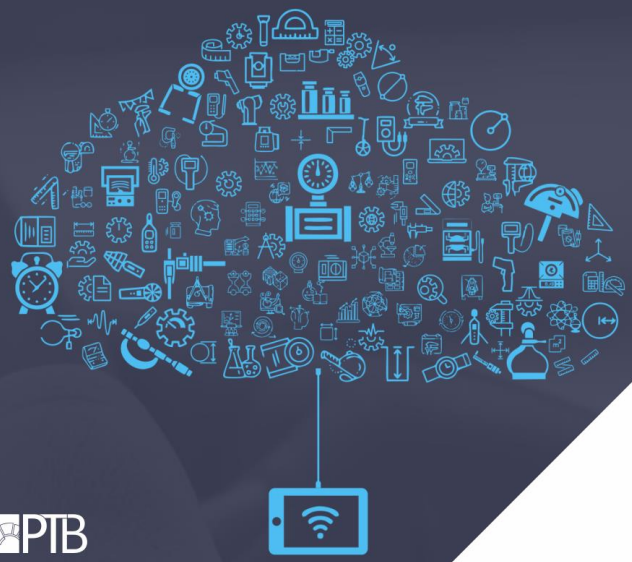
First steps towards the development of a digital twin.



Aldo adrián García González
M4DT Agile Projects

SIM
SISTEMA INTERAMERICANO DE METROLOGÍA

Metrology for Digital Transformation
SIM-MWG-14

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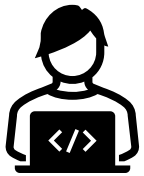
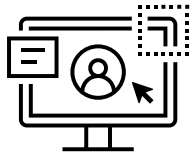
Content

