What is DFSS?

- A structured approach for designing new products, processes and/or services, or for redesigning existing products, processes and/or services;
- An approach for building quality into the product during development;
- A toolbox, containing engineering and statistical tools;
- A method for ensuring that customer expectations are understood and are met or exceeded.
What is DFSS?

- The basic algorithm for DFSS is known as IDOV. We discuss the details shortly.
- Traditional Six Sigma for continuous improvement almost universally uses the DMAIC algorithm as a basis for organizing project work.
- Design for Six Sigma or DFSS does not have a consensus among practitioners as to a best algorithm.
- Countless variants to IDOV exist, but all share a core set of concepts and tools.

The IDOV Process

The primary deliverables of IDOV are:

- **Identify** the voice of the customer (VOC), translate customer needs into functional responses (CTCs), and prioritize CTCs.
- Translate functional responses into product design characteristics and process variables, and develop transfer functions.
- Predict process capability, optimize the design, and develop tolerances.
- **Validate** performance, address gaps in capability, and implement process controls.
The IDOV Process

Key activities are summarized in the IDOV checklist:

<table>
<thead>
<tr>
<th>Identify</th>
<th>Design</th>
<th>Optimize</th>
<th>Validate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Review initial project charter</td>
<td>Develop design concepts</td>
<td>Apply robust design</td>
<td>Finalize design details</td>
</tr>
<tr>
<td>Form team and identify necessary training</td>
<td>Evaluate design concepts, and select the best concept</td>
<td>Define tolerances, and determine if they are acceptable</td>
<td>Develop process map or value stream map</td>
</tr>
<tr>
<td>Develop project milestones, a project plan, and a communication plan</td>
<td>Use DFMEA to analyze design and identify risks, and apply mistake-proofing</td>
<td>Use transfer functions and simulation to determine ability to meet functional requirements</td>
<td>Use cause and effect diagrams, and QFD 4, and FMEA to identify critical process controls</td>
</tr>
<tr>
<td>Identify customer requirements (VOC)</td>
<td>Develop design validation test plan (DVP)</td>
<td>Use QFD 3 to identify critical process variables</td>
<td>Develop process control plan</td>
</tr>
<tr>
<td>Use QFD House 1 to translate customer requirements into functional responses (CTCs)</td>
<td>Use QFD 2 to translate CTCs into design characteristics</td>
<td>Apply design for manufacturing (DFM)</td>
<td>Complete the design validation plan (DVP)</td>
</tr>
<tr>
<td>Prioritize CTCs, add specs and targets</td>
<td>Begin to develop transfer functions</td>
<td>Use process FMEA to identify and mitigate risks</td>
<td>Perform gap analysis</td>
</tr>
<tr>
<td>Populate performance scorecard</td>
<td>Update scorecard</td>
<td>Update scorecards</td>
<td>Update scorecards</td>
</tr>
<tr>
<td>Gate Review - Go/Kill</td>
<td>Gate Review - Go/Kill</td>
<td>Gate Review - Go/Kill</td>
<td>Gate Review - Go/Kill</td>
</tr>
</tbody>
</table>

Lean Six Sigma

Whereas DFSS is used for design or redesign, Lean6Sigma is used to improve existing processes. Lean6Sigma is:

- **A business strategy** for continuous improvement, integrating lean and 6 sigma tools and methods
- **A fact-based, data-driven problem solving methodology** (DMAIC):
  - Define
  - Measure
  - Analyze
  - Improve
  - Control

A toolkit, providing a variety of problem solving, project management, lean and statistical tools.
The DMAIC Process

The process is defined, and key process inputs and outputs are identified.

Key characteristics are measured, measurement systems are evaluated, a baseline is established, and process capability is assessed.

Root causes of problems are identified using analytic and statistical tools, and opportunities for improvement are identified.

Potential solutions are identified, evaluated, tested, and implemented.

The process is monitored and controls are implemented, and new methods and processes are standardized.

Transactional Six Sigma

Six Sigma was originally developed at Motorola in the 1980’s by an engineer named Bill Smith.

The original focus of Six Sigma was on improving yields of manufacturing processes.

In recent years there has been a recognition that large gains in business performance can be made in non-manufacturing areas.

A version of Lean6Sigma referred to as Transactional Six Sigma has evolved to achieve continuous improvement in these non-manufacturing areas.

