Respecting the World, Respected Worldwide

Evolving Quality Perspective with Advanced Analytics

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Quality Systems and Advanced Analytics Department
Central R&D

March 20th, 2019
KNIME SUMMIT, Berlin
Introduction to Arçelik

Data Analytics beyond Six Sigma

Role of Quality in Industry 4.0

Ongoing Data analytics programme at Arçelik

Some success projects with KNIME

Conclusion
What is next in Manufacturing?
How much addicted are you to connect the life?

3 key themes driving the connected life

Effectiveness & Productivity

Growth & Personal Development

Balance & Awareness
“The journey of 1,000 miles begins with a single step.”

Lao Tzu

“The best way to predict the future is to create it.” (Drucker)

In order to succeed greatly, you have to be prepared to fail greatly. If you can not do both of them, you’ve got a problem

Mike Tyson

“Without data you're just another person with an opinion”

W. Edwards Deming

“With data, you’re not just another person with an opinion; you know something useful.”
WHAT IS NEXT IN MANUFACTURING?

Elon Musk boasted:

“The competitive strength of Tesla long-term is not going to be the car; it’s going to be the factory. We are going to productize the factory”

In a call to Wall Street investors in early 2018
If all DATA of the organization would have been given to you, What would you do?

More Data, More Sources, More Problems

https://hbr.org/2019/03/digital-transformation-is-not-about-technology
Introduction to Arçelik
<table>
<thead>
<tr>
<th>Arçelik</th>
<th>Household solutions provider</th>
</tr>
</thead>
</table>

- **Founded in 1955**
- **12** Brands
- **19+1** Production Facilities
- **33** Sales & Marketing Offices
- **5** Billion USD Turnover (as of 2018 year-end)
- **145** # of Countries
- **30,000** # of Employees
Brands

Beko
Global home-appliances brand sold in more than 100 countries

Grundig
Europe’s full range premium home-appliances brand

Arçelik
The leading home-appliances brand in Turkey

ALTUS

arctic

Blomberg

Dawlance

DEFY

Elektro Bregenz

FLAEL

Leisure

VOLTAS • BEKO

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Innovation

Investing in R&D
Investing in The Future

- 28 YRS R&D Experience
- 16 R&D Centers Worldwide
- 3,000+ Patent Applications
- 1,500+ Researchers
- 71st in the world patent league on the top global patent filers list published by the World Intellectual Property Organization (WIPO)

Memberships and Collaborations

- Leader in Horizon 2020 with 15 Projects
- 18 projects EUureka & Eureka Programs

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SMART PRODUCTS TO SMART HOMES

Value

System of systems

Smart, connected product

Smart product

Product

Time

Time

Smart, connected product

System of systems

Value
Role of Quality in Industry 4.0
QUALITY MANAGEMENT SYSTEMS AND OBJECTIVES
ROLE OF QUALITY IN INDUSTRY 4.0

Quality 4.0

<table>
<thead>
<tr>
<th>Subject</th>
<th>Traditional Quality</th>
<th>Quality 4.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management System</td>
<td>Process Harmonization</td>
<td>Connected/Autonomous Processes, Risk based</td>
</tr>
<tr>
<td>Data &amp; Analytics &amp; Scalability</td>
<td>Descriptive, Diagnostic &amp; Low Volume Data</td>
<td>Predictive, Prescriptive, Visualized &amp; High Volume Data</td>
</tr>
<tr>
<td>Connectivity</td>
<td>Traditional Product and Processes</td>
<td>Connected Product/Processes/Supply Chain/Operations/Testing/</td>
</tr>
<tr>
<td>Competency</td>
<td>Individual</td>
<td>Structured/New Talents/Connected people</td>
</tr>
<tr>
<td>Leadership</td>
<td>Functional based and KPI</td>
<td>End to end, connected top-down, Process Performance Indicators (PPI)</td>
</tr>
<tr>
<td>Culture</td>
<td>Functional</td>
<td>Cross Functional Empowerment and Participation</td>
</tr>
</tbody>
</table>

Scheme: LNS Research
Data Analytics beyond Six Sigma
Six Sigma Program Started in 1998

Arçelik

Six Sigma Certified People

1400

Six Sigma Trained People

820

Six Sigma Projects in last 10 years

2850

Quality Systems and Advanced Analytics Department

Predictive and Prescriptive Analytics

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DIGITAL WORKPLACE’S PRIORITIES

Defining the Digital Workplace

Organization’s top 3 digital workplace priorities?

