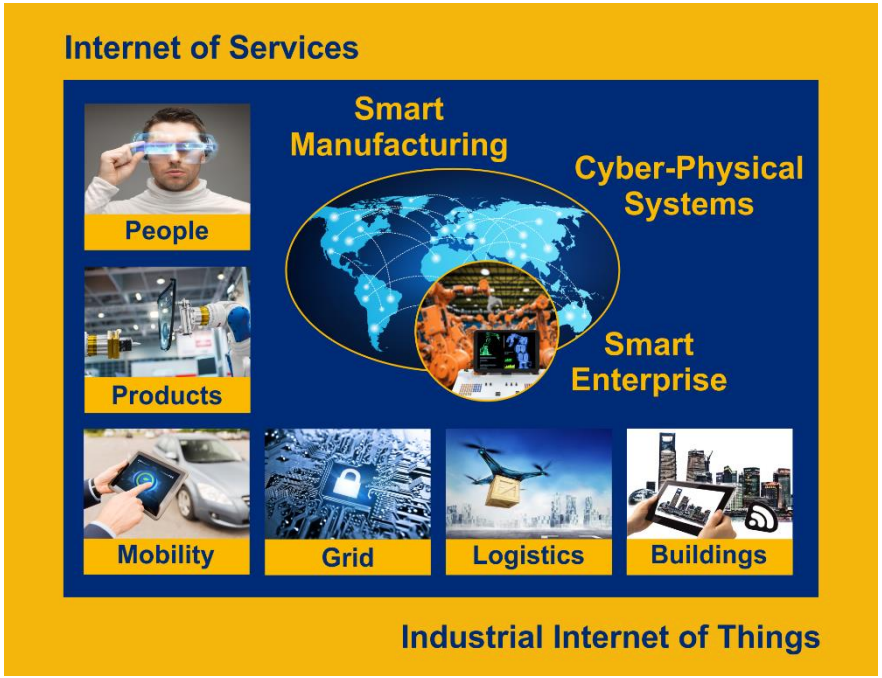


Unleashing The Hidden Power in Your Quality Data

by Edward Morris and Marco Nanninga

Agenda

- The hidden benefits of combining process and quality data.
- How quality data can aid continuous improvement initiatives.
- Real-world examples of production data integration.
- Q&A

Webinar Panelists

Marco Nanninga
Product Specialist at ATS Global

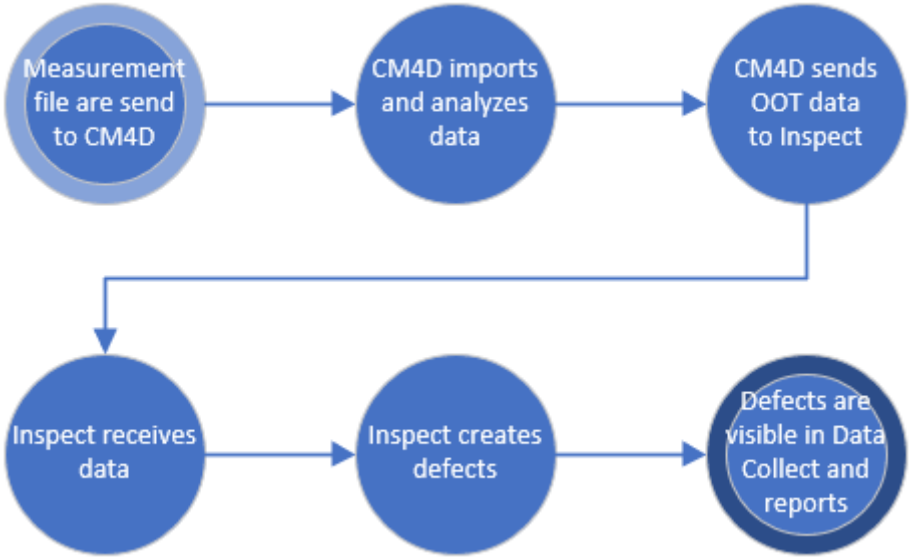
Marco has a wealth of experience from working with manufacturers of all types for more than a decade to define and implement projects related to improving the capture and use of quality data.

Edward Morris
Dimensional Quality Expert at ATS Global

Ed is dedicated to reducing the cost of quality for manufacturers the world over. His decades of experience designing solutions for manufacturers across a range of industries gives him a unique insight into the future of manufacturing quality.

Combining Attribute data

Use Case: CM4D to receive and evaluate dimensional data. For any out of tolerance value a defect is created in Inspect to combine with attribute data.

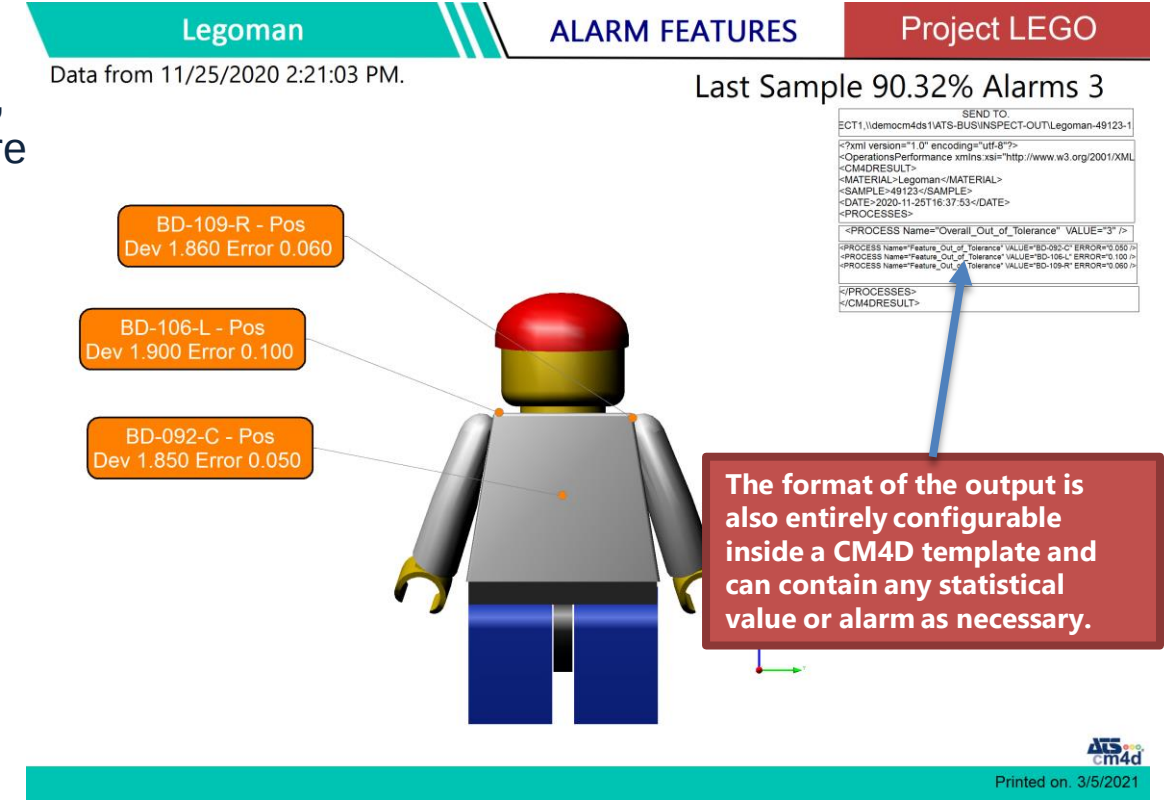


CM4D receives measurement files and processes these. For Out Of Tolerance values a message can be send to Inspect to create a defect. Inspect picks up this message with Communication Service and creates the defect. This defect is then available in Inspect Data Collect and Inspect Reporting

