SIEMENS
Ingenuity for life

Siemens Engineering Excellence & Design (SEED)

Siemens Gas & Power

2019-07-23

SIEMENS
Ingenuity for life

S • E • E • D

Siemens Engineering Excellence & Design

Think tank for disruptive engineering methods and energy enterprise solutions

The industry faces various challenges, we bring in technological expertise, skilled labor and experience

SIEMENS
Ingenuity for life

Trends & Challenges

TRENDS

Globalization

Decarbonization

Digitalization

CHALLENGES

We are a trusted partner for our customers and support to outperform the industry standard

SIEMENS
Ingenuity for life

SEED in brief

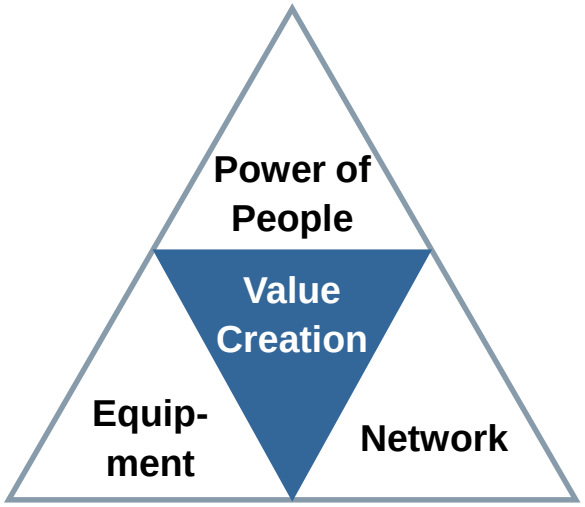
HOW

Customer Focus

Value Orientation

Adaptability

Team



WHAT

Consulting Services

- value orientation
- co-creation
- transformation
- economic analysis

+

Technology as a Service

- probabilistic analytics
- material engineering
- energy enterprise solutions
- additive manufacturing
- testing
- …

VALUE

- **Access to competencies**
- **Reduced cost (“flex loading”)**
- **Provide access to broad network**
- **Benefit from our experience**

SEED offers network & global presence, technology & equipment and people & competence to co-create customer value

SIEMENS
Ingenuity for life

Customer value creation

Our
Competence
For
Your Value!

Globalization

Global Presence
14 locations
covering Europe, Americas, Asia

Regional
Experts
understanding regional differences

Network
> **25 partners**
with academia and companies

Network & Presence

Technical Complexity

Digital Transformation
- probabilistic analytics
- IoT, 'big / smart data'
- 90+% connected products at GP

Design & Material Complexity
- new materials, sourcing
- >1,000 materials in database
- design for additive and 3D printing

Energy Enterprise Solutions
- energy as key factor for production
- decarbonization to impact industry

Technology & Equipment

Skilled Labor

Experience
over **15 yrs**
in probabilistic analytics

Value creation
> **€20 mn/a**
by increased lifing

Probabilistic
over **60 HC**
for probabilistic analytics

People & Competence

SEED as a think tank for disruptive engineering methods and energy enterprise solutions

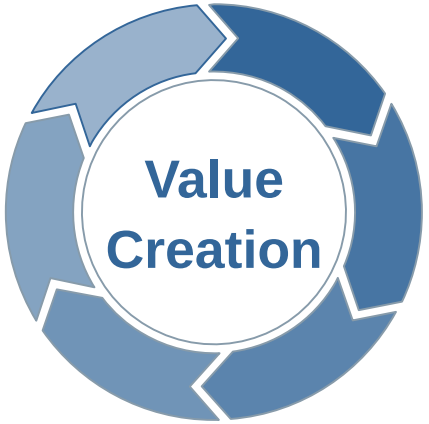
SIEMENS
Ingenuity for life

Customer value creation

Interdisciplinary, **multi-cultural team** and **global network** to academia and companies in Europe, Americas and Asia

Right tools and **capability** to identify, prioritize and implement **customer use case**

Track record of more than **80+** successfully **implemented projects** in Siemens



Apply **digital technologies** (Probabilistic Analytics) to **turn data into value**