- CULTURE AND CHANGE: 10.5%
- BIG DATA (ADVANCED ANALYTICS AND DECISION SUPPORT): 10.0%
- EMPLOYEE EXPERIENCE: 9.8%
- UNIFIED COMMUNICATIONS AND RELATED TOOLS: 9.3%
- KNOWLEDGE MANAGEMENT: 8.8%
- INTELLIGENT WORKPLACE (CHATBOTS, AI, INTEGRATED WORKFLOWS): 8.6%
- DIGITAL LITERACY AND CAPABILITY: 8.0%
- GOVERNANCE, RISK AND COMPLIANCE: 7.1%
- ENTERPRISE SOCIAL / REAL-TIME COLLABORATION: 6.4%
- LEARNING AND DEVELOPMENT: 6.0%
- SEARCH & INFORMATION FINDABILITY: 6.0%
- INTRANET EFFECTIVENESS: 6.0%
- MOBILE SERVICES AND ADOPTION: 5.7%
- PERFORMANCE MANAGEMENT: 5.5%
- SMART OFFICE / PHYSICAL AND DIGITAL WORKPLACE ALIGNMENT: 4.9%
- IDEATION TOOLS AND PLATFORMS: 4.9%
- ONBOARDING AND TRAINING: 4.7%
- ENTERPRISE SERVICE / APP STORE: 4.7%
- OTHER: 3.7%

SOURCE: WIDGONSWIRE DIGITAL WORKPLACE SURVEY 2019
SOLUTIONS BEYOND SIX SIGMA

SIX SIGMA TOOLS are very useful if

- SINGLE HYPOTHESIS
- LINEAR REGRESSION MODELS
- PRE-DESIGNED EXPERIMENTS
- AN OPTIMUM SOLUTION IN A GIVEN DATASET LIMITS

ADVANCED ANALYTICS METHODS are essential from now on.

- THOUSANDS OF HIDDEN HYPOTHESES EXIST IN DATA POPULATION
- THERE ARE STREAMLINING DATA FROM PRODUCTS AND PRODUCTION
- TENS OF DIFFERENT REGRESSIONS EXIST TO USE
- NEED LIVING MODELS TO PREDICT THE VALUE
**ADVANCED DATA ANALYTICS WAY**

**Present Capabilities**

- GB
- BB
- MBB

Training and Certification Programme

**New Talent**

- ARÇELİK ADVANCED DATA ANALYTICS PROGRAMMES
  - Predictive Analytics, Reliability
  - Project Leadership + Exam
  - Certificate

+ Python, R etc.
Ongoing Data Analytics Programme at Arçelik
SKILL GAP IS WIDENING IN THE WORLD

The skills gap is widening

Over the next decade nearly 3 ½ million manufacturing jobs will likely be needed and

2 Million
are expected to go unfilled due to the skills gap

The implications are significant
Every job in manufacturing creates another 2.5 new jobs in local goods and services

2.7 Million
baby boomer retirements

For every $1 invested in manufacturing, another $1.37 in additional value is created in other sectors

Only 1.4 Million jobs are likely to be filled
leading to an expected
2 Million manufacturing jobs unfilled due to the skills gap

By 2025 the skills gap is expected to grow to
2 Million

In 2011, 600K jobs were unfilled due to the skills gap

The retirement of baby boomers, strength of the economy and attractiveness of the industry are ranked among leading factors impacting the talent shortage.

Deloitte Institute

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Deloitte Institute
«Winning Companies will empower people to become more capable with their own data, and that's enabling them to think about their business in new ways."
DATA ANALYTICS PROCESS APPROACH

Set Process Standards

Collecting Feedback (Use-Cases, KPI/Data Mappings, Pains/Gains)

Analyze Feedbacks & Data infra

Prioritize Use-Cases

Integrate Prioritized Use-Cases & Measures

Doing Data Analytics Project (CRISP-DM)

Dissemination of the results & Review Model

Input
TAKING SOME DATA

Output
FITTING TO MODEL

Sustaining analytics approach

Question:
WILL PROCESS OWNERS ACCEPT?

INPUT:
• PM, PLANTS
• CUSTOMER CARE
• QUALITY
• MARKETING
• DIGITAL TRANSFORM
• SUBSIDERIES
• Etc.

OUTPUT:
• BIZ IMPACT
• OPPRTUNITIES
• MODEL ALGORITHM
• VARIANT ROJECTS
• PROJECT QUALITY
• LIBRARY
• TALENT UP

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ARÇELİK ADVANCED DATA ANALYTICS PROGRAM

VISION, MISSION AND GOALS

USE-CASE MANAGEMENT

1. Training & Certification
2. Program Governance
3. Project Management & Reporting
4. Global Deployment

ADVANCED ANALYTICS TOOLS

DATA GOVERNANCE AND IT INFRA

DATA-DRIVEN ORGANIZATION CULTURE

Make ready the higher level specialists to create additional values
EXPANDING DATA ANALYTICS SKILLS

- Udemy, Coursera
  - Massive open online courses
- Go deep with University programs
- Python, R, etc.
  - Short and focused data science courses
- Tool-based learning
- Kaggle
  - Learning by attacking data science problems
- Scholar Books
  - Dive deep with free data science books
TRAINING & CERTIFICATION