CM4D

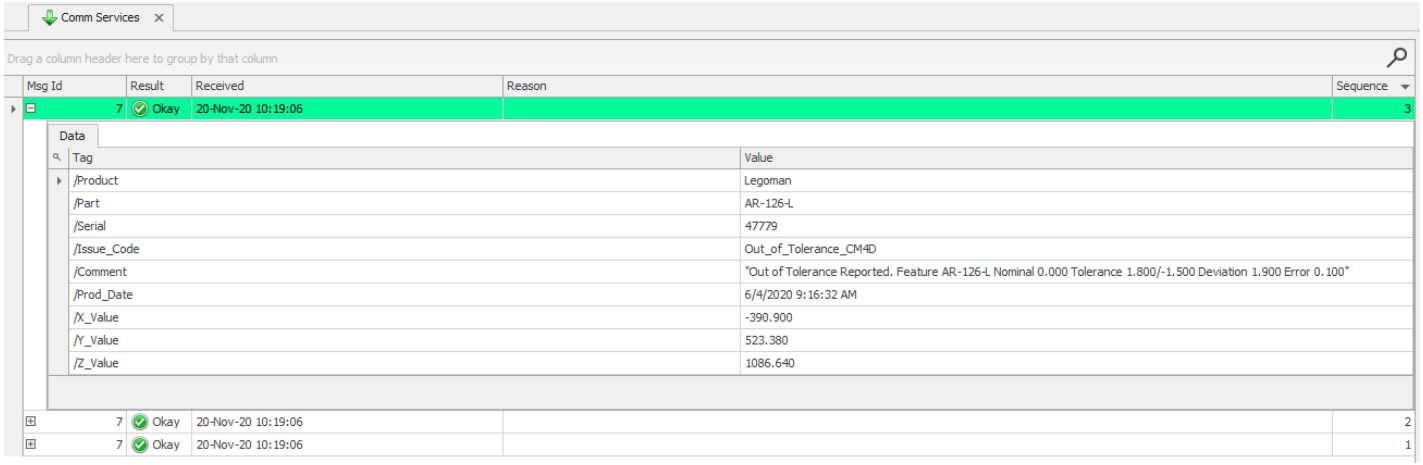
CM4D DataSmith processes the incoming data files.
CM4D analyses the data and if an alarm occurs, a data file is created and send to a network share monitored by Inspect Communication Service.

The trigger for the data file creation is fully configurable in CM4D.
It could be simple tests such as out of tolerance or could highlight statistical events such as change process stability or upward trends towards failure.

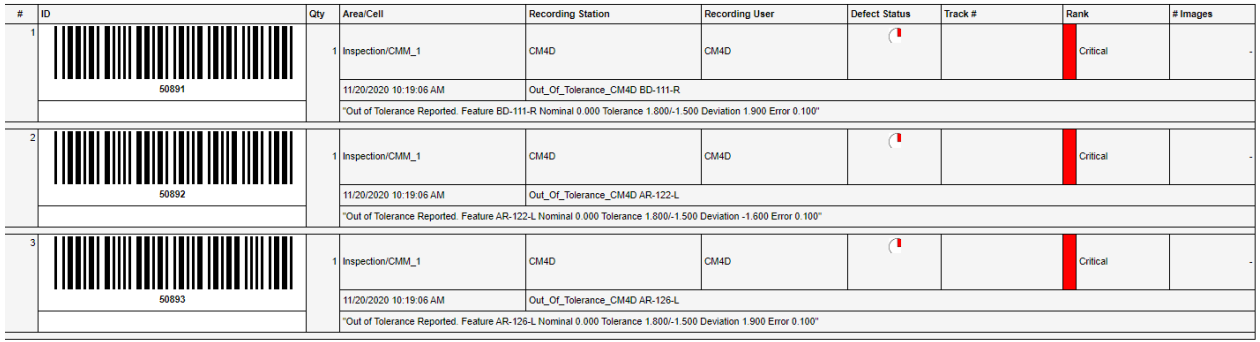


Inspect

ATS Inspect Communication Service picks up the data file and creates the defects that are in that data file. As soon as the file is processed the defect is visible when the serial number is loaded in Data Collect and also in Reporting in any relative report.

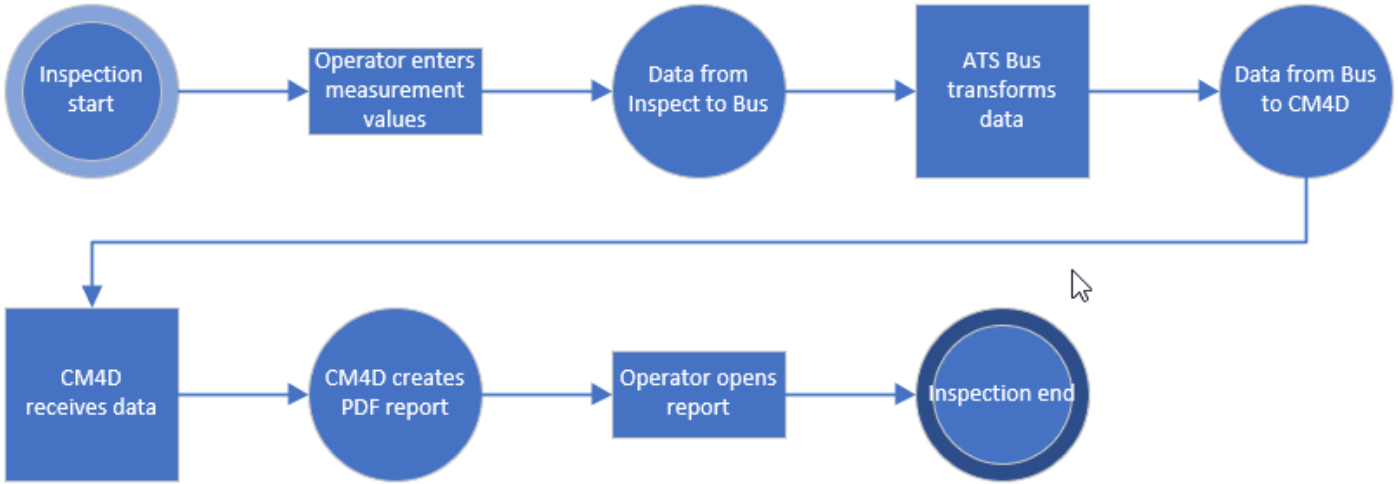


Depending on the logic in the store procedure that handles the data files missing items can be created on the fly in Inspect.