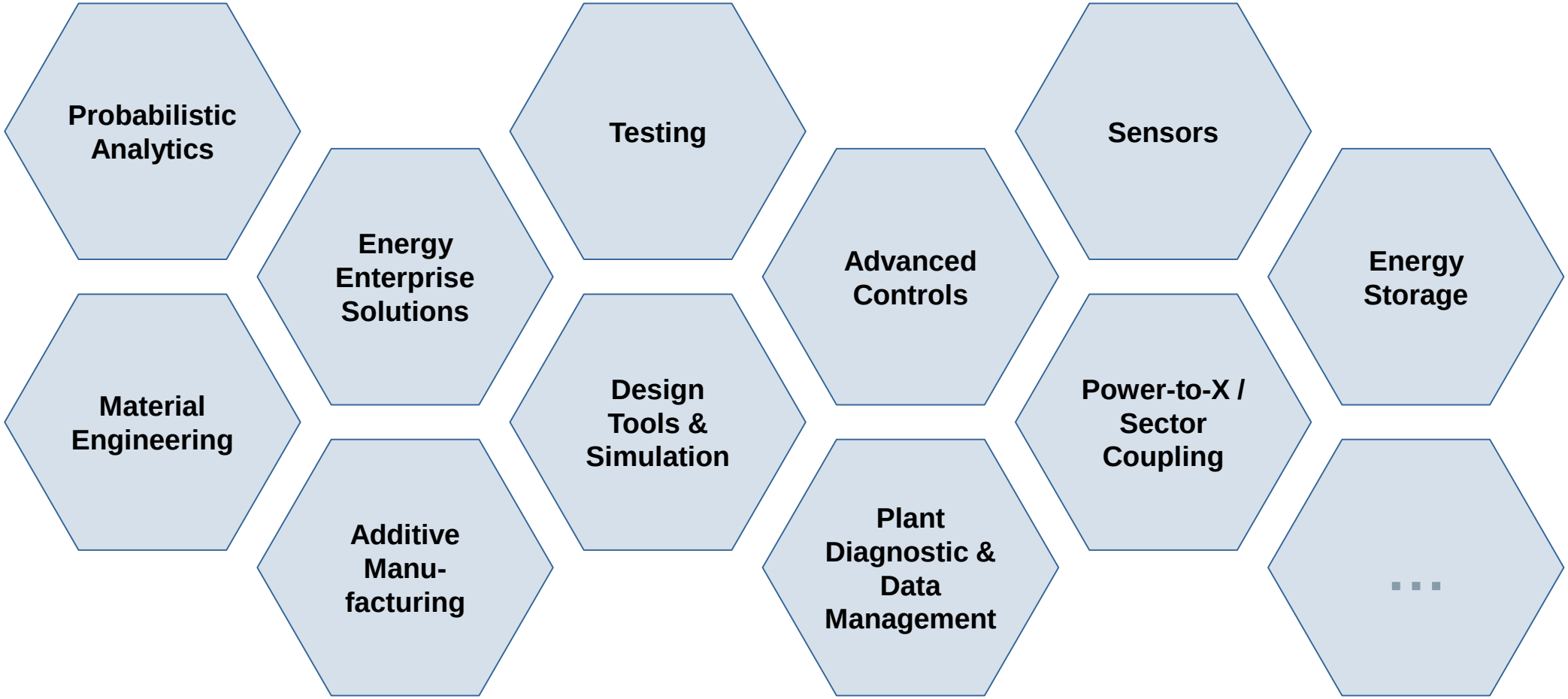
Direct **access** to know-know for disruptive **engineering solutions**, **products** and **process innovation** around the globe

Broad **competences** & **experience** in mathematics, physics, materials science, mechanical engineering, data science

We provide a broad range of technology expertise

SIEMENS
Ingenuity for life

Technology as a Service



Stepwise approach to co-create customer solution and to generate value

SIEMENS
Ingenuity for life

Customer co-creation

0 Problem Statement

Understand Problem

- Understand customer problem
- Challenge understanding
- Define stakeholders
- Clarify target

