

FoF Optimization: Human and Process Perspectives

- 09/06/2022
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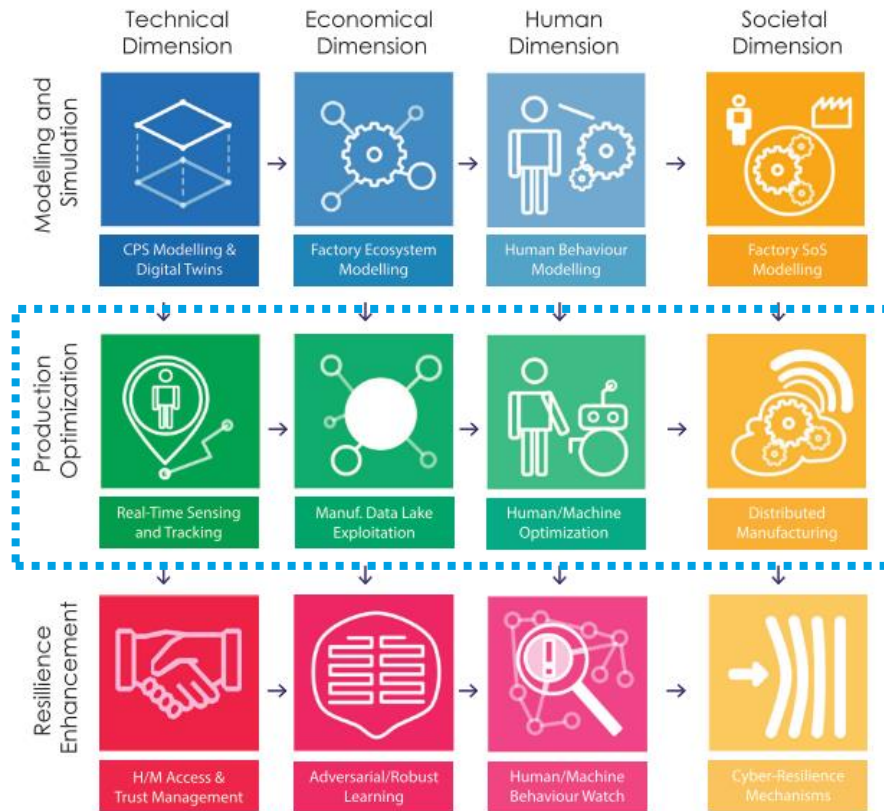


- One of the main technical workpackages of the project
- Solve complex, yet concrete, management problems at manufacturing shopfloors:
 - (O1) Understand the human dimension of work (mood, tiredness, efficiency, security...)
 - (O2) Efficiently organize the production in distributed manufacturing environments
 - (O3) Efficient energy consumption - diagnosis and prognosis
 - (O4) Network intrusion detection and mitigation

To tackle these problems, the following capabilities were developed:

- RT sensing & tracking
- Data lake Exploitation
- Human/Machine Optimization
- Distributed Manufacturing

(At least) 1system/capability was developed within the portuguese consortium



Consortium complementarity...

SisTrade[®]
Software Consulting, S.A.

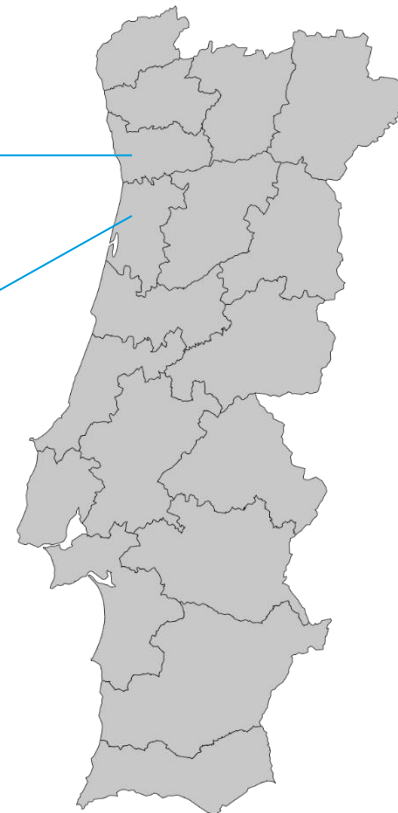
ERP & supply
chain provider

isep Instituto Superior de
Engenharia do Porto

Research Institute

idepa THE ACCESSORY
IS ESSENTIAL

End-user/Pilot



Idepa - Indústria de Passamanarias

Portuguese SME | Textile Fine Fittings | Accessories
for Brand Value

Well established | 50 years of history

Production Models | Stock | Build-to-order

Wide Range of Processes | Warp and Weft |
Jacquard Weaving | Ratière Weaving | Dyeing |
Printing | Cut and Finishing