Combining Dimensional data

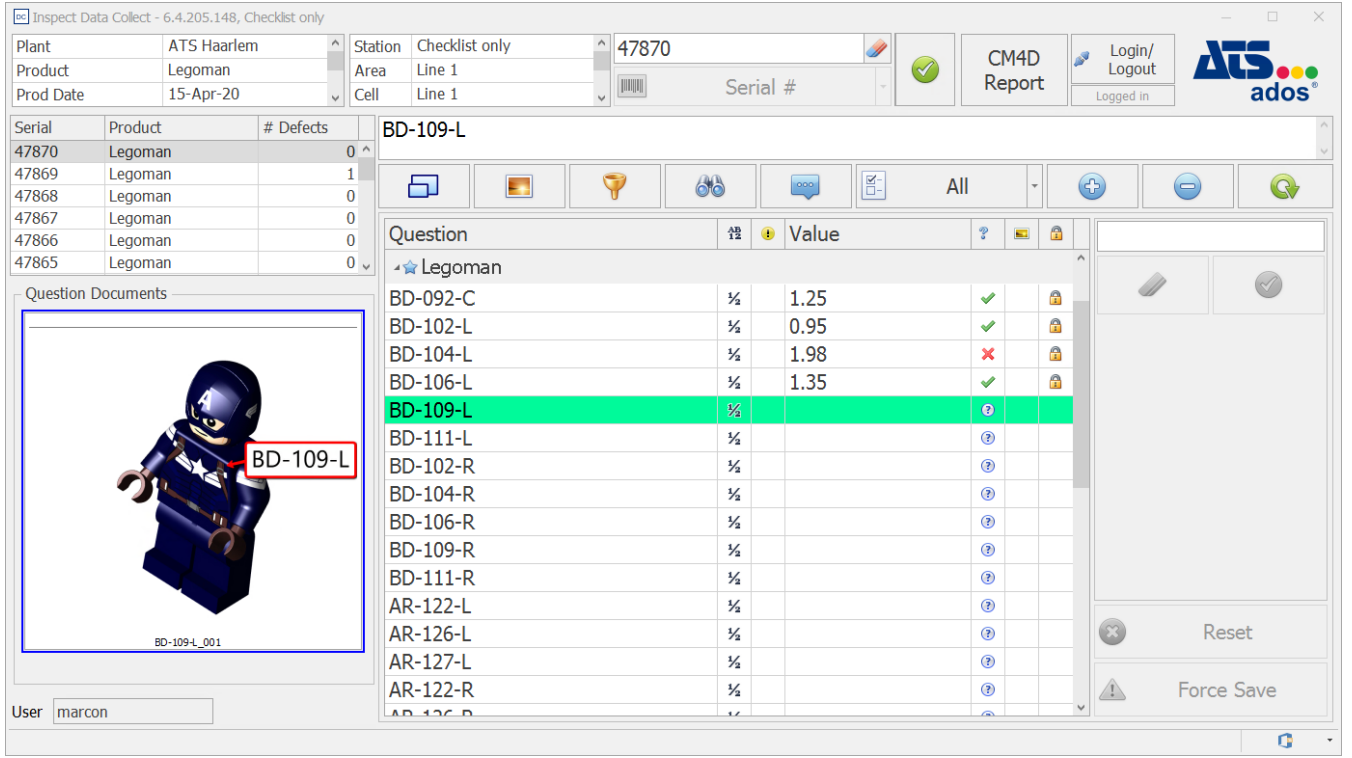
Usecase: Enter dimensional data in Inspect, this data is pushed to CM4D and a PDF report is returned.



Use Inspect Data Collect to enter measurement data by answering numeric questions.
This could be either a dedicated station or part of normal inspection station.
The results are passed to ATS Bus where a data transformation is done to create an output with only relevant information for CM4D.
CM4D picks up the data, stores it in the CM4D database. A PDF report is created automatically.
In Data Collect this report can be opened with the push of a single button.

Inspect Data Collect

Here is an example of a Data Collect station with a main form setup for dedicated Checklist questions answering.
Images are presented to the operator for each question/measurement point to help ensure that the right measurement is being entered.

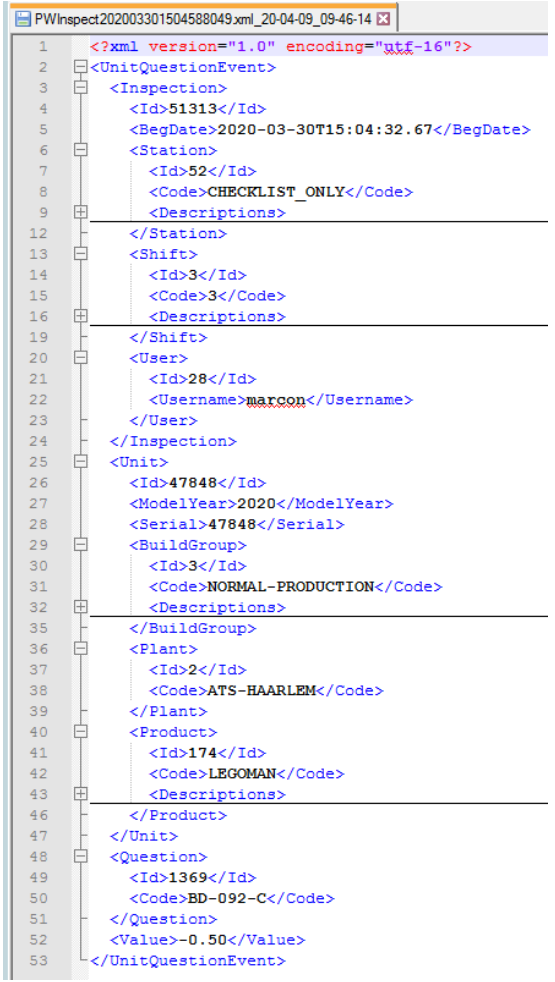


ATS Bus

ATS Bus receives the measurement results from Inspect including the serial number and other traceability information on the ADOS bus stop.

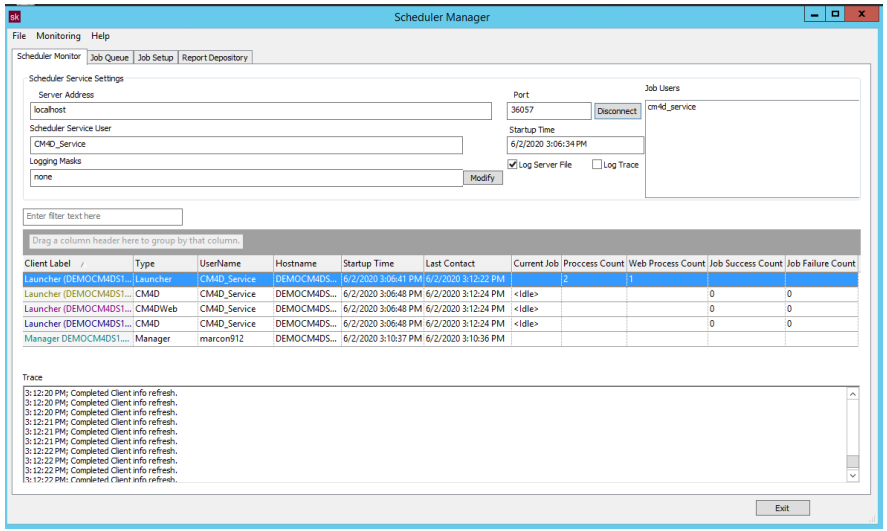
ATS Bus forwards the information to an XML channel where a XSLT transformation is done to strip unneeded data and create an XML file with only the data useful for CM4D. This XML file is stored in a network location monitored by CM4D.