1 Research & Co-Define

Understand & Generate Insights

- Jointly look at information/data to better understand problem
- Research of similar problem (input of Siemens experience)
- Co-define next steps: workshop, team, project setup

2 Co-Creation

Generate Ideas & Develop Concepts

- Challenge definition
- Connect with similar solutions
- Perform co-creation session
- Collectively create solutions (minimum viable product)

3 Prototyping / Pilot

Prototype Concepts & Refine, Iterate

- Identify / create pilot
- Test minimum viable product
- Refine & iterate
- Define roadmap for implementation

Probabilistic analytics turns data into value by combining engineering, data science and computational modelling

SIEMENS
Ingenuity for life

Probabilistic analytics

Pro • ba • bi • li • stic

= related to probability

A • na • ly • tics

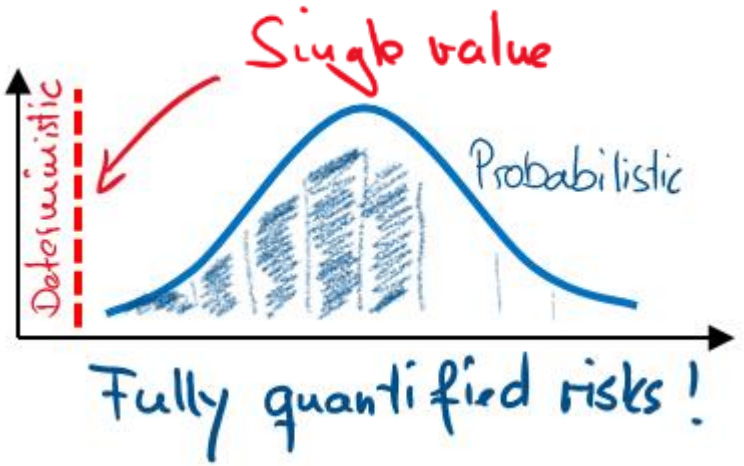
= art of analysis

Target

turn data into value

by predictive analytics and
data science

Engineering + Data Science + Computational Modelling



Probabilistic solutions are able to tackle the challenge to turn all data into useful business insights by customer co-creation

SIEMENS
Ingenuity for life

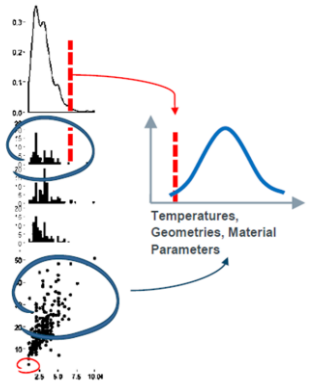
Customer co-creation

Data Collection

Data Collection & **Expert Interviews**

- Identify information needs, source and system interfaces
- Provide transparency about available data and data infrastructure
- Define and collect relevant data for analysis

Data Assessment



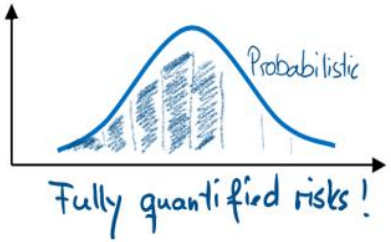
- Check data quality and completeness
- Consider lack of knowledge
- Structure and assess relevant data (e.g. geometries)
- Analyze influence of data

Modelling, Coding, Simulation

Computer Science
+
Data Science
+
Engineering Science

- Apply mathematical models and “domain models” (e.g. physical and logistic models)
- Consider field data
- Combine with methods of stochastics to quantify the underlying risks

Evaluation & Decision-Making



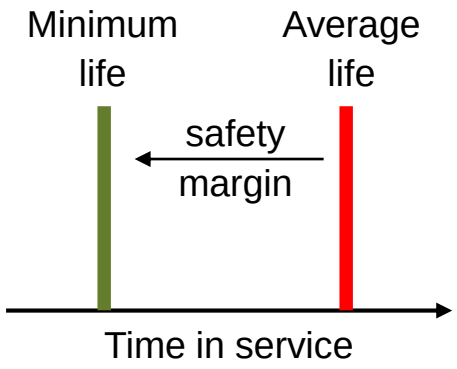
- Interpret modelling results
- Derive possible improvement levers (e.g. characteristics of the product, material used, service concept)
- Recommend options for decision-taking & report