Transactional Six Sigma uses the DMAIC process, however, the emphases and tools differ from the manufacturing version.
An innovative and “leaner” approach to Six Sigma is evolving which relies on the powerful and dynamic visualization capabilities of modern statistical software.

The goal of Visual Six Sigma (VSS) is to reduce the amount of time needed to achieve results in a Six Sigma project.

VSS uses visualization on existing or newly generated databases to explore relationships among variables and generate causal hypotheses, which may be confirmed in several ways.

We will be publishing a case study oriented book, based upon the JMP® statistical software, on VSS in the first half of 2009.

The next slide contains a VSS project roadmap.
DFSS and Lean6Sigma

- Design for Six Sigma and Lean6Sigma are linked:
  - DFSS may be used for redesign if it is determined that the product or process, even after improvements, will never meet customer expectations.
  - Lean6Sigma may be used to reduce variation when process capability is insufficient.

Why DFSS?

- Up to 80% of overall costs are established during the design phase. The remaining 20% are fixed during or after launch.

- DFSS invests time and resources early in the product development cycle to:
  - Lower development and overall product cost;
  - Speed time to market;
  - Efficiently utilize resources (rather than fire fighting);
  - Produce robust product designs;
  - Satisfy customer needs.
Why DFSS?

The DFSS Vision

- From reactive design …
- Changing requirements, multiple design iterations
- Supplier or process capability issues after launch
- Multiple build-test performance evaluation cycles
- Performance issues addressed after product launch
- ‘Tested-in’ quality
- … to predictive design
- Disciplined requirements flow-down
- Capability estimates factored into design analysis
- Product performance modeled and simulated
- Robust design and Design for Manufacturing (DFM), issues addressed prior to launch
- ‘Designed-in’ quality

DFSS Tools

On the following slides, we will introduce some common tools used by DFSS teams.

These include:

- VOC, Conjoint Analysis, Data mining
- Quality Function Deployment
- Transfer Functions
- Scorecards
- FMEA
- Design Validation Test Plans
- Communication Plans
- Designed of Experiments (DOE)
- Robust Design
- Tolerance Design
- Control Plans
Tools: Conjoint Analysis

Voice of the customer or VOC is critical to designing a product or process that meets or exceeds customer requirements.

Much literature exists on VOC, however a more quantitative approach is known as **Conjoint Analysis**.

Conjoint Analysis is a cousin of design of experiments. It allows designers to uncover important characteristics to the customer as well as important interactions among those characteristics.

For example, a customer may be more likely to purchase a more expensive cell phone only if it is bright red and has a larger keypad.

Conjoint Analysis allows one to develop statistical models to predict customer preferences and associated cost models.

---

Tools: Quality Function Deployment

Quality Function Deployment (QFD) consists of four “houses”, and is used for “requirements flow-down”.

House 1, which is perhaps the most important, translates customer requirements (VOC) to **measurable** system level functional responses (CTC’s).
Tools: Quality Function Deployment

House 2 relates the functional responses to design characteristics.

Houses 3 and 4 relate the design characteristics to process variables and manufacturing controls, respectively.

Tools: Transfer Functions

There are three “domains” of interest in design:

- The functional domain
- The physical domain, and
- The process domain

This following schematic shows the design flow, in terms of “domains”.

For a complex part, each of these domains will have a hierarchical structure.
Tools: Transfer Functions

A transfer function is a function that relates one set of variables to another.

Two transfer functions are of major interest in DFSS projects.

- The Physical Mapping relates the design characteristics to the functional responses.
- The Process Mapping relates the process variables to the design characteristics.

Tools: Score Cards

Scorecards are living documents used to track and summarize performance across the functional, physical, and process domains.

The probability of system conformance, as well as yield based on DPU, are computed from the individual scorecards.

Below, we see an example of a Part/Component scorecard, and the resulting Product summary information.
Tools: FMEA

FMEAAs are living documents used to uncover problems in designs, or in the manufacture of product, that could result in product failures or safety risks.

- **Design FMEAs (DFMEA)** are used during the Design phase.
- **Process FMEAs (PFMEA)** are used during the Design and Optimize phases.

### Step/Function

<table>
<thead>
<tr>
<th>Potential Failure Mode</th>
<th>Potential Effects</th>
<th>Potential Causes</th>
<th>Control</th>
<th>Severity</th>
<th>Occur</th>
<th>Detect</th>
<th>Recommend</th>
<th>Action and Results</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Prepared By:**

**Process/Product FMEA Form**

Date: __________________

Process or Product Name:

Page ______ of ______

DFMEAs and PFMEAs are related to HOQs 2 and 3, as shown in the schematic below.
Tools: Design of Experiments

DOE is a structured, efficient approach in which factors are systematically changed and the effects on the response(s) are observed. DOEs are used to:

- determine if factors have an effect on the response,
- determine if two or more factors interact in their effect on the response, and to
- model the behavior of the response as a function of the factors.