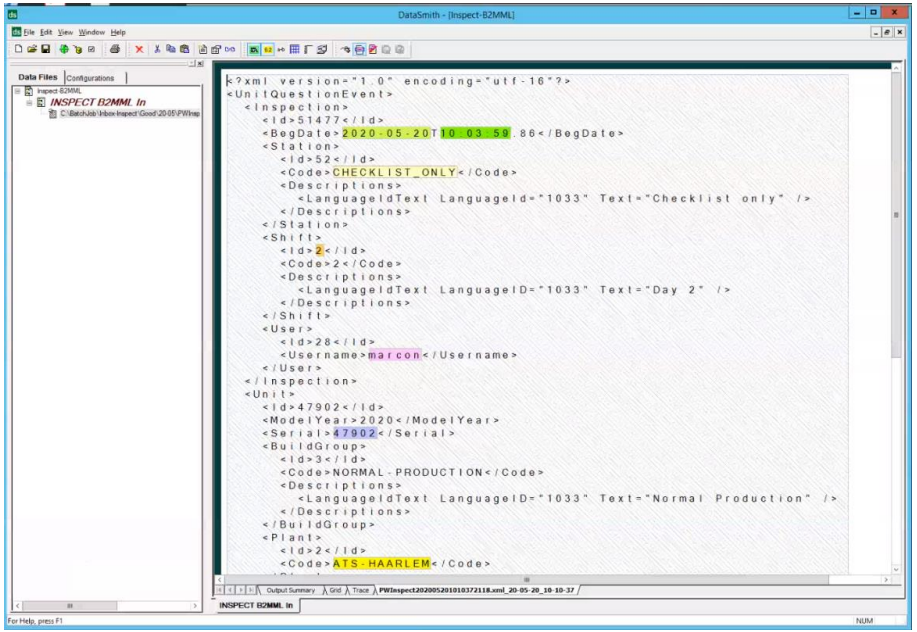
If required, the ATS bus can also receive a return message from CM4D and pass the message to either Inspect or any other linked system.



CM4D

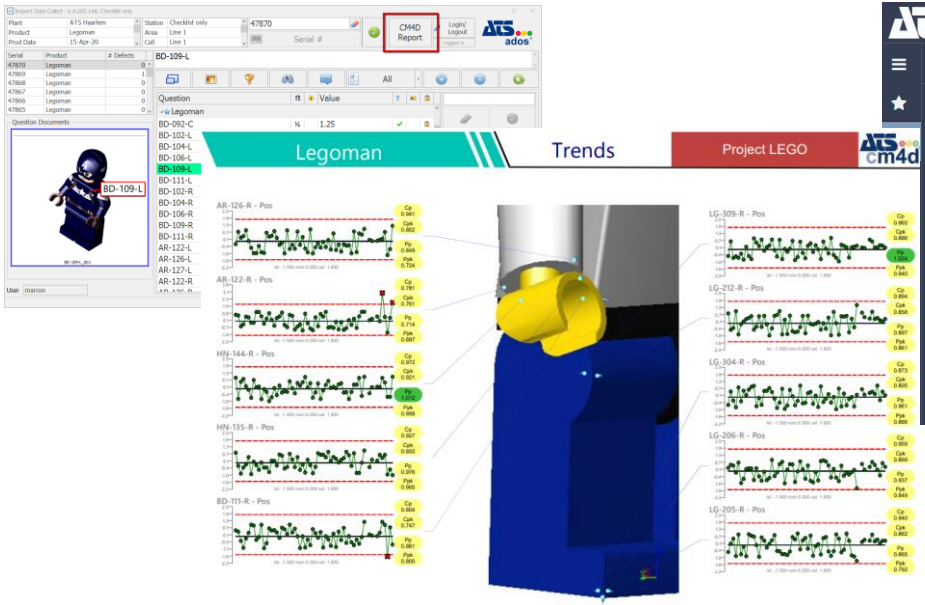
ATS CM4D picks up the XML file automatically. The DataSmith service reads in the XML file and stores the information in the CM4D database.
When all the measurement results from a Data Collect station for a serial number have been received by CM4D it will trigger analysis for the inspected product. This is configured in the Scheduler Manager. This will create a PDF report that highlights any items of concern, shows trend information based on e.g. the last 50 measured serials of that product and creates an overview thumbnail. CM4D is configured to create the PDF with the Data Collect station name and the Serial number as the filename.

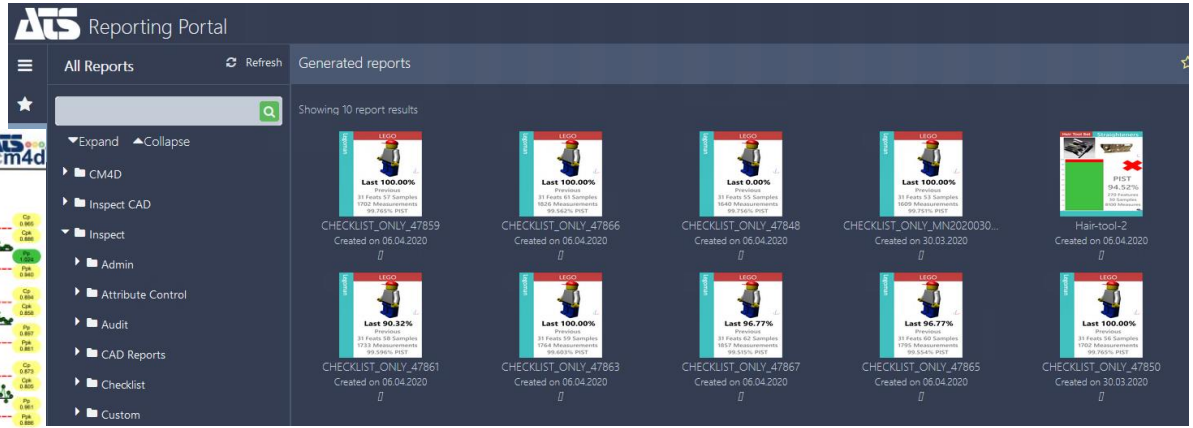




Reporting

The PDF report generated by CM4D is stored in a network location accessible by Data Collect.
There is a button added to Data Collect to load the PDF for the current serial number and data collect station to ensure the right PDF is opened.
The CM4D reports can be accessed from the ATS Reporting Portal as well, together with the Inspect reports.



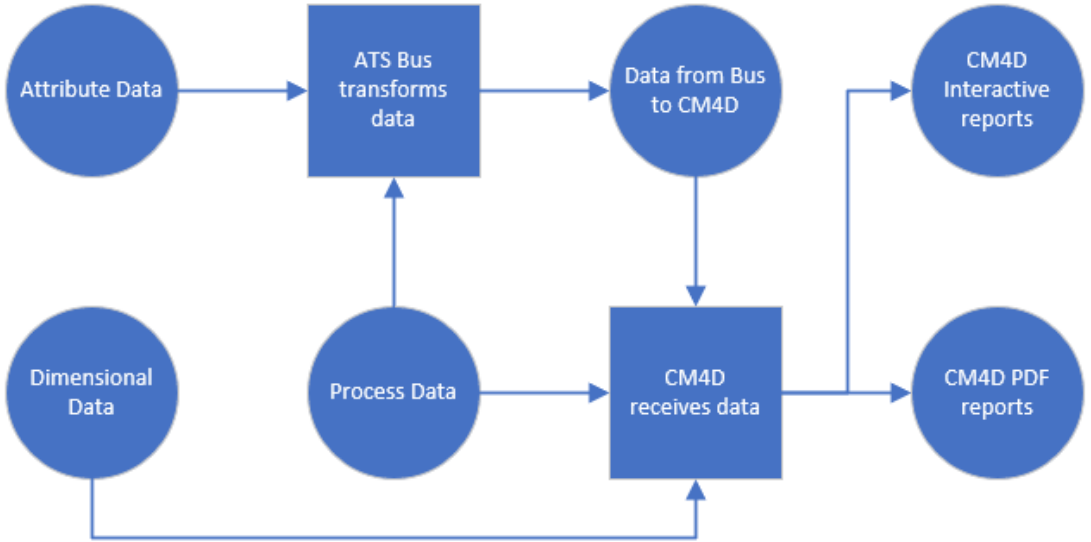


Process and quality data correlation

Dimensional, Attribute and Process data is collected from various sources and send to CM4D for analysis, correlation and reporting.