Probabilistic approach allows for improved risk assessment

Deterministic vs. probabilistic design

Deterministic Approach

Uncertainties taken into account via *safety margins*

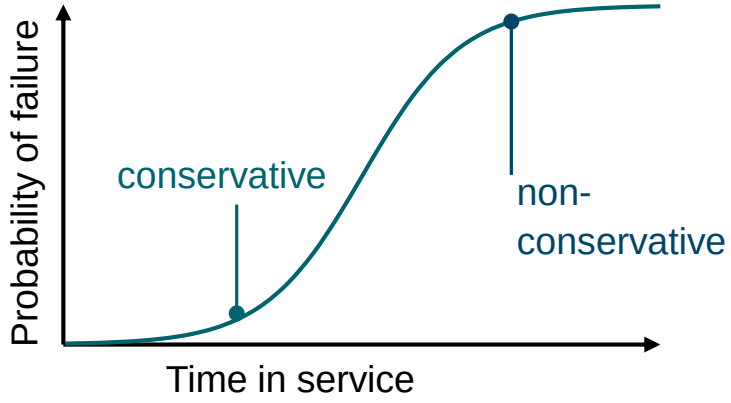


No information about risk / reliabilities available
Single value

“Optimization problem”

Probabilistic Approach

Consider uncertainties *explicitly*



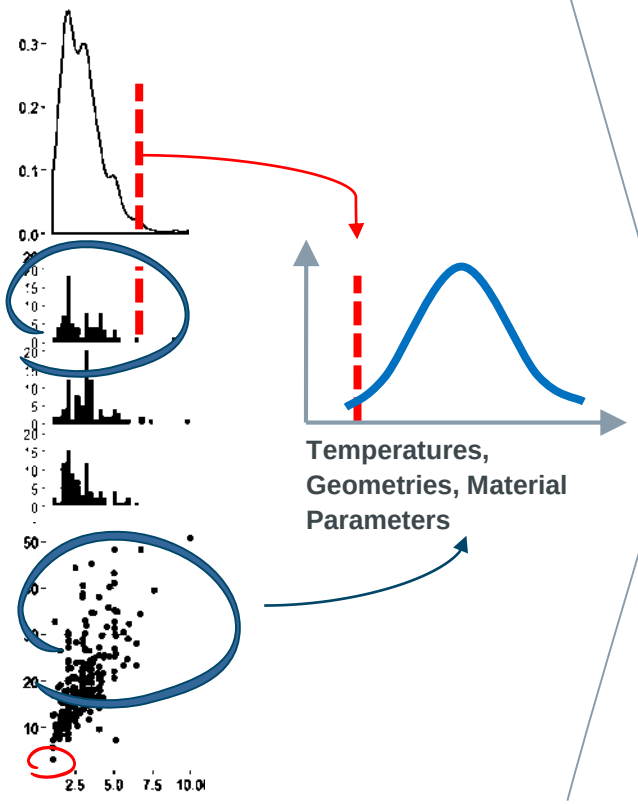
Identify design margins
Improve service concepts
Calibrate models based on field data