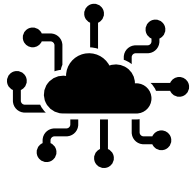
Intro & Definition



Steps



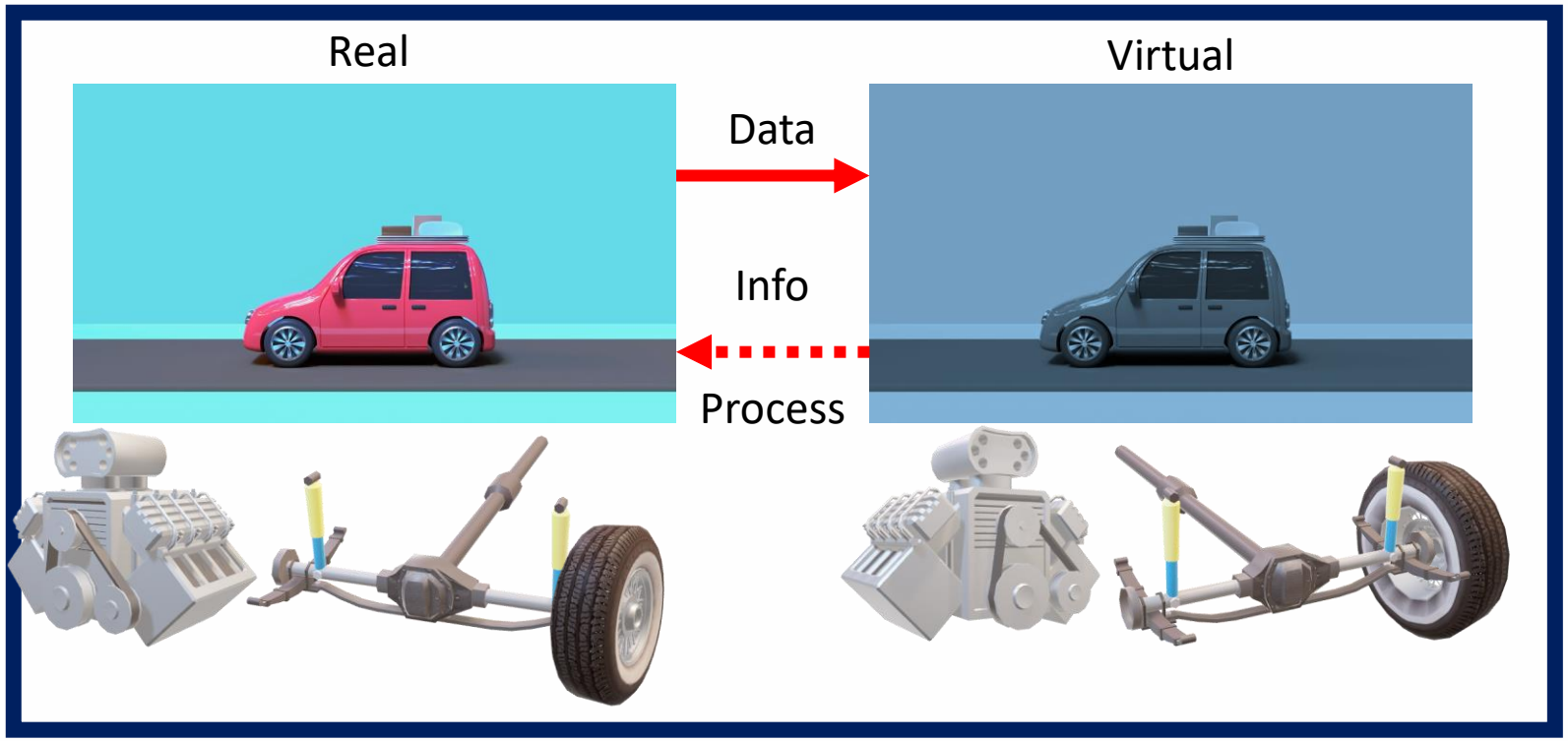
Example



Work in progress

Introduction & Definition

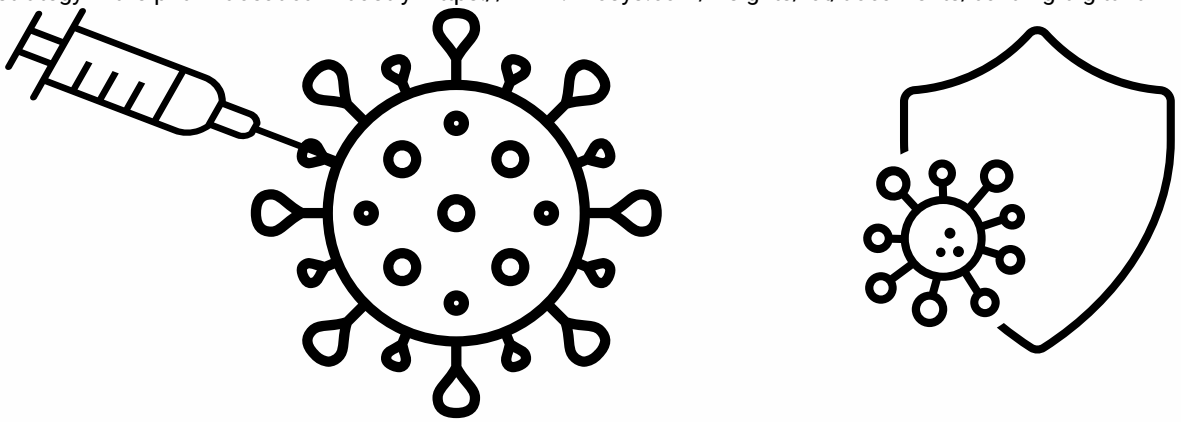
“ Its a virtual representation employed to understand and foretell the behavior of its physical equivalent”



DT at health

DT modelling for vaccine manufacturing[1]

Digital Twin strategy in the pharmaceutical industry- https://www.infosys.com/insights/iot/documents/building-digital-twin.pdf



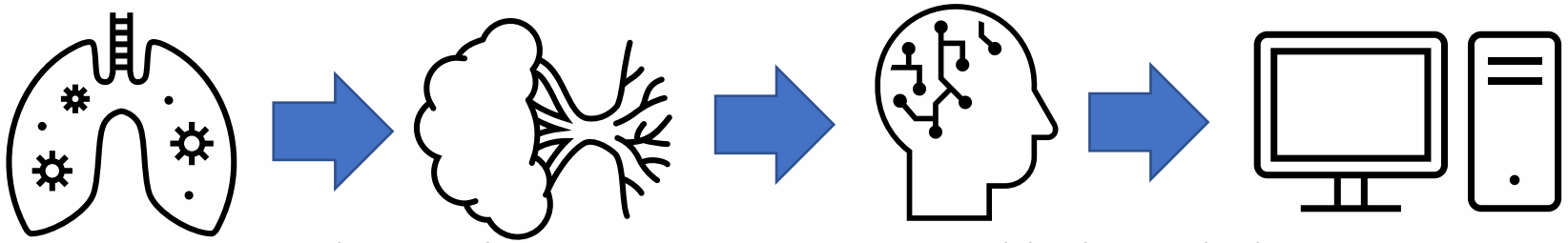
DT Strategy to Stabilize Ventilator Demand Amidst Pandemic

Image Lungs and créate 3D model

Run Sims of blood And Oxygen Flow

Train AI with Simulation Data

Predict Ventilation Requiriments



BreathEasy project- https://www.enterpriseai.news/2020/04/15/onscale-launches-project-breatheasy/

Update Digital Twin

Potential of the DT

3D Representation

Visualization

Data Model

Model Syncrhronization

Simulation

Document Manager

Model

Connected analytics

Types of DT

Classes of DT

C/Part

Asset

System

Process

Twinning

EPICS/GOALS:

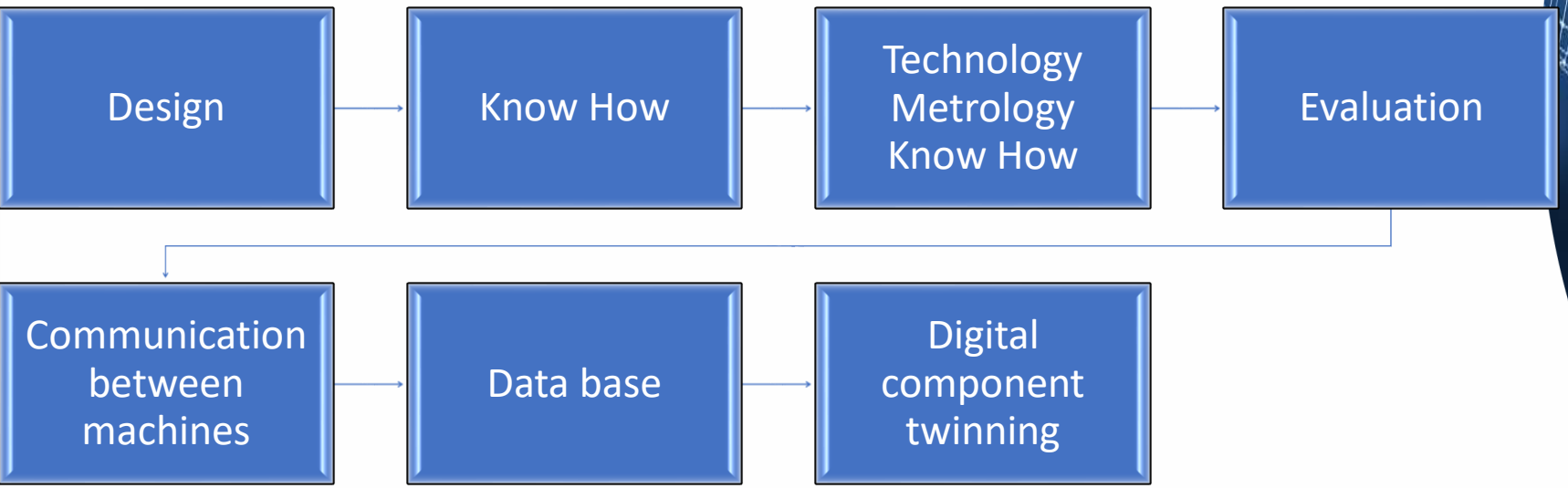
Vibration analysis system for farm tractor differential