Besides reporting there is also alarming to e.g., send out alarm before failure occurs.

With this system we have the opportunity to use the available data for predictive analysis and machine learning.



Process and quality data correlation

Example inputs of Dimensional, Attribute and Process data.

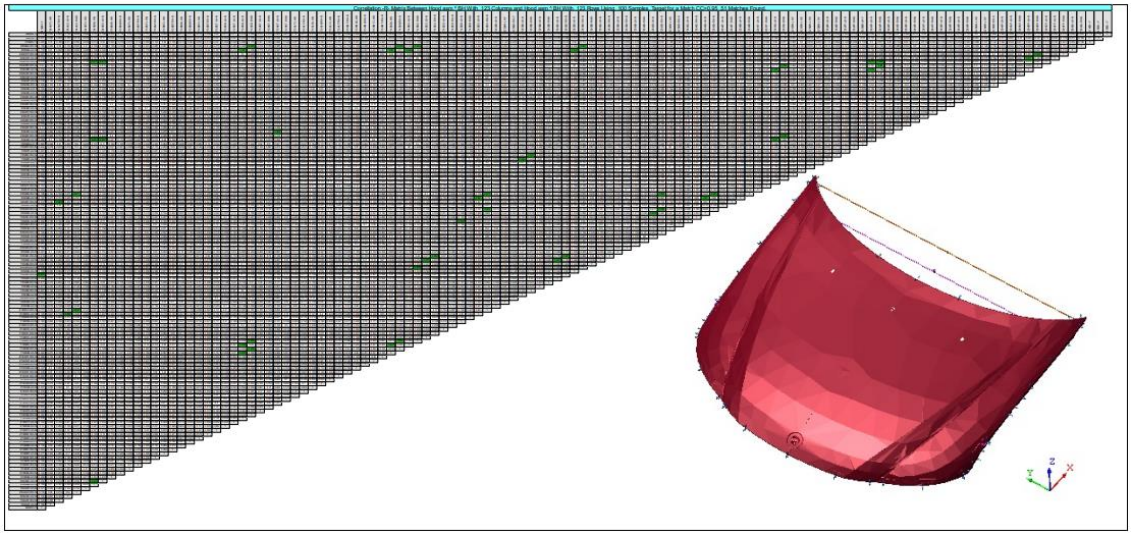
```
<0700
/Product=fender
/Part=fender
/Serial=FE86636597HG
/Issue_Code=scratch
/Comment=
/Prod_Date=2020-04-15
/X_Value=546,65
/Y_Value=284,35
/Z_Value=153,78
>
```

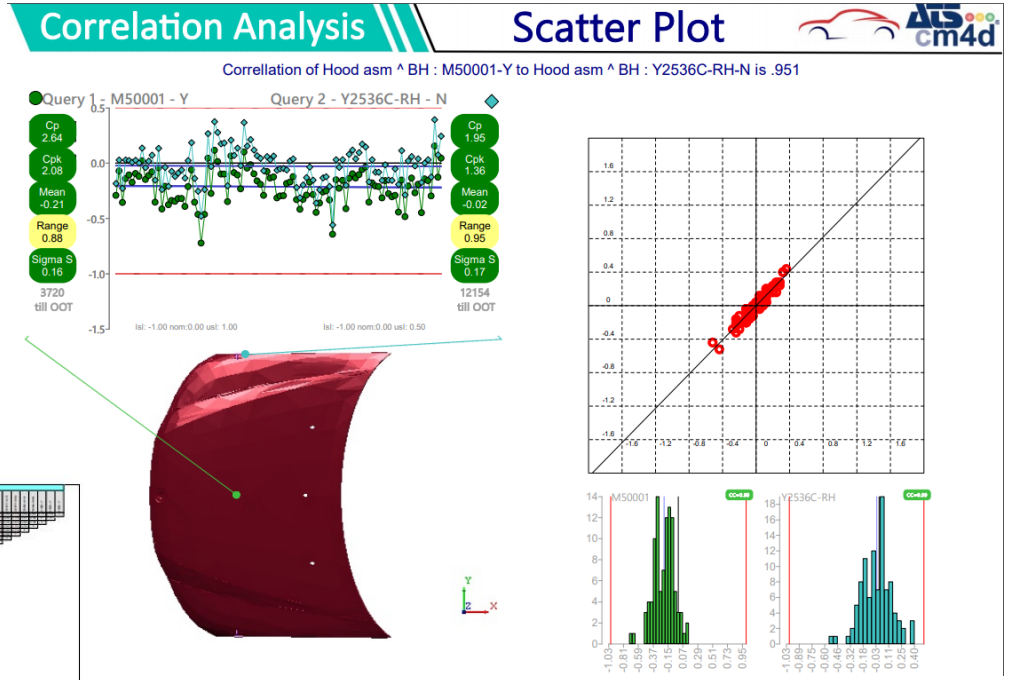
```
<?xml version="1.0" encoding="ISO-8859-1"?>
<MEASUREMENTS>
  <MEASUREMENT>
    <HEADER>
      <SYSTEM>Legoman - 03 Body</SYSTEM>
      <HAND>Both</HAND>
      <FILTERA>qLego</FILTERA>
      <FILTERB>Beta</FILTERB>
      <MEASDATE lextype="yyyy-mm-dd">2006-10-01</MEASDATE>
      <MEASTIME lextype="HH.MM.SS">00:00:00</MEASTIME>
      <PRODNUM1>S000001</PRODNUM1>
      <PRODNUM3>1</PRODNUM3>
      <MODE>CONTINUOUS</MODE>
    </HEADER>
    <MEASDATA>
      <MEASDATAITEM>
        <FEATURENAME>BD-091-C</FEATURENAME>
        <SENSORNAME>2911</SENSORNAME>
        <MEASSTATUS>9</MEASSTATUS>
        <PROBINGDIR>NTM</PROBINGDIR>
        <MEASSTRATEGY>STANDOFF</MEASSTRATEGY>
        <DATATYPE>DEVIATIONS</DATATYPE>
        <COORDINATESYSTEM>NTM</COORDINATESYSTEM>
        <ANALYSISSTRATEGY>POSITIONAL ERROR</ANALYSISSTRATEGY>
        <DEV>
          <X>-0.047</X>
        </DEV>
      </MEASDATAITEM>
```

```
<?xml version="1.0" encoding="utf-16"?>
<OperationsPerformance xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:xsd="http://www.w3.org/2001/XMLSchema"
<StartTime>0001-01-01T00:00:00</StartTime><EndTime>0001-01-01T00:00:00</EndTime>
<PerformanceState>Completed</PerformanceState>
<PublishedDate>0001-01-01T00:00:00</PublishedDate>
<OperationsResponse>
<ID>ABCDE01</ID>
<StartTime>0001-01-01T00:00:00</StartTime>
<EndTime>0001-01-01T00:00:00</EndTime>
<ResponseState>Completed</ResponseState>
<SegmentResponse>
<ID>10</ID>
<ActualStartTime>2016-03-14T14:28:08.888+01:00</ActualStartTime>
<ActualEndTime>2016-03-14T14:28:16.12+01:00</ActualEndTime>
<SegmentState>Completed</SegmentState><SegmentData>
<ID>ThroughCoolant</ID><Value><ValueString>37.132261545427</ValueString></Value></SegmentData><SegmentData>
<ID>CoolantTemp</ID><Value><ValueString>20.3678571313881</ValueString></Value></SegmentData><SegmentData>
<ID>SpindlePower</ID><Value><ValueString>48.301904629113</ValueString></Value></SegmentData><SegmentData>
<ID>MotorTemp</ID><Value><ValueString>35.54473229168</ValueString></Value></SegmentData><SegmentData>
<ID>CNC_Prog</ID><Value><ValueString>Prog01</ValueString></Value></SegmentData><SegmentData>
<ID>ThroughCoolant_Target</ID><Value><ValueString>0</ValueString></Value></SegmentData><SegmentData>
<ID>ThroughCoolant_LSL</ID><Value><ValueString>25</ValueString></Value></SegmentData><SegmentData>
<ID>ThroughCoolant_USL</ID><Value><ValueString>100</ValueString></Value></SegmentData><SegmentData>
<ID>CoolantTemp_Target</ID><Value><ValueString>0</ValueString></Value></SegmentData><SegmentData>
<ID>CoolantTemp_USL</ID><Value><ValueString>42</ValueString></Value></SegmentData><SegmentData>
<ID>CoolantTemp_LSL</ID><Value><ValueString>2</ValueString></Value></SegmentData><SegmentData>
<ID>SpindlePower_Target</ID><Value><ValueString>50</ValueString></Value></SegmentData><SegmentData>
<ID>SpindlePower_LSL</ID><Value><ValueString>100</ValueString></Value></SegmentData><SegmentData>
<ID>SpindlePower_USL</ID><Value><ValueString>0</ValueString></Value></SegmentData><SegmentData>
<ID>MotorTemp_Target</ID><Value><ValueString>0</ValueString></Value></SegmentData><SegmentData>
<ID>MotorTemp_LSL</ID><Value><ValueString>100</ValueString></Value></SegmentData><SegmentData>
<ID>MotorTemp_USL</ID><Value><ValueString>0</ValueString></Value></SegmentData>
<MaterialActual><MaterialUse>Produced</MaterialUse></MaterialActual>
</SegmentResponse>
</OperationsResponse>
</OperationsPerformance>
```