Good Ol' European Manufacturing | Remanescent of
the 1st industrial Revolution | European Know-how



Idepa Product Families

Branding

Promo

Automotive

Yarns

Technical



Capability Objective: Extend tracking and geolocation to materials, people, smart manufacturing assets and finished goods; provide data for the situational awareness of the whole process, entities and environment;

Capability Developments:

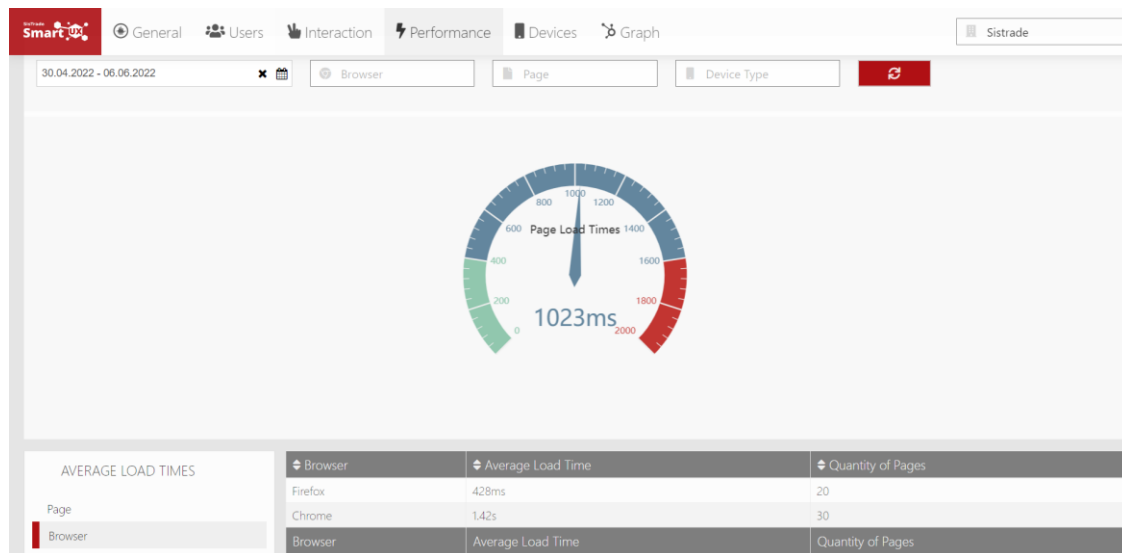
- Shopfloor analysis (existing machines and sensorization maturity level)
- Data acquisition layer (with schema specification)
- Energy Analysers
- SmartIOT Hub



Real-Time Sensing
and Tracking

SmartUX is a tool for automatic and non-intrusive [Human-machine data collection](#)

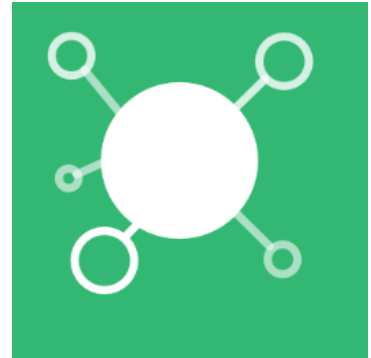
- Monitors and continuously gather usability metrics
 - Page Visits
 - Number of Clicks
 - Distance Travelled
 - Exit and Bounce Rates
 - Performance Data
- Allows misusing detection
- Integrated interface
- Anonymous data collection



Capability Objective: Enabling of opportunities to build new business opportunities based on big data analytics over the manufacturing data thread

Capability Developments:

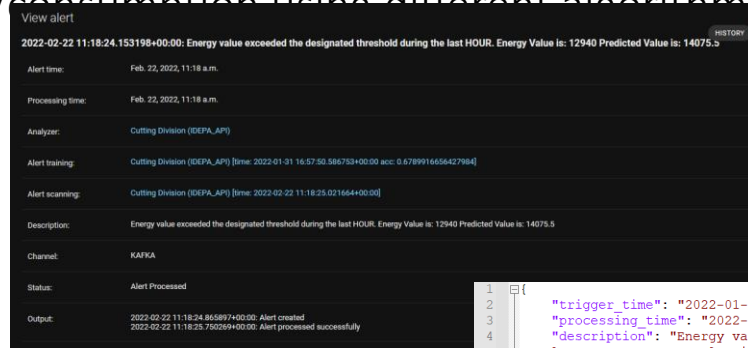
- Data Lake
- Energy Consumption (diagnosis and prognosis)
- Human Emotional and Physical Behavior Detection
- Network Intrusion Detection
- IoT Sensing



Manuf. Data Lake
Exploitation

CyberFactory#1 **Energy Forecasting Tool** aims at providing a multifunctional tool to perform forecasting for power generation/consumption using different algorithms.

- Consumption profiling (sections/machines)
- Day-ahead forecasting
- Anomaly Detection (alarm generation)



View alert

2022-02-22 11:18:24.153198+00:00: Energy value exceeded the designated threshold during the last HOUR. Energy Value is: 12940 Predicted Value is: 14075.5

Alert time: Feb. 22, 2022, 11:18 a.m.

Processing time: Feb. 22, 2022, 11:18 a.m.

Analyzer: Cutting Division (DEPA_API)

Alert training: Cutting Division (DEPA_API) time: 2022-01-01 16:57:50.586753+00:00 acc: 0.6789916656427984

Alert scanning: Cutting Division (DEPA_API) time: 2022-02-22 11:18:25.021664+00:00

Description: Energy value exceeded the designated threshold during the last HOUR. Energy Value is: 12940 Predicted Value is: 14075.5

Channel: KAFKA

Status: Alert Processed

Output: 2022-02-22 11:18:24.865897+00:00: Alert created
2022-02-22 11:18:25.750269+00:00: Alert processed successfully

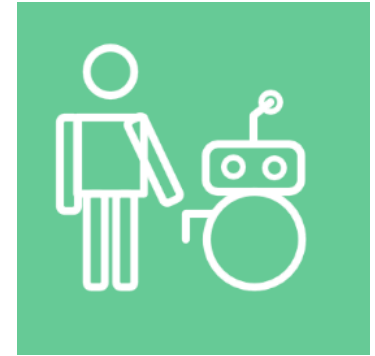


```
1 [{"trigger_time": "2022-01-17T16:24:54.787484+00:00",
2  "processing_time": "2022-01-17T16:24:54.997518+00:00",
3  "description": "Energy value exceeded the designated threshold during the
4  last HOUR. Energy Value is: 13833 Predicted Value is: 11665.076923076924",
5  "analyzer": "Cutting Division",
6  "provider": "IDEPA",
7  "training_details": {
8    "start_time": "2022-01-17T16:24:20.562542+00:00",
9    "end_time": "2022-01-17T16:24:22.381506+00:00",
10   "accuracy_r2": 0.8392024963776039,
11   "columns": "[\"year\", \"month\", \"day\", \"hour\", \"target\"]",
12   "data_rows_num": 73,
13   "data_columns_num": 5,
14   "estimator_details": "AdaBoostRegressor()",
15   "validation_details": "KFold(n_splits=5, random_state=None,
16   shuffle=True)",
17   "aggregation_window": "HOUR"
18 },
19 "scanning_details": {
20   "start_time": "2022-01-17T16:24:53.981535+00:00",
21   "end_time": "2022-01-17T16:24:55.184482+00:00",
22   "prediction_sample": "[2022, 1, 17, 15]",
23   "actual_energy_value": 13833.0,
24   "predicted_energy_value": 11665.076923076924,
25   "diff_energy_value": 2167.923076923076,
26   "threshold_energy_value": 1000.0
27 }
}
```