1. Introduction to Data Science
   - Data Wrangling
   - Entry Level Data Analytics
   - Project, Exam
   - Power Data Users

2. Advanced Level Data Analytics
   - Project, Coaching
   - Citizen Data Scientist Certificate

3. Data Science Specialist (Koç Üniv. Academy)
   - Data Scientist

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Three E’s
"Easy to access, Easy to learn, Ease of use"
PROGRAM GOVERNANCE

- Collect Use-Cases in a Library
- Best Practice Sharing
- Role & Responsibility Management
- Performance Tracking
- HR Recognition
PROJECT MANAGEMENT & REPORTING

- Methodology: CRISP-DM
- Team Setup & Coaching
- Quantified Business Impact
- Project’s Quality Evaluation
- Library, Online Share & Dashboards

CRISP-DM Cycle
(Cross-industry standard process for data mining)
PROJECT TEAM SETUP  

**Data Analytics is a Team Sport.**

- **Power Data Users / Statisticians/BBs**
  - Data ETL
  - Exploratory Analysis
  - Descriptive Segmentation
  - Predictive Modelling

- **Business Manager**
  - Domain Expert
  - Make Decisions
  - Evaluates Processes and ROI

- **Expert Data Scientists**
  - Advance Project ownership
  - Coaching to Data Miners
  - Library enriching
  - New Advance Methods

- **Quality Sys. & Advanced DA Dept.**
  - Arranging Trainings with KNIME
  - Project management by CRISP-DM
  - Evaluation & Certification
  - Managing Use-Case Library
  - Coordination with other Depts.

- **IT Systems / Management**
  - Model Validation
  - Model Deployment
  - Model Monitoring
  - Data Preparation

- **Business Analyts**
  - Data Explorations
  - Data Visualizations
  - Report Creation

- **Explore & Analyze**
  - Collaborate & Publish
  - Deploy & Operate
DATA ANALYTICS PROGRAMME EXPANSION

Global Deployment Plan
- Subsidiary Data Infra prep
- Team development
- Central coaching availability

Subsidiary Management Awareness W/Shops
- Management Buy-in
- HR Support
- Develop Local coaching

Team Building & Training
- Train the Trainer
- Train Power users
- Find local consultancy

In-Organization D/A Community
- Cultural change
- Initiative deployment
- Learning on analytics
- Use cases from different functional groups
BARRIERS TO RAPID PROGRESS

- The skills gap: Industry 4.0 workforce will need coding skills
- Significant investment in existing infrastructure needed
- Data in Silos and not viewed as an asset between processes
- Data users unwilling to share data
- Lack of quality system standardization for data management

"SEE THE VALUE AND REFOCUS ON QUALITY"
Some success projects with KNIME
Refrigerator LPT Duration Shortening (Project Definition)

Solution Description

- As Arcelik Refrigerator plant, Quality Department makes final performance tests to detect cooling performance defected products. Quality department wants to predict long performance test result before completing whole test time, so that Quality department can control more products with limited resources.

- Developing the algorithm that classify shortage of cooling performance products and good products with the related data collected from final performance tests of the refrigerator.

- This algorithm runs on the database and creates prediction result directly onto the control operator screen while testing.

- An advanced analytics model that learns from historical test results and historical failure patterns, predict the failure of the testing products. The analytics model will create green light for good products and red light for failure products to warn control operator.

Data/ Technical Requirement

- Freezer temperature /minute (NTC Thermistor Probes)
- Freshfood temperature/minute (NTC Thermistor Probes)
- Consumed power /minute (Emco Power Analyser)

Business Context/Key Pain Points

- Long Performance Test process capacity increase
- Shortage of Main Production Line Long Performance Test Laboratory Capacity

Potential Solution Provider

- KNIME
- Visual Studio

Team Members

- Mertcan Özbek (Quality - Domain Expert)
- Ali Babayiğit (R&D - Domain Expert)
- Berker Bektöre (IT - Data Engineer)
- Emre Oruç (R&D - Domain Expert)

Project Category

Quality improvement & Productivity increase

Key Benefits

- Increase Quality Department test capacity >20%
- Improvement of suspect products testing ratio by %10

Success Criteria

- Predicting NG products with accuracy of %90

Hadi Özkan
(Q. Sys. & Adv. Data Ana. - Citizen Data Sci.)