Real World Examples

Hood correlation example based on real data. The system searches for links between features on the same part and can also look for links between a part and an assembly or quality and a process parameter.





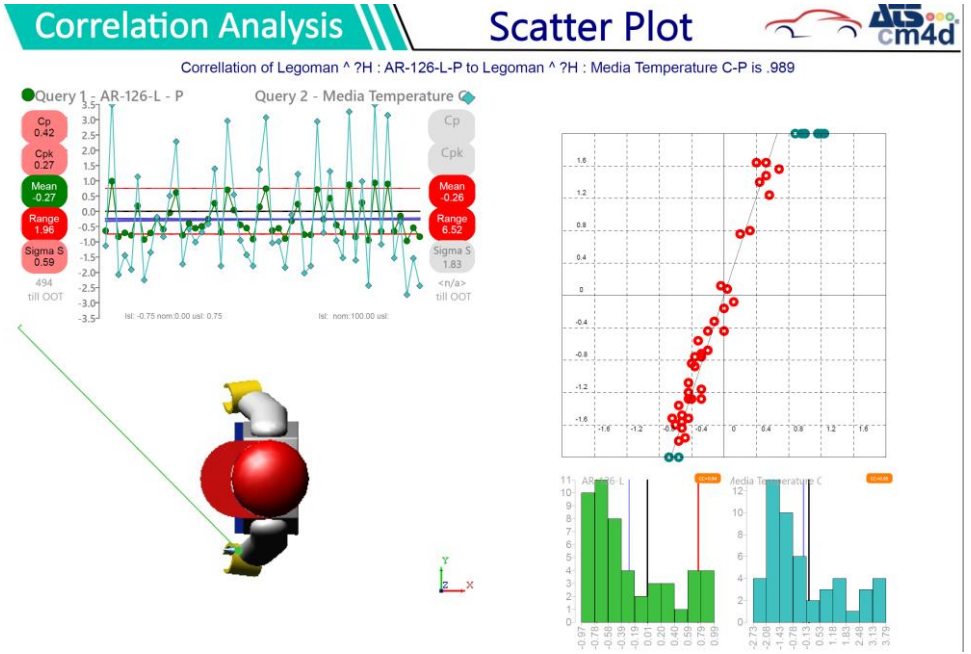

```
Query 1 Routine : Feature , Query 2 Routine : Feature , Correllation Coefficient
Hood asm ^ BH : M50001-Y,Hood asm ^ BH : Y2536C-RH-N,.951465684050554
Hood asm ^ BH : Y04AAT-RH-N,Hood asm ^ BH : X2546T-RH-N,.968951164449413
Hood asm ^ BH : Z04AAC-LH-N,Hood asm ^ BH : Z14BDC-LH-N,.995002578890934
Hood asm ^ BH : Z04AAC-RH-N,Hood asm ^ BH : Z14BDC-RH-N,.997416751939323
Hood asm ^ BH : Z04AAC-RH-N,Hood asm ^ BH : Z2546B-RH-N,.970640802694352
Hood asm ^ BH : Z04ABB-LH-N,Hood asm ^ BH : Z04ABC-LH-N,-.992632214502526
Hood asm ^ BH : Z04ABB-LH-N,Hood asm ^ BH : Z2640P-LH-N,-.960513198302258
Hood asm ^ BH : Z04ABB-LH-N,Hood asm ^ BH : Z29HCP-LH-N,-.977055685060754
Hood asm ^ BH : Z04ABC-LH-N,Hood asm ^ BH : Z2640P-LH-N,.957491167974101
Hood asm ^ BH : Z04ABC-LH-N,Hood asm ^ BH : Z29HCP-LH-N,.974751841835812
Hood asm ^ BH : Y13HKB-LH-N,Hood asm ^ BH : Y14BAB-LH-N,.995399366333515
Hood asm ^ BH : Y13HKB-LH-N,Hood asm ^ BH : Y14BBC-LH-N,.987926221815491
Hood asm ^ BH : Y13HKB-LH-N,Hood asm ^ BH : Z6582A-LH-N,.960167621852414
Hood asm ^ BH : Y13HKB-RH-N,Hood asm ^ BH : Y14BAB-RH-N,.994820130439724
Hood asm ^ BH : Y13HKB-RH-N,Hood asm ^ BH : Y14BBC-RH-N,.985586218744611
```

Real World Examples

Process parameter correlation.
The system searches for links between quality and process parameters from the machine controller.

```
Query 1 Routine : Feature , Query 2 Routine : Feature , Correllation Coefficient
Legoman ^ ?H : BD-092-C-P,Legoman ^ ?H : Tool Temperature C-P,.998055239007777
Legoman ^ ?H : BD-109-R-P,Legoman ^ ?H : Feed Pressure PSI-P,.972097711853572
Legoman ^ ?H : AR-126-L-P,Legoman ^ ?H : Media Temperature C-P,.989263775859194
Legoman ^ ?H : AR-127-L-P,Legoman ^ ?H : Act Feed Screw Speed %-P,.889732469209797
Legoman ^ ?H : AR-127-R-P,Legoman ^ ?H : Holding time-P,.908448111907511
```

Strong relationships are registered in the database as part of the machine learning process.