![Strength Predicted P=0.0035 RSq=0.80 RMSE=3.1091](image)

**Summary of Fit**
- RSquare: 0.802217
- RSquare Adj: 0.728048
- Root Mean Square Error: 3.109126
- Mean of Response: 27.5
- Observations (or Sum Wgts): 12

**Analysis of Variance**

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F Ratio</th>
<th>Prob &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>3</td>
<td>104.556</td>
<td>10.816</td>
<td>0.0035*</td>
<td></td>
</tr>
<tr>
<td>Error</td>
<td>8</td>
<td>9.667</td>
<td>1.133</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. Total</td>
<td>11</td>
<td>114.223</td>
<td>11.333</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Robust design is a statistical/engineering methodology employed to optimize a process or product in terms of its mean performance and variation.

![Robust Design](image)
The goals of robust design are to:

- Find and adjust the fixed settings of the control factors to optimize mean performance,
- Simultaneously make that performance insensitive to variation in the noise factor settings.

Tools: Robust Design

Tolerance Design utilizes analytical and statistical methods to optimize tolerances.

This involves using transfer functions to determine the sensitivity of the output, Y, to the inputs, or Xs.

Suppose that, for the transfer function f, Y is very sensitive to variation in X₁, but robust to variation in X₂.

Then, as suggested in the diagram, we may be able to optimize the response and minimize cost by:

- reducing variation in X₁, and
- allowing more variation in X₂.
Tools: Control Plans

Process controls are identified using QFD 4 in the validate phase.

A control plan is a summary of the types of process controls that will be used to monitor and control critical process variables (KPOVs and KPIVs).

<table>
<thead>
<tr>
<th>Operation</th>
<th>Characteristic</th>
<th>Measurement Method</th>
<th>Responsible</th>
<th>Frequency</th>
<th>Type of Control</th>
<th>Signal</th>
<th>Corrective Action</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Washing</td>
<td>Water consumption</td>
<td>Observation of reservoir level</td>
<td>Operator</td>
<td>Daily</td>
<td>Plan/s</td>
<td>More than 10, less than 30</td>
<td>Check supply lines for leaks and valves for correct settings. See WI-027RevA.</td>
<td>Operator</td>
</tr>
<tr>
<td>Bath</td>
<td>Concentration</td>
<td>10ml sample from tank 477</td>
<td>Lab technician</td>
<td>Daily</td>
<td>SPC</td>
<td>Out of control condition</td>
<td>Addemulsion as directed by lab technician. Sample additional parts and re-wash if required.</td>
<td>Lab technician</td>
</tr>
<tr>
<td>Product</td>
<td>Cleanliness</td>
<td>50 piece random sample (pull evenly from available boxes) once</td>
<td>Lab technician</td>
<td>Daily</td>
<td>SPC</td>
<td>Out of control condition</td>
<td>Contain suspect production. Notify supervisor and investigate.</td>
<td>Quality?</td>
</tr>
</tbody>
</table>

DFSS Case Study
Design and Build a Better Bicycle
Case Study: Build a Better Bicycle

A team has been asked to develop a bicycle that will meet the needs of multiple demographic groups.

Customer requirements for different demographic groups and intended uses were summarized using a VOC Table.

### VOC Summary Table for Multi-purpose Bicycle

<table>
<thead>
<tr>
<th>Demographic Information</th>
<th>Intended use of Product or Service</th>
<th>Customer Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age 18-29, predominantly males</td>
<td>Off road and city, medium to long distances</td>
<td>Fast, lightweight, attractive, rugged</td>
</tr>
<tr>
<td>Age 30-50, females</td>
<td>Gentle trails and city, short to medium distances</td>
<td>Comfortable, attractive, easy to use, easy to maintain</td>
</tr>
<tr>
<td>Age 30-50, males</td>
<td>Off-road and city, medium to long distances</td>
<td>Fast, lightweight, comfortable, easy to maintain, easy to transport</td>
</tr>
<tr>
<td>Age &gt;50, males and females</td>
<td>Gentle trails and city, short to medium distances</td>
<td>Comfortable, easy to use, easy to maintain, rugged, inexpensive</td>
</tr>
</tbody>
</table>

A tree diagram was used to organize and analyze VOC data collected by the team.