Capability Objective: Optimization of human / machine collaboration on the shop-floor

Capability Developments:

- Human Pose Detection
- Human Recognition
- Facial Recognition



Human-Machine
Optimization

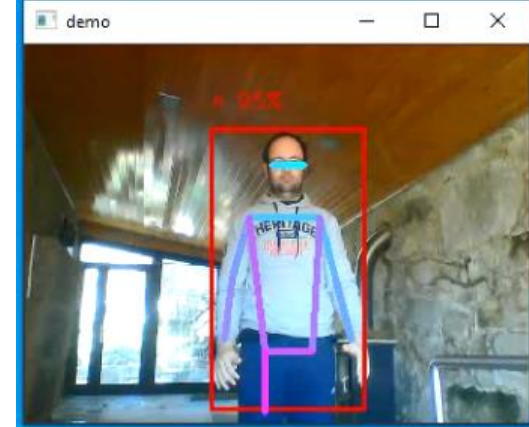
Emotion Detection



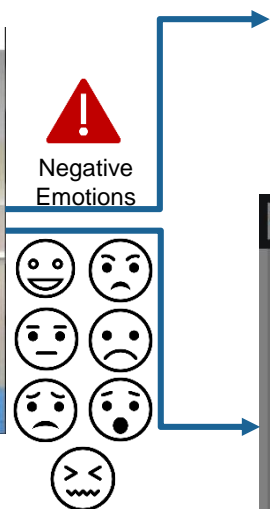
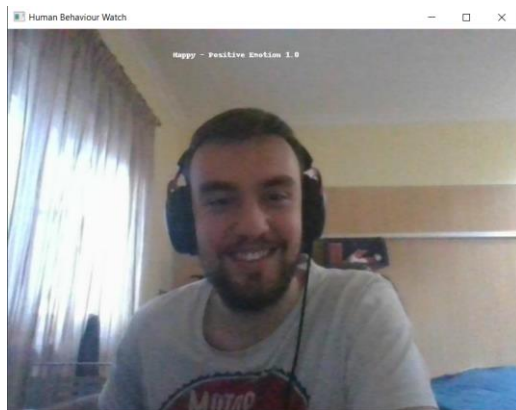
Human Recognition



Human Pose Detection



Negative Emotion Detection



Go/NoGo Results

Average reaction time: 279 ms
Number of Go fails: 0 of 16 (0%)
Number of NoGo fails: 2 of 4 (50%)

Fatigue prediction

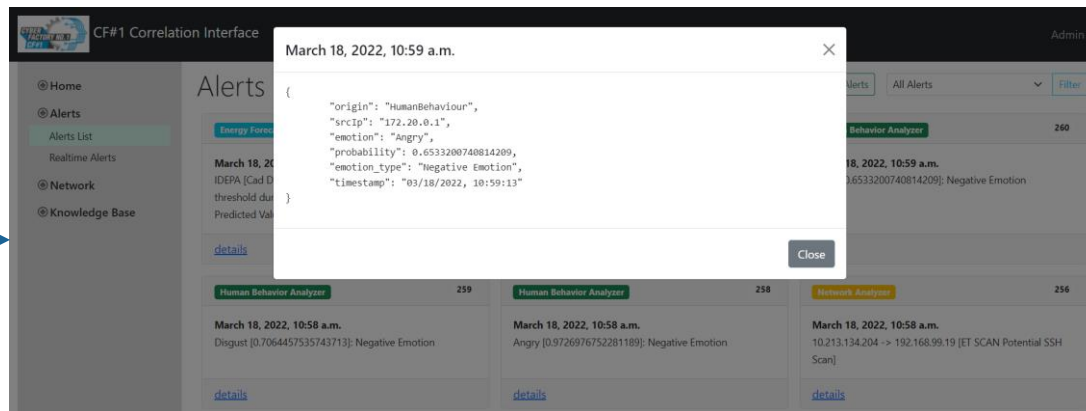
Fatigue level: Pending prediction
Description: No description

Fatigue

Please rate your fatigue level by choosing the description that best matches your condition.