Probabilistic analytics – Turning all data into value

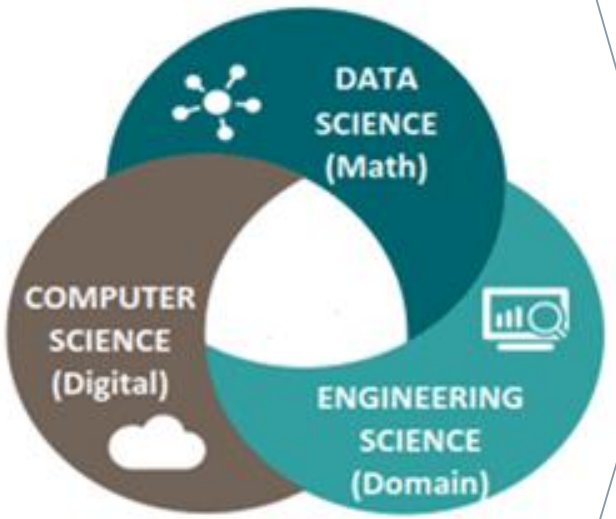
SIEMENS
Ingenuity for life

Probabilistic analytics

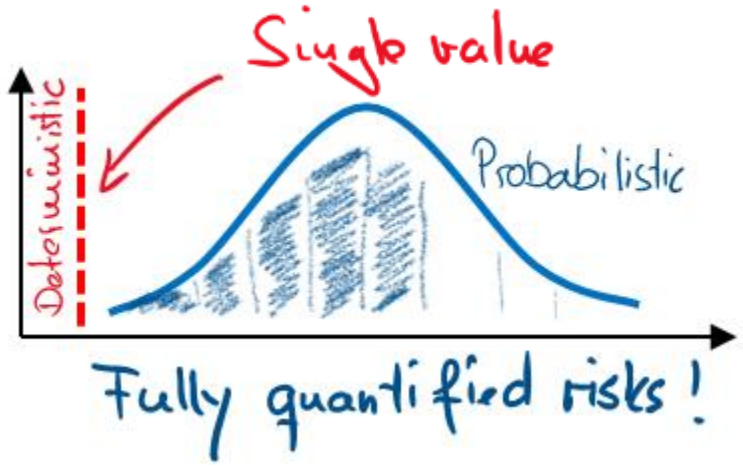
Data Assessment



Modelling, Coding, Simulation



Evaluation, Decision-making



Deterministic
- single value: risk not quantified

VS

Probabilistic
+ optimize design margins
+ improve service concepts
+ model calibration w/ field data

Probabilistic activities across the full value chain drive business value and sustainable utilization of natural resources

SIEMENS
Ingenuity for life

Probabilistic analytics

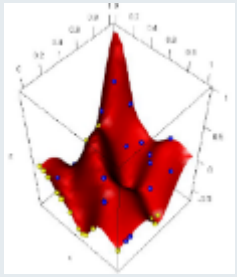
Design | Manufacturing | Bidding | Operation | Service

Lifing

- fatigue (LCF, TMF)
- fracture mechanics
- structural dynamics (HCF)
- creep, oxidation, coating systems
- material properties
- service life extensions (e.g. rotor disks)

Sustainable utilization

Optimization



- testing plans
- specifications and tolerance settings
- robust design (aero and mechanical)
- system optimization (power plant)
- statistical bid optimization
- business models and flexible pricing

Add'l customer value

Risk Modelling

- functional safety
- field experience (operation and service)
- contingency calculation for field issues
- manufacturing deviations

Cost savings

Engineering + Data Science + Computational Modelling

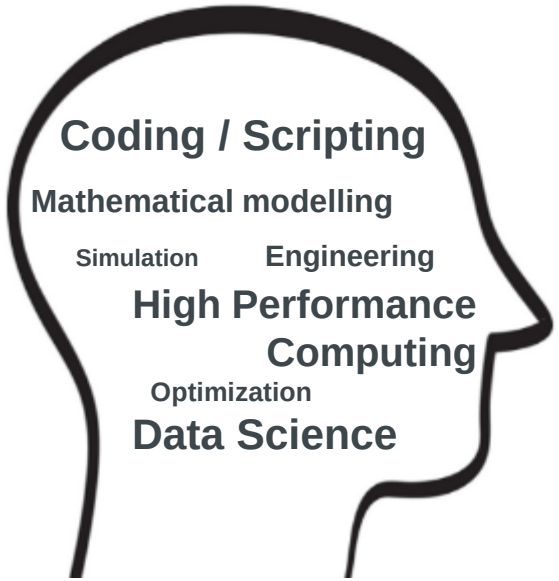
Probabilistic analytics @ Siemens: Proven track record since 2005