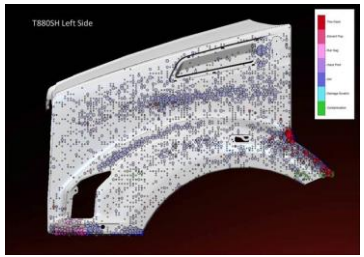
Correllation -R- Matrix Between Legoman ^ ?H With 31 Columns and Legoman ^ ?H With 9 Rows Using 50 Samples.

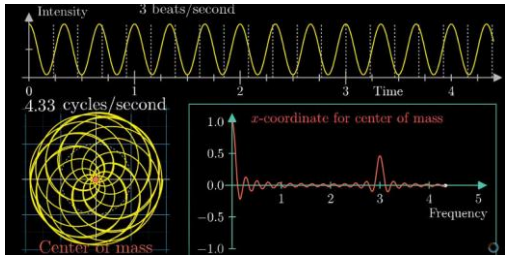
	BD-092-C-P	BD-102-L-P	BD-102-R-P	BD-104-L-P	BD-104-R-P	BD-106-L-P	BD-106-R-P	BD-109-L-P	BD-109-R-P	BD-111-L-P	BD-111-R-P	AR-122-L-P	AR-122-R-P	AR-126-L-P	AR-126-R-P	AR-127-L-P	AR-127-R-P	HN-135-L-P	HN-135-R-P	HN-144-L-P	HN-144-R-P
Tool Temperature C-P	0.998	0.187	0.141	0.054	0.221	0.029	0.021	0.005	0.238	0.118	0.031	0.075	0.017	0.005	0.201	0.113	0.1	0.123	0.011	0.171	0.02
Shift-P	0.001	0.034	0.161	0.073	0.18	0.091	0.06	0.217	0.082	0.196	0.023	0.019	0.186	0.013	0.102	0.123	0.045	0.245	0.086	0.269	0.074
Media Temperature C-P	0.002	0.176	0.02	0.176	0.067	0.199	0.274	0.068	0.18	0.04	0.142	0.105	0.076	0.989	0.03	0.081	0.075	0.043	0.142	0.005	0.275
Material Batch-P	0.105	0.083	0.177	0.102	0.366	0.05	0.145	0.174	0.215	0.019	0.231	0.005	0.183	0.085	0.165	0.04	0.079	0.078	0.296	0.066	0.044
Machine ID-P	0.169	0.106	0.073	0.064	0.062	0.178	0.196	00	0.104	0.178	0.003	0.079	0.07	0.107	0.238	0.064	0.212	0.057	0.194	0.079	0.034
Holding time-P	0.224	0.006	0.28	0.032	0.073	0.009	0.173	0.159	0.027	0.022	0.164	0.088	0.119	0.09	0.085	0.15	0.908	0.08	0.052	0.037	0.119
Feed Pressure PSI-P	0.331	0.166	0.192	0.07	0.067	0.063	0.025	0.189	0.972	0.075	0.034	0.089	0.018	0.193	0.265	0.07	0.21	0.139	0.296	0.195	0.047
Ambient Temperature C-P	0.022	0.254	0.203	0.098	0.031	0.082	0.093	0.32	0.008	0.252	0.177	0.008	0.033	0.031	0.083	0.017	0.202	0.038	0.123	0.001	0.027
t Feed Screw Speed %-P	0.16	0.347	00	0.397	0.08	0.145	0.05	0.187	0.09	0.024	0.067	0.153	0.047	0.106	0.077	0.89	0.031	0.172	0.044	0.072	0.287

How Does CM4D Learn About Relationships.

Sources of Influence.

1. XYZ Position.
2. Tolerance Stack Analysis
   (VSA/RDnT).
3. Correlation Analysis.
4. User Input.
5. Complex Pattern Analysis.
   (Rulex/Fourier Transform).
6. Condition Based Maintenance.
   (IBM Watson)



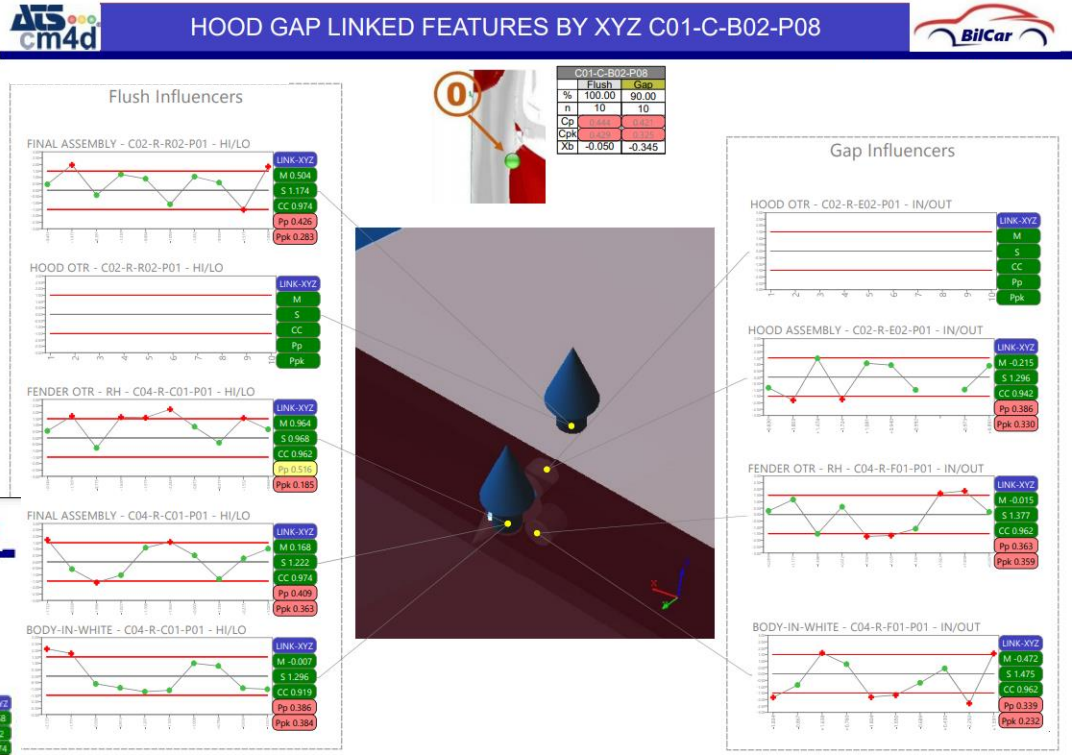


Overall Methodology…

- Sources of influence create relationships.
- A separate file is created for each source of influence.
- The contents of the output files are added to the CM4D database as feature links.
- Features that have at least 1 feature of influence will be marked using a feature filter.
- Users can then search for those features with influence and easily see the list of influencers.
- A CM4D script enables a user to rapidly build a view template for any routine or feature.