- L1 Fully Alert; Wide Awake; Extremely Peppy
- L2 Very Lively; Responsive; But Not At Peak
- L3 Okay; Somewhat Fresh
- L4 A Little Tired; Less Than Fresh
- L5 Exhausted; Unable to Concentrate
- L6 Extremely Tired; Very Difficult to Concentrate
- L7 Completely exhausted; Unable to Function Effectively; Ready to Drop

Submit



CF#1 Correlation Interface

Alerts

March 18, 2022, 10:59 a.m.

```
{
  "origin": "HumanBehaviour",
  "srcip": "172.20.0.1",
  "emotion": "Angry",
  "probability": 0.653200740814209,
  "emotion_type": "Negative Emotion",
  "timestamp": "03/18/2022, 10:59:13"
}
```

Human Behavior Analyzer 259

Human Behavior Analyzer 258

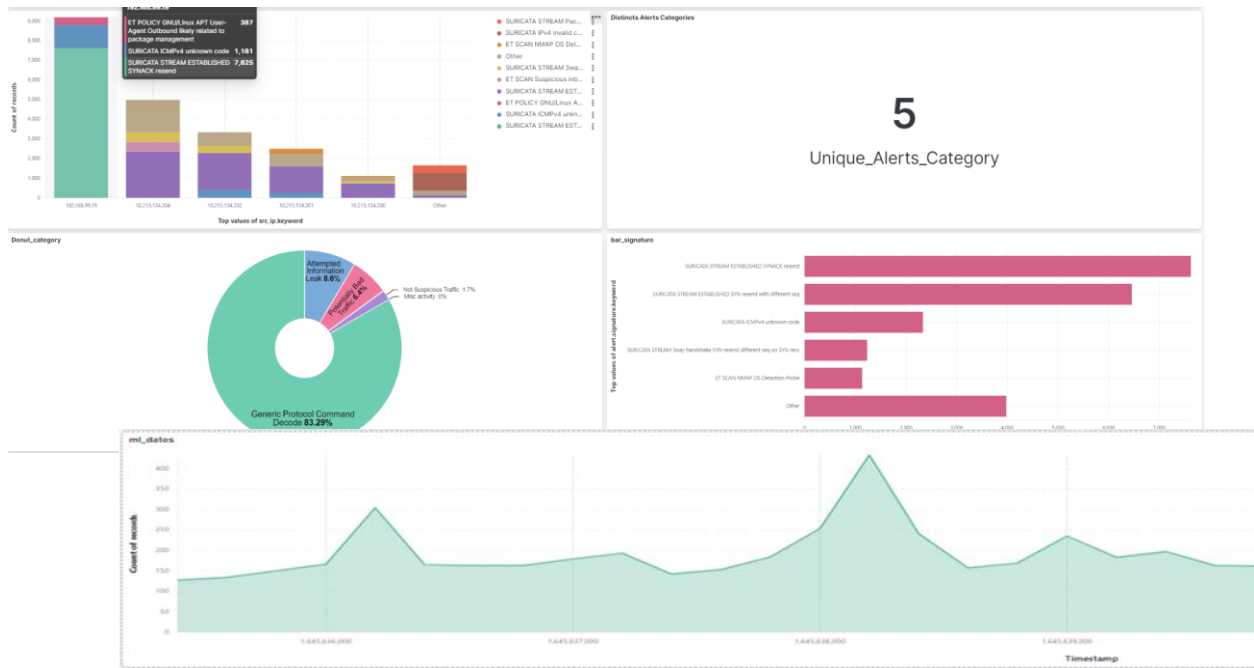
Network Analyzer 256

March 18, 2022, 10:58 a.m.
Disgust [0.7064457535743713]: Negative Emotion

March 18, 2022, 10:58 a.m.
Angry [0.9726976752281189]: Negative Emotion

March 18, 2022, 10:58 a.m.
10.213.134.204 -> 192.168.99.19 [ET SCAN Potential SSH Scan]