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Refrigerator LPT Duration Shortening (KNIME Workflow)

1) Data understanding & preparation

2) Feature Optimization

3) Modelling & Evaluation

4) Deployment
Refrigerator LPT Duration Shortening (Result)

Total «OK» → 36639 + 35868 = 72507

Total «NG» → 8 + 294 = 302

«NG product recall ratio → %97»

8 NG product not detected by model

294 NG product detected by model

### Confusion Matrix

<table>
<thead>
<tr>
<th>Target</th>
<th>Actual</th>
<th>Prediction</th>
</tr>
</thead>
<tbody>
<tr>
<td>OK</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>OK</td>
<td>NG</td>
<td>NG</td>
</tr>
<tr>
<td>NG</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>NG</td>
<td>NG</td>
<td>OK</td>
</tr>
</tbody>
</table>

### Optimization Table

<table>
<thead>
<tr>
<th>Duration</th>
<th>Threshold</th>
<th>OK/OK</th>
<th>OK/NG</th>
<th>NG/OK</th>
<th>NG/NG</th>
<th>Current Test Time</th>
<th>After Test Time</th>
<th>Capacity Gain</th>
<th>Current Test Sample (Qty)</th>
<th>After Test Sample (Qty)</th>
<th>NET NG Sample Gain (Qty)</th>
</tr>
</thead>
<tbody>
<tr>
<td>180</td>
<td>0,95</td>
<td>36.639</td>
<td>35.868</td>
<td>8</td>
<td>294</td>
<td>20.873.190</td>
<td>16.974.954</td>
<td>19%</td>
<td>72.809</td>
<td>89.529</td>
<td>109</td>
</tr>
<tr>
<td>120</td>
<td>0,95</td>
<td>28.855</td>
<td>43.652</td>
<td>9</td>
<td>293</td>
<td>20.873.190</td>
<td>16.075.895</td>
<td>23%</td>
<td>72.809</td>
<td>94.536</td>
<td>118</td>
</tr>
<tr>
<td>90</td>
<td>0,95</td>
<td>38.364</td>
<td>34.143</td>
<td>23</td>
<td>279</td>
<td>20.873.190</td>
<td>13.333.944</td>
<td>36%</td>
<td>72.809</td>
<td>113.976</td>
<td>151</td>
</tr>
</tbody>
</table>

**Actual testing capacity:** 20.873.190 min

**Model testing duration:** 16.974.954 min

**Capacity Gain:** %19

**Additional Sample #:** 17.000

**Add. Detected NG #:** 109

- Random forest
- 180 Minutes
- 0,95 Threshold value

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Motor Acoustic Quality Recognition (Project Definition)

Business Context/Key Pain Points
- Characterizing the motor sound
- Detection of motors before failure on customer

Solution Description
- A data acquisition infrastructure and a standardized process are established.
- Analog signals, which are passed over the sensor, IoT device or microphone, are converted to the workable digital signals with the help of amplifier on the line and power increasing on it.
- Data features for pre-processing are created according to the voice characteristic with the help of the digital signal processing techniques such as time domain features and frequency domain features which are generated in one of the signal processing software.
- Feature-based model is simplified with standard deviation implementations and each digital signal is labelled to train supervised classification method.
- As a result of the classification methods, model with high success is achieved and it is applied to the process to classify the defective motors.

Data/Technical Requirement
- 48 kHz sampling frequency / rate
- Vibration 9.785 mV/g
- Wave. 15 sec on the production line ok / no registration file

Potential Solution Provider

Project Leader
Oğuz Yasin
Production Tech.& Ind. 4.0 Dept. Citizen Data Scientist

Project Member
- Halil Yücel (Business Intelligence)
- Cem İşbilir (Automation)
- Mert Ali Çalduk (Domain Expert)
- Serdar Özsoy (Citizen Data Scientist)
- Gökhan Kuluptakan (IT)
- Dinçer Öztürk (Data Engineer)

Key Benefits
- Characteristic sound model is created and instant checks with real-time monitoring of the system to create
- Establishing control system where machine learning algorithms run on platform instead of human

Success Criteria
- To reduce %60 home appliance motor’s SCR on customer

Project Category
Digital Performance Management
Motor Acoustic Quality Recognition (KNIME Workflow)
Motor Acoustic Quality Recognition (Result)

The model accuracy has reached 0.90 with 0.79 Cohen’s kappa value.

This decision support system has provided 60% reduction in faulty motors returned from customers.

In next step, it is aimed to implement the model at station on behalf of operator.
Conclusion
✓ Be aware that software is eating the world and low code machine learning (AI) is eating the hard coding.

✓ Organizational questions will be more critical than technological questions

✓ The winners of tomorrow will be company culture and information structure that allows the whole organization to learn faster and deeper.

✓ Do not worry about wrong decisions, fail fast and early, otherwise you may be too slow.

✓ Watch out for internal&external strong partnerships.
Arçelik Asista

"Hi Assista! Any Question?"

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"He who would search for pearls must dive below"

John Dryden

Thank You For Listening

http://www.beko.com/
https://www.grundig.com

March 20th, 2019
KNIME Summit, Berlin