SIEMENS
Ingenuity for life

Probabilistic analytics

Competencies

of the probabilistic team



Global Network

with external and internal partners

Experiences

within power generation

Gas turbines
e.g. fatigue and fracture, materials, aero dynamic

Steam turbines
e.g. rotor and casing life, rotor dynamics

Generators
e.g. rotor lifing, geometry optimization, bidding

Power Plants
e.g. pipings, transformers, operational data

Material engineering

Ma • te • ri • al

= the matter from which a thing is or can be made

En • gi • nee • ring

= branch of science and technology concerned with the design, building, and use of engines, machines, and structures

Target

Cost reduction

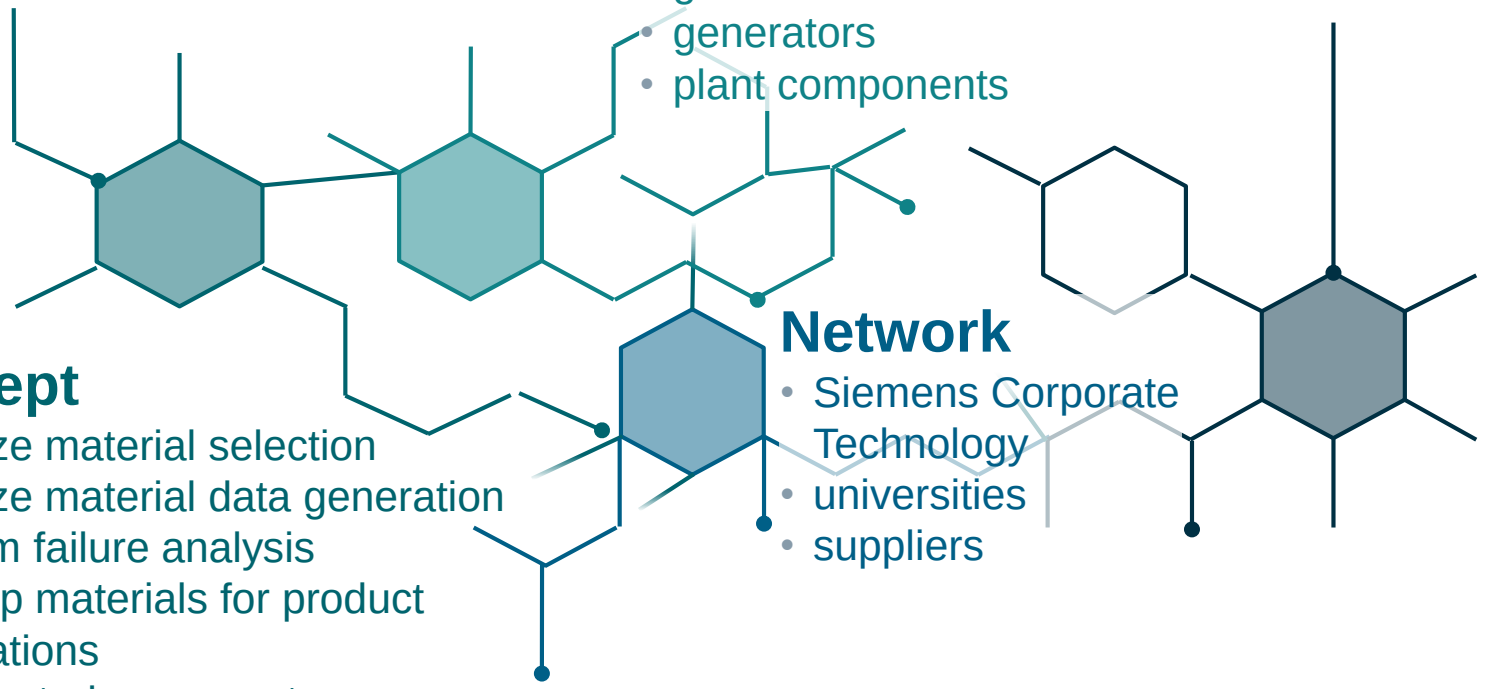
while maintaining high quality

Engineering + Material Science + Material Test Labs

Material engineering ensures quality in supply chain management and manufacturing