Network Analyser



```
{
  "_index": "ml_alerts",
  "_type": "_doc",
  "_id": "8jmSJ38B0lvkqJMhWkCX",
  "_version": 1,
  "_score": 1,
  "_source": {
    "SrcIp": "192.168.99.19",
    "DestIp": "10.213.134.202",
    "SrcPt": "417",
    "DestPt": "36667",
    "Timestamp": 1645636377,
    "Proto": "TCP",
    "InBytes": "20",
    "OutBytes": "0",
    "InPkts": "1",
    "OutPkts": "0",
    "tcp_flags": "...A.R.."
  },
}
```

Capability Objective: Distributed manufacturing capability: enabling to optimize the distributing of production load over a network of factories or fab-labs in real time

Capability Developments:

- Cloud based service scheduling of distributed production



Distributed
Manufacturing

PICO is a distributed production scheduling optimization API, with **multi-factory representation**, **multi-domain** and **multi-criteria** decision making

- Scheduling and multi-site shopfloor data exchange
- Multi-criteria optimization
- Automatic optimization features (algorithms/parameters)



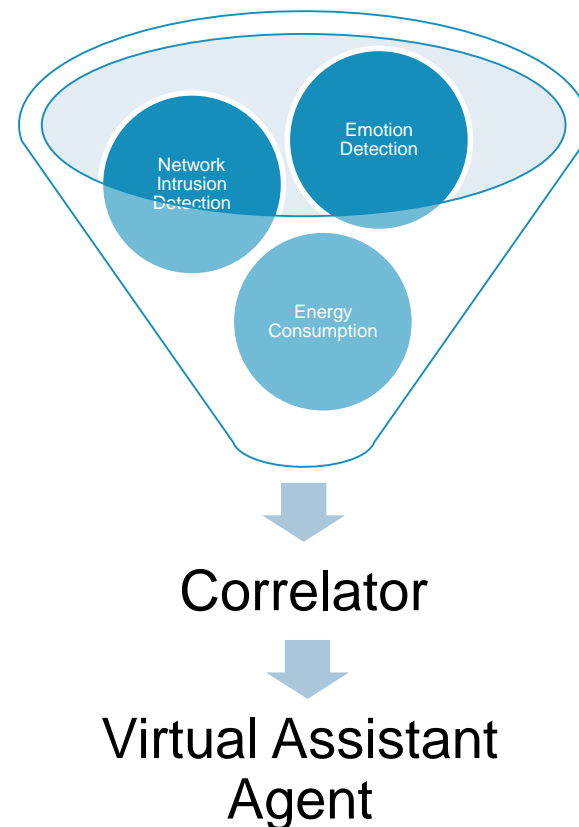
Output

Optimized plan (gains comparison)



- SmartUX was installed on the IDEPA's ERP systems
- The Data Acquisition Layer was connected to the IOT infrastructure
- Energy analysers were installed in all shopfloor sections
- Intrusion Detection System (IDS) was deployed to the IDEPA's network
- PICO API was exposed and connected to the IDEPA's scheduling module
- **Correlator** and **Virtual Assistant Agent (VAA)** modules were developed to assist in the integration of the previous modules