- Develop a high resolution vibration analysis algorithm system using accelerometers
- Develop an algorithm to upload measured data to digital data cloud (XML)
- Industry 4.0+Metrology 4.0 (traceability)
- Future Digital Component Twinning in collaboration with the client

METHODOLOGY :

Vibration analysis system for farm tractor differential

Metrological projects are focused in the develop of systems that adapts to the costumer needs, in this case a vibration analysis system test cell was developed to measure the “health” of the mechanism inside of a tractor differential in a production line



Important aspects of the proyect:

Vibration analysis system for farm tractor differential

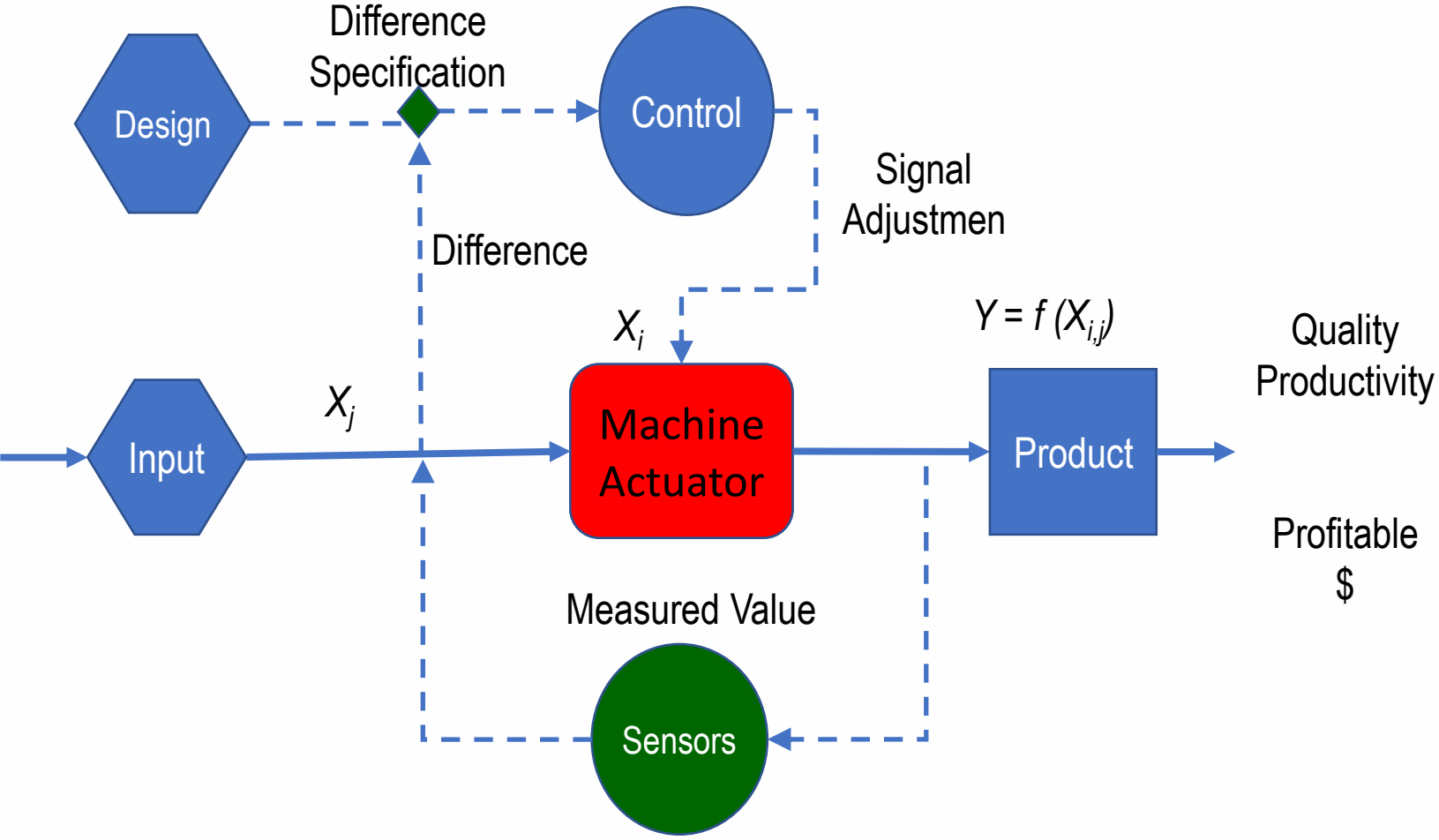
Creation of a Line for Design and Manufacture of Equipment for Functional Testing of Automotive Transmissions.

- One of the most fruitful avenues for innovation in metrology is when integrating measurement technology into direct industrial application equipment.
- Online functional and dynamic measurement is fundamental to smart manufacturing systems (Industry 4.0 & Digital Twins).
- The measurement of functional parameters of manufactured systems poses complex challenges due to the combination of variables involved.
- This article shows a successful example of systems integration for measurement of this type, achieved by the institutional collaboration with stakeholders.
- It is hoped that examples such as this one will open the way for the development of an integration and instrumentation industry at SIM.