SIEMENS
Ingenuity for life

Material engineering



Application
- gas and steam turbines
- generators
- plant components

Concept
- optimize material selection
- optimize material data generation
- perform failure analysis
- develop materials for product applications
- manufacturing support

Network
- Siemens Corporate Technology
- universities
- suppliers

Competencies
- material engineering
  - design data
  - failure analysis
  - modelling
  - material substitution
- know-how
  - base materials
  - joining
  - coatings
  - corrosion & oxidation
  - non-destructive examination
- testing & investigation
  - test concept
  - mobile tests (e.g. small punch)
  - in-house labs

SEED boosts savings through technical optimization by its broad competence

SIEMENS
Ingenuity for life

Customer offering – Examples

Potential Analysis → Implementation

Siemens Engineering Excellence & Design (SEED) combines Siemens **inhouse knowledge and capabilities**, a **broad network** and **more than 3,000 R&D experts & engineers**. to boost savings in technical optimization projects for industrial clients.

Analytics

EXPERT WORKSHOPS
METALLOGRAPHY
ELECTRON MICROSCOPY SCAN
ECONOMIC ASSESSMENT
OPTICAL MICROSCOPY
EXPERT WORKSHOPS

Savings Potential

Design

PROBABILISTIC ANALYTICS
3D COMPONENT DESIGN & PRINTING
ADVANCED CAX
PROBABILISTIC-COMPATIBLE PROPERTY
MATERIAL TESTING
ADDITIVE MANUFACTURING
RESIDUAL STRESS MEASURE

Improved Design

Selection

BEHAVIOR PREDICTION
CORROSION RESISTANCE
MATERIAL SUBSTITUTE DATABASE
COATING, COMBUSTION
MINIMAL SPECIFICATION

Optimal Material

Productization

MECHANICAL PROPERTIES
ENGINEERING CAPACITY
HARDNESS, STRENGTH, WEAR..
FAILURE ANALYSIS

Fast Implementation

Technical and commercial optimization paves the way to an enhanced use of materials and maximized cost efficiency

SIEMENS
Ingenuity for life

Materials engineering

Challenge

Availability
Standards (ISO, ASTM, China etc.), alternative materials

Quality
Deviation of chem. composition, mech. properties or production routes

Customer requirements
Ensure required properties, minimize specification

Solution

know how experience

databases

testing

global network

Database
More than of 1,000 materials available

Material testing and evaluation
Internal and external labs

Global network
Expert knowledge and many years of experience in materials engineering and testing

Benefit

Cost reduction
Global sourcing of required quality

Efficient production
Higher design flexibility and cost efficient choice of materials and supplier base

Cost reduction for component of 66% realized

SIEMENS
Ingenuity for life

Material engineering

Challenge

°C high temperature

product costs

manufacturing

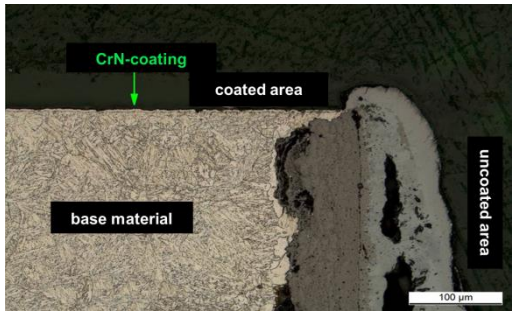
solid particle erosion

High temperature
High temperature application implies specific material requirements

Manufacturing
Ni-base material demands high manufacturing effort

Product costs
High production cost in terms of base materials and manufacturing

Solution



Base material
High Cr-steel provides adequate mechanical properties but insufficient oxidation resistance at given temperature range

Protection Measure
PVD coating (6 µm thickness) provides efficient oxidation protection and allows Cr-steel to withstand high temperatures

Benefit

Coated Cr-steel instead of Ni-base alloy

Cost Reduction
Smart and efficient choice of base material and coating

Efficient Production
Higher design flexibility, efficient manufacturing processes

Material engineering to optimize material e.g. regarding cost, properties, sourcing, conformity to standards

SIEMENS
Ingenuity for life

Material engineering