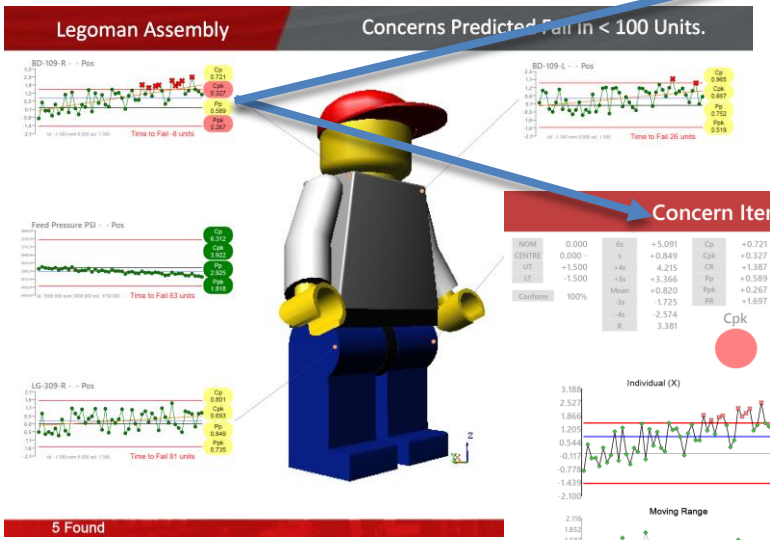
Real World Examples

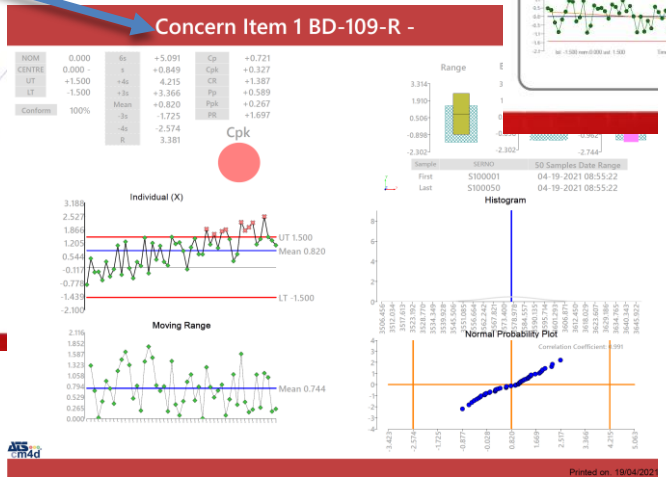
Here CM4D has detected a problem with Gap and Flush at the hood corner.
A query is run to collect data from related features throughout the vehicle structure.
A report showing all known causes of gap / flush quality issues is immediately sent to the responsible engineer.

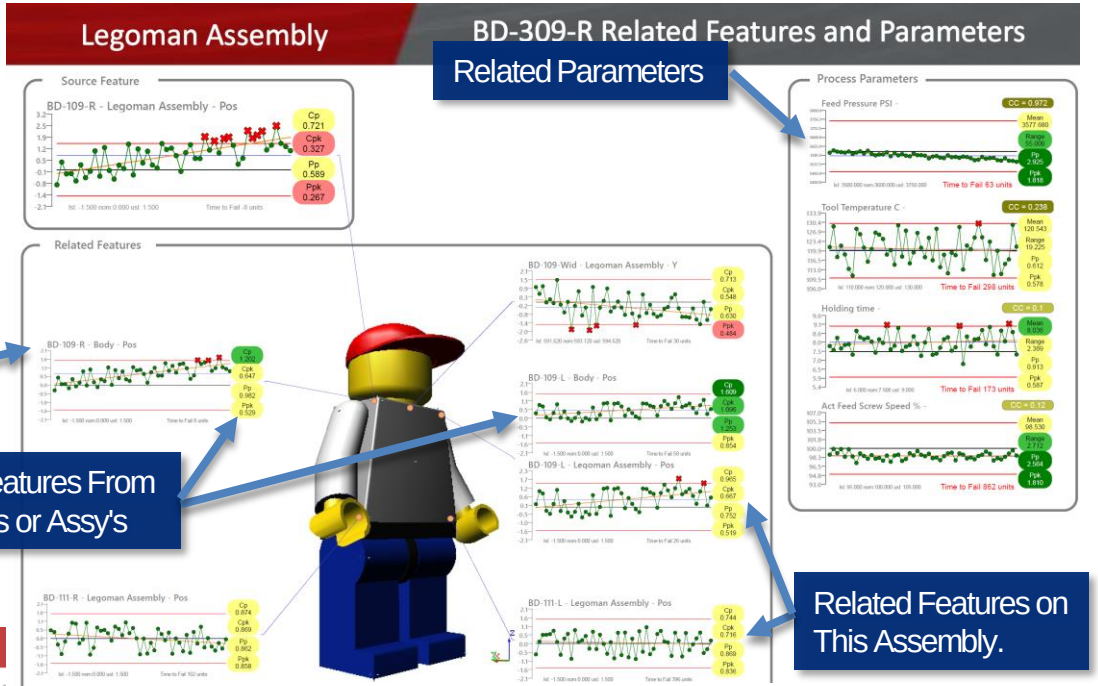


Real World Examples

The CM4D alarming can be set to predict time to failure.
When feature BD-309-R triggers it gets a full-page statistical analysis and a single page report showing the data from all related features and process parameters.







The drop in process pressure seems to be the cause of a number of related quality issues, despite still being within acceptable limits.

As more data is collected and more relationships discovered the system becomes incrementally better at finding the root cause of any issue.

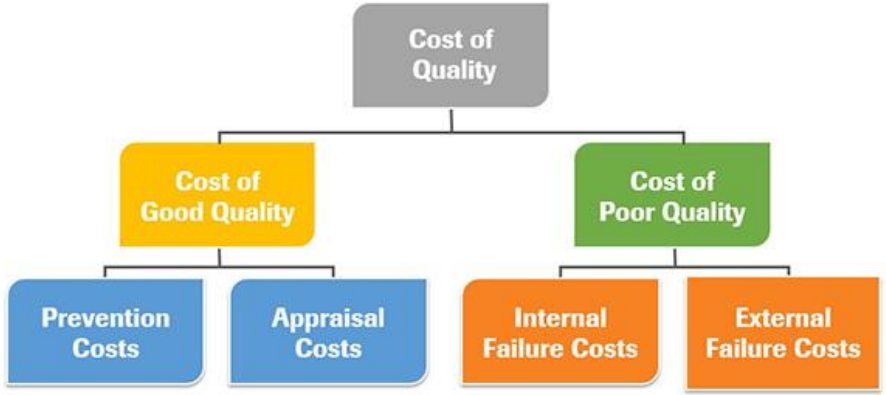
Conclusion

By combining the already available data, quality and process, you can reduce cost of quality, improve quality and output.

By applying modern analysis techniques, you can reduce reports to only show items of concern.

By applying machine learning and linking to AI systems it is possible to predict failure and rapidly get to the root cause of failures/issues.

Future work will enable the system to suggest actions to prevent failure.



• Q&A

Upcoming webinar:

29 April at 3PM BST

The No-Code Approach to Manufacturing Data Integration

How can you connect the systems and equipment in your entire plant together, without writing a single line of code benefits and more.

The *Independent* Solution Provider for Smart Digital Transformation

our experience, your success

LinkedIn Facebook Twitter YouTube

Marco Nanninga
Marco.Nanninga@ats-global.com

Edward Morris
Edward.Morris@ats-global.com