Project Vision:

Vibration analysis system for farm tractor differential

Measurement-Control-Process System
in the Value Chain of a Production System



Echeverria –Villagomez, J.S, Zambrano, L,.etal. Metrology Investment Porjectsfor process effectiveness. NCSL, Tx, USA 2015

Know and then undestand the needs:

Vibration analysis system for farm tractor differential

The client

- Manufactures and assembles powertrain differential mechanisms for tractors.
- All powertrain components combine material (strength, hardness, weight...), dimensional (length, diameters, complex shapes...) and functional requirements.
- Among the functional requirements of a differential gearbox are:
  - Pinion and Gear interaction.
  - Misalignment
  - Bearings.
  - Backlash.
  - Torque or residual friction torque.
- The Customer requires, at the end of its assembly line, a work station that allows to measure the previous parameters and others coming from vibrations inside the mechanism, at 100% of its production, in a dynamic way, and to determine if the differential passes or does not pass according to a study made to the different models.
- M2M communication

DESIGN:

Vibration analysis system for farm tractor differential

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Design

Know and then undestand the needs → Increase quality production, reduce assembly defects and the noise caused by them. In a Pass/fail system

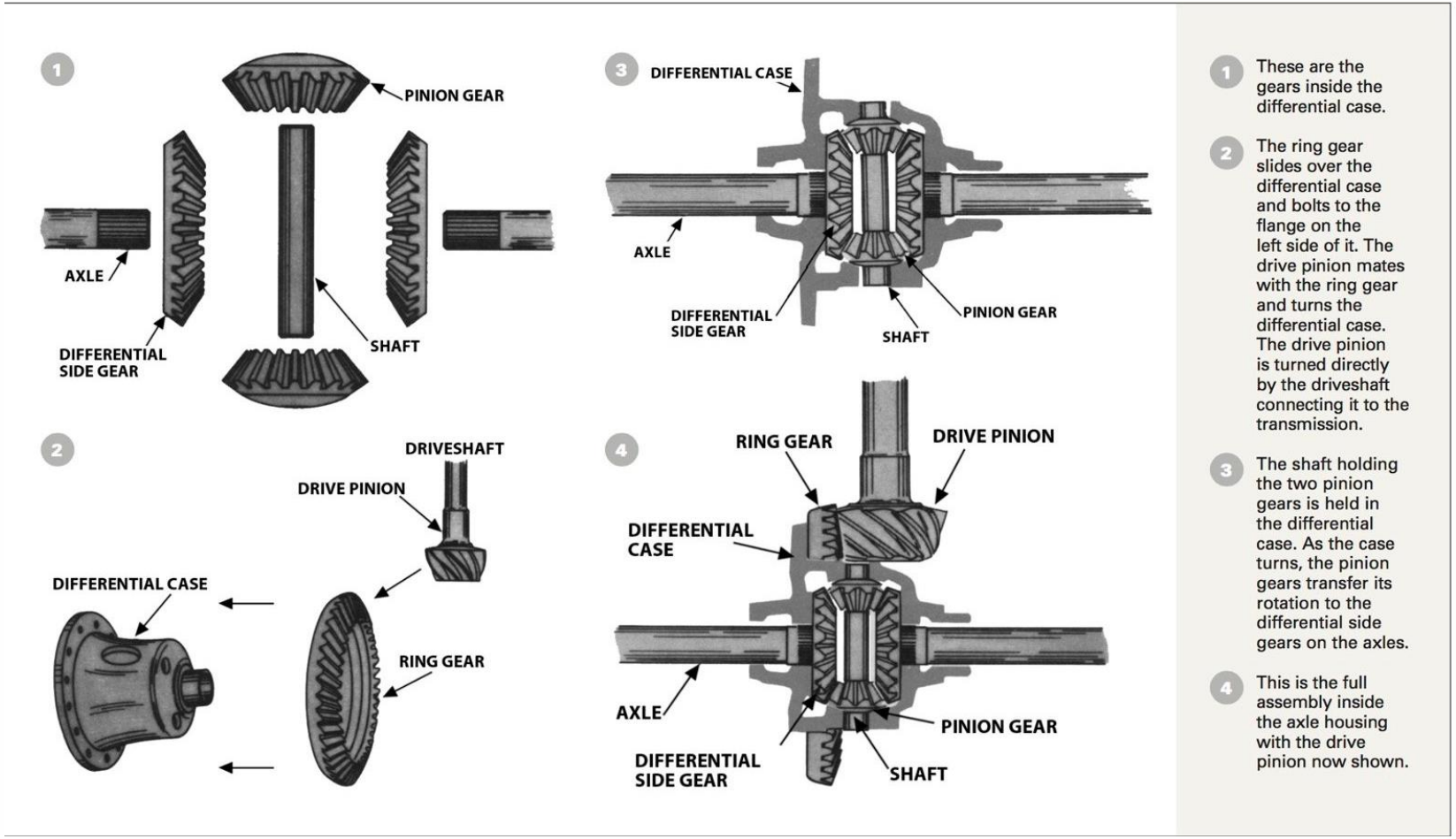
Create a design → Research about tractor differential mechanism define FR´s and DP´s

Create a model → Develop a test bench to generate a measurement knowledge

Test and evaluation → Iterative XP process to improve measurement system and TT.