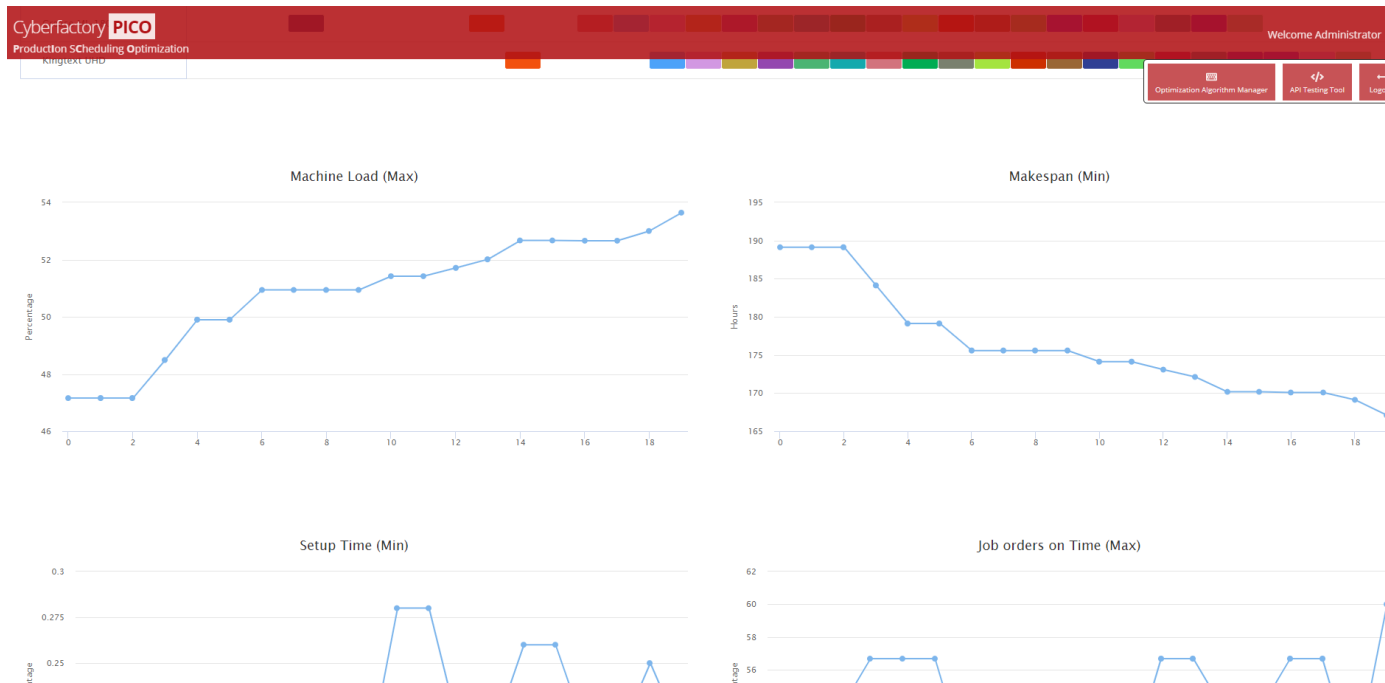
- Integration steps:
 - All the anomalous events detected are merged by the Correlator
 - The Correlator computes an event that is sent to the Virtual Assistant Agent (VAA)
 - The VAA can trigger notifications or actions



From (Pre-Project)	To (Post project)	How CF#1 provide value
Selling products	Selling products + associated data services + Innovative Billing Models	Data Lake Exploitation Data as base for additional services
Data used for monitoring status	Data used to drive better production and management decisions (+efficiency and Resilience, - cost)	Predict Energy Consumption Distributed Optimization Predict Human Emotions and Status
Manual efforts to ensure customer IP Protection	Ai-Driven cybersecurity to ensure Customer IP protection	Detect Cyberthreats at network-level Detect misuse at ERP level Facilitate role Management Automate Response
Don't know how internal systems are used	Know how internal systems are used	Detect Cyberthreats at network-level Detect misuse at ERP level
Few Cybersecurity mechanisms and awareness	Enhanced Cybersecurity Mechanisms, increased self-awareness	Facilitate Role management Facilitate adoption of cybersecurity policies and technologies

Objective	Metric
Services integrated into the deployed solution	Energy Consumption Prediction; Human behavior analyser; Intrusion Detection System;
Distributed Production Scheduling improvements in production time reduction	Average 37%
Emotion recognition model accuracy	Average 70%
Integration with existing enterprise management plataforms and variables	60 metrics

Distributed Manufacturing



Conclusion

- Achieved step changes in the production efficiency;
- Synergetic effect: Integrated with the resilience capabilities for full synergy extraction (stay tuned for the next presentations!);
- Project developments were key to the transition from a product-driven business to a data-driven service;
- Proven that traditional european industries can fully benefit from smart manufacturing approaches improving its efficiency and competitiveness;
- The breadth of the developments done could only be carried on through an open innovation initiative (such as CF#1).

Future Horizons...

- Increase data acquisition to enable further data lake exploration (e.g. Product quality correlation with environmental and production settings);
- Improvements in user profiling to improve worker condition and satisfaction (i5.0);
- Collaborative IDS with AI Federated Learning;
- Integration of energy forecast with weather forecast for fotovoltaic production and production scheduling for enhanced energy cost reduction and sustainability;
- Dynamic distributed production scheduling with realtime transport cost and material availability data fusion.

Thank you!

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