Create a design:

Vibration analysis system for farm tractor differential



1. These are the gears inside the differential case.
2. The ring gear slides over the differential case and bolts to the flange on the left side of it. The drive pinion mates with the ring gear and turns the differential case. The drive pinion is turned directly by the driveshaft connecting it to the transmission.
3. The shaft holding the two pinion gears is held in the differential case. As the case turns, the pinion gears transfer its rotation to the differential side gears on the axles.
4. This is the full assembly inside the axle housing with the drive pinion now shown.

https://www.grainews.ca/machinery-shop/how-it-works-the-differential/

Create a model:

Vibration analysis system for farm tractor differential

Test & Evaluation:
Vibration analysis system for farm tractor differential

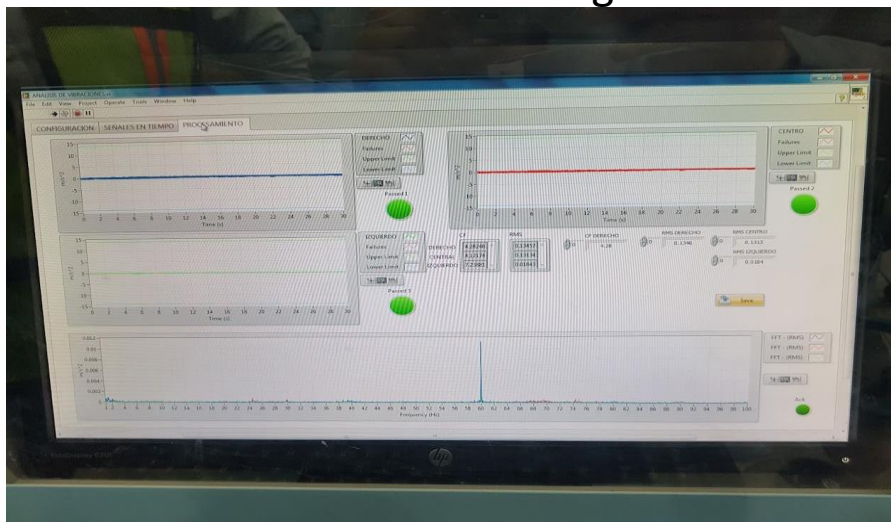
Transfer Metrology Know how:

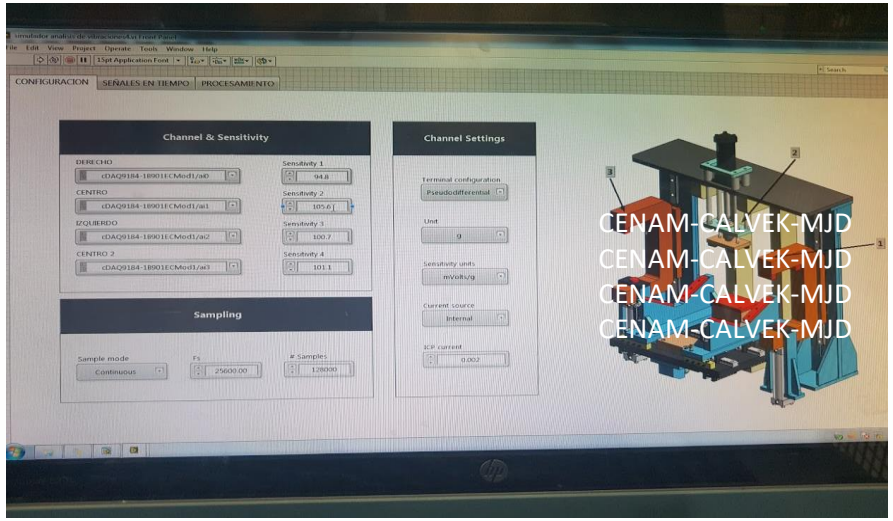
Vibration analysis system for farm tractor differential

M2M Communication:

Vibration analysis system for farm tractor differential

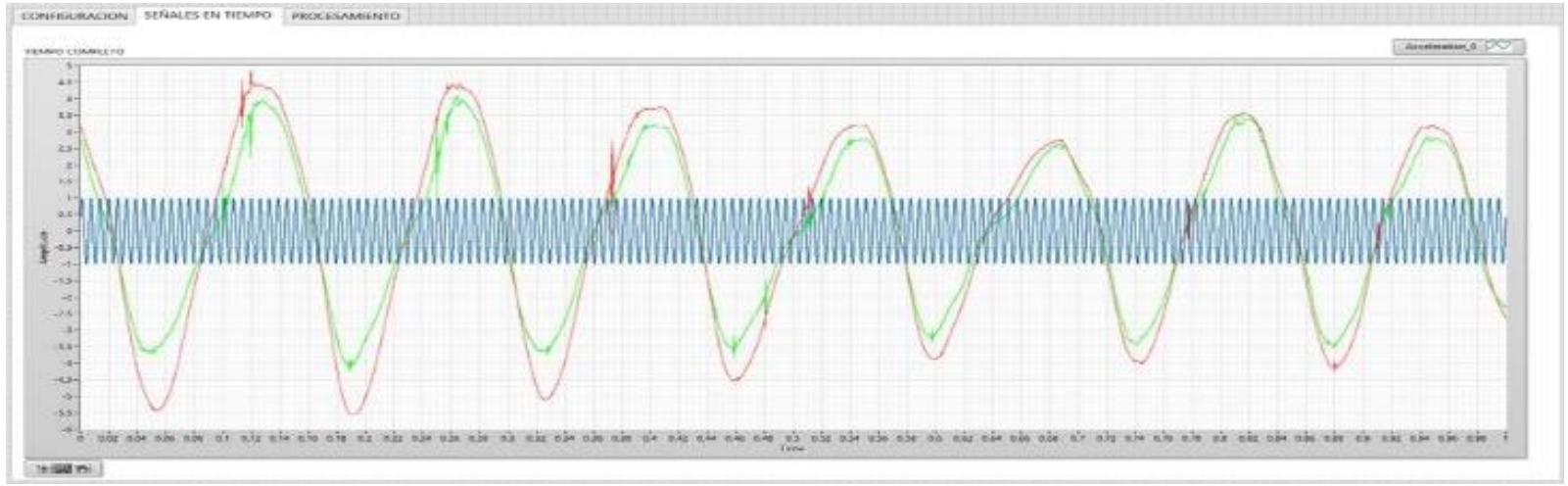
Developed Software in LabVIEW+ XML communication stage

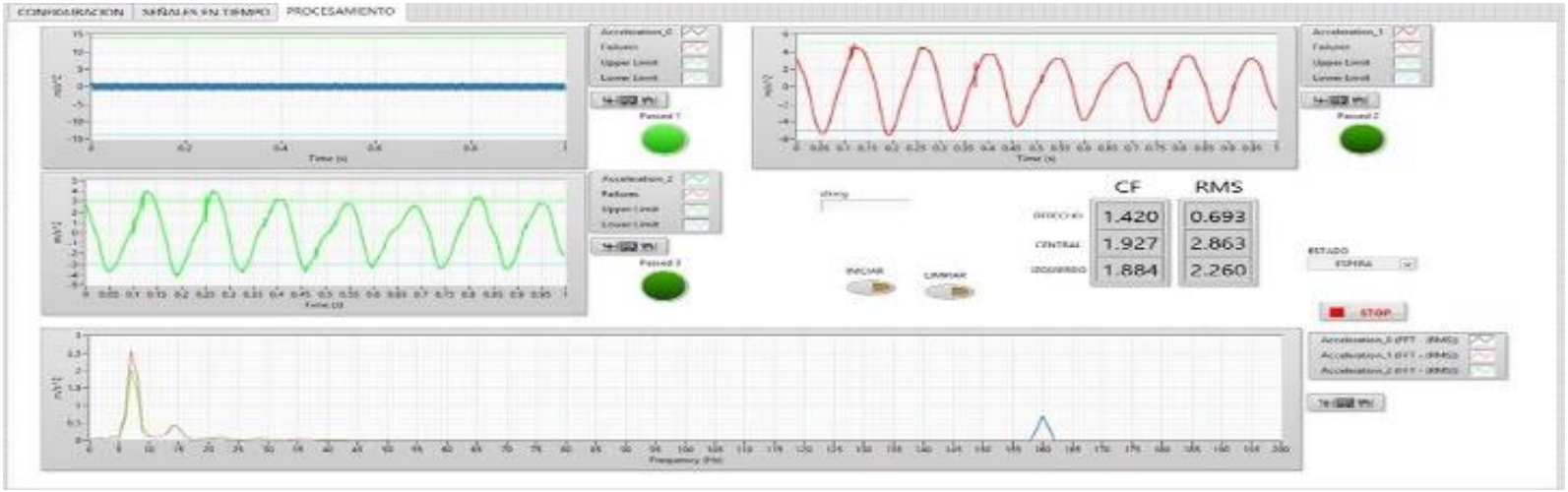




M2M Communication:
Vibration analysis system for farm tractor differential

- The system works as follow:





M2M Metrology Parameters:

Vibration analysis system for farm tractor differential

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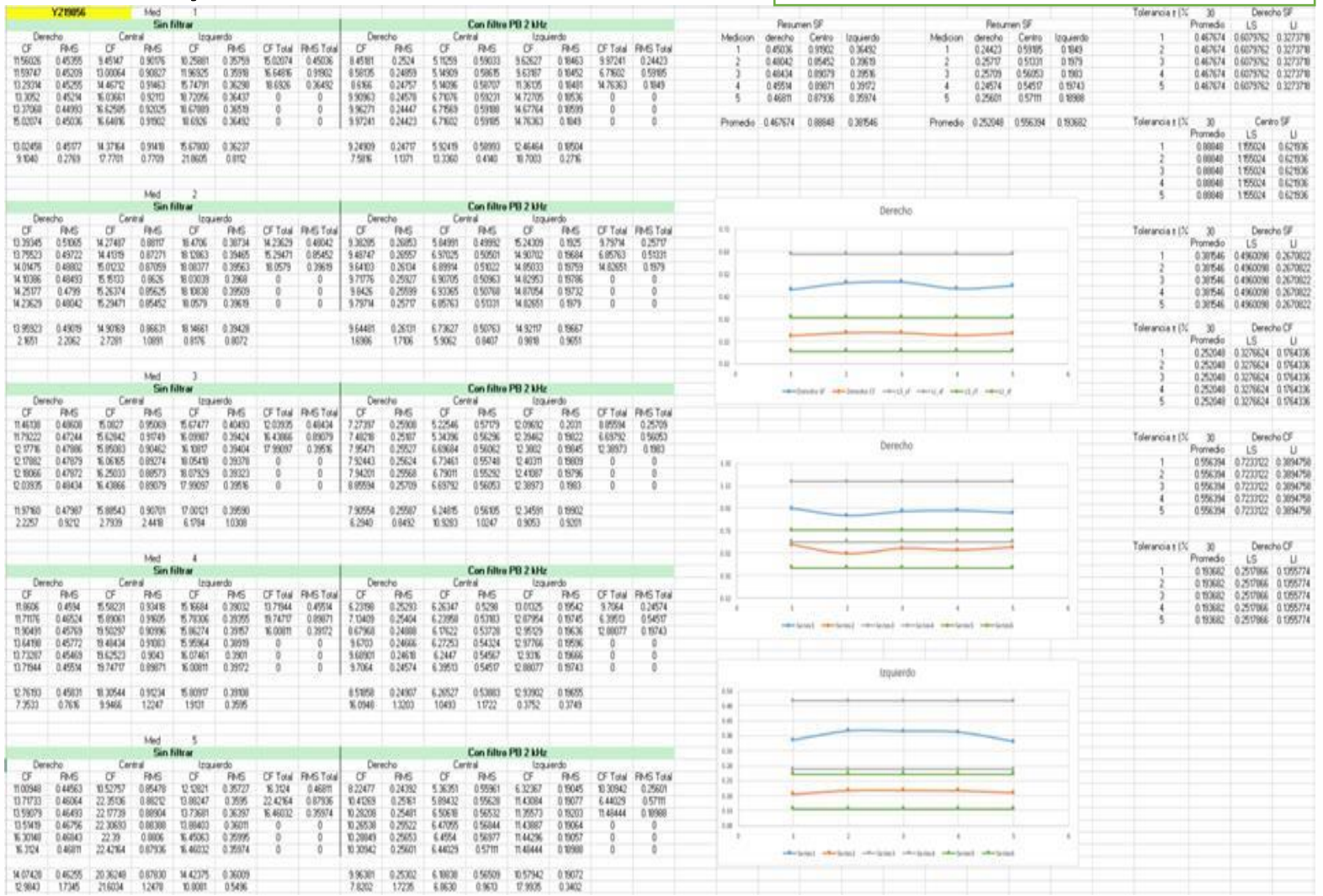
- The system works as follow:

Collected data obtained of the test of the differentials to stablish new limits



Data Base input :

Vibration analysis system for farm tractor differential

- The system works as follow:

Developed algorithm to send the results in XML and then to the data cloud

Parte: Eje Captura

Serial Num: YZ123

Model Num: 456

Station Result: PASS

Operation Result: PASS

Result	Value Result	Upper Limit
Pass	0.111	1.1
Pass	0.222	1
Pass	0.333	0.95
Fail	1.11	2.2
Fail	1.22	2.6
Fail	1.33	2.1

XML String

```
<?xml version="1.0" encoding="utf-8"?>
<root xmlns="http://www.sciemetric.com/namespace">
  <single_part>
    <information>
      <source>
        <version>1.0</version>
        <date> 2017-03-22T09:47:46</date>
        <application>Vibration_Test</application>
      </source>
    </information>
    <part>
      <label>Eje Captura</label>
      <serial_number>YZ123</serial_number>
      <model_number>
        <label>456</label>
      </model_number>
    </part>
    <sections>
      <section>
        <label>Section_1</label>
        <stations>
          <station>
            <label>Station_1</label>
            <result>
              <label>PASS</label>
            </result>
            <type>
              <label>Vibration_test</label>
            </type>
            <operations>
              <operation>
                <label>Operation_00</label>
                <description>Axle vibration test</description>
                <result>
                  <label>PASS</label>
```

Digital Component Twinning:

Vibration analysis system for farm tractor differential

Real

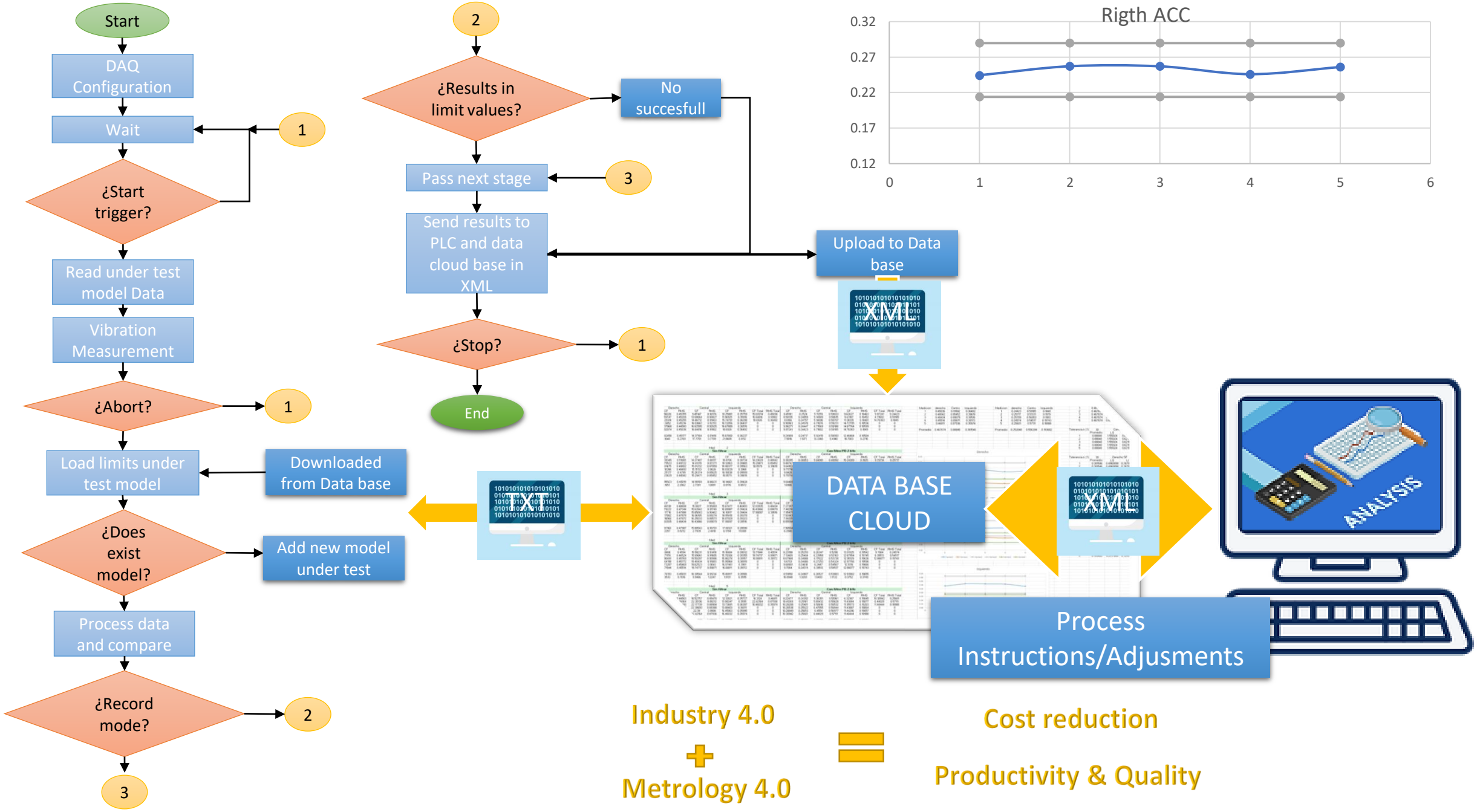
Data

Raw DATA
XML Data
CC Accelerometer
CC DAQ

Info-Calculed New Trends

Process/Adjustment

Virtual /
Client Software


Start
DAQ Configuration
Wait
1
¿Start trigger?
Read under test model Data
Vibration Measurement
¿Abort?
1
Load limits under test model
Downloaded from Data base
¿Does exist model?
Add new model under test
Process data and compare
¿Record mode?
2
3
2
¿Results in limit values?
No succesfull
Pass next stage
3
Send results to PLC and data cloud base in XML
¿Stop?
1
End
Rigth ACC
0.32
0.27
0.22
0.17
0.12
0
1
2
3
4
5
6
Upload to Data base
XML
DATA BASE CLOUD
XML
ANALYSIS
Process Instructions/Adjusments
Industry 4.0
+
Metrology 4.0
=
Cost reduction
Productivity & Quality

Work in progress:

Digital Twin Implementations

Add Agile Model to develop Projects (MESURA+AGILE)

Include DCC to digital traceability and DT actualization.

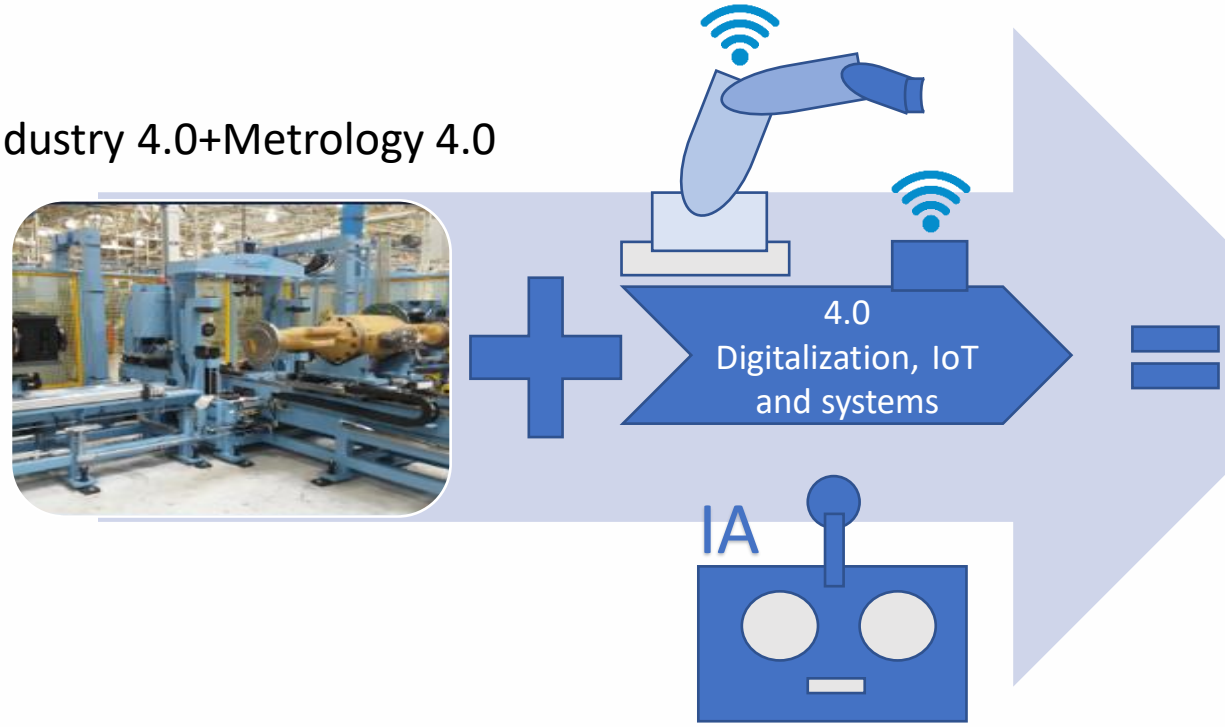
Implement our own AI algorithms for focusing on metrology.

Implement DPS for Real Time process improvement

Develop better toolkits of XML Metadata

Remote Verification for accelerometers

Industry 4.0+Metrology 4.0



Metrology for Digital Transformation

SIM Conference 2021

September 1st and 2nd

organized by SIM-MWG-14

Thanks for your atenttion

ALDO ADRIÁN GARCÍA GONZÁLEZ

E-MAIL: algarcia@cenam.mx

TEL: 4422110500 EXT 3502

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