Tree diagrams can also be used to help expand ideas, or to fill in gaps or missing thoughts.

Note many approaches exist to organizing and analyzing VOC data.

Other common tools are Affinity Diagrams, KJ Analysis, and Kano Analysis.
Case Study: Build a Better Bicycle

The team completed **HOQ 1** to translate customer needs into design requirements.

Put a “9” in the box if the relationship is high
Use a “3” if the relationship is medium
Use a “1” if the relationship is low
Leave blank if there is no relationship.

The QFD Structure

House 1 is typically filled out in the following order:

1. Customer needs
2. Planning matrix
3. Functional Response
4. Relationships
5. Technical correlations
6. Technical targets, etc.
Case Study: Build a Better Bicycle

Next, the team used a design synthesis matrix to identify solutions to the functional responses from HOQ 1. Combinations of solutions define potential design concepts.

<table>
<thead>
<tr>
<th>Functional Response</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top speed on flat terrain</td>
<td>Medium wide high pressure slick, Wide high pressure slick, Medium wide high pressure slick, Wide high pressure slick, Medium wide high pressure slick</td>
</tr>
<tr>
<td>Handlebar design</td>
<td>Drop handlebars, Regular handlebars, Drop handlebars, Regular handlebars, Drop handlebars, Regular handlebars</td>
</tr>
<tr>
<td>Wheel size</td>
<td>26 inch, 27 inch, 29 inch, 27 inch, 29 inch, 27 inch</td>
</tr>
<tr>
<td>Gear ratios*</td>
<td>Gear Set 1, Gear Set 2, Gear Set 3, Gear Set 4, Gear Set 2, Gear Set 3</td>
</tr>
<tr>
<td>Total wheel weight</td>
<td>3.79 lbs, 2.69 lbs, 2.88 lbs, 3.21 lbs, 2.88 lbs, 2.69 lbs</td>
</tr>
<tr>
<td>Drivetrain weight</td>
<td>5.0 lbs, 5.5 lbs, 6 lbs, 6 lbs, 5.5 lbs, 6 lbs</td>
</tr>
<tr>
<td>Seat comfort index</td>
<td>Shape 1, Shape 2, Shape 3, Shape 2, Shape 2, Shape 2</td>
</tr>
<tr>
<td>Material</td>
<td>Gel, Gel, Gel, Gel, Gel, Gel</td>
</tr>
<tr>
<td>Construction</td>
<td>Springs, No springs, Springs, No springs, Springs, No springs</td>
</tr>
<tr>
<td>Total weight</td>
<td>5.99 lbs, 6 lbs, 5.99 lbs, 6 lbs, 6 lbs, 5.99 lbs</td>
</tr>
</tbody>
</table>

The team identified five potential design concepts. The first design concept was used as a baseline, or datum, for comparisons.
Case Study: Build a Better Bicycle

The team used a **weighted Pugh Matrix** to compare potential design concepts.

The team wants to know the following:

- Does any one design concept stand out as being the best?
- Do any concepts have a lot of weaknesses compared to the datum?

### Pugh Concept Selection Matrix

<table>
<thead>
<tr>
<th>Functional Responses</th>
<th>Concept 1</th>
<th>Concept 2</th>
<th>Concept 3</th>
<th>Concept 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top speed on flat terrain</td>
<td>58</td>
<td>0</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Wheel size</td>
<td>73</td>
<td>0</td>
<td>-</td>
<td>s</td>
</tr>
<tr>
<td>Gear ratios</td>
<td>61</td>
<td>0</td>
<td>s</td>
<td>+</td>
</tr>
<tr>
<td>Total weight</td>
<td>95</td>
<td>0</td>
<td>s</td>
<td>+</td>
</tr>
<tr>
<td>Seat comfort index</td>
<td>89</td>
<td>0</td>
<td>s</td>
<td>-</td>
</tr>
<tr>
<td>Seat adjustments</td>
<td>107</td>
<td>0</td>
<td>-</td>
<td>s</td>
</tr>
<tr>
<td>Bike comfort index</td>
<td>99</td>
<td>0</td>
<td>s</td>
<td>+</td>
</tr>
<tr>
<td>Frame size options</td>
<td>112</td>
<td>0</td>
<td>s</td>
<td>+</td>
</tr>
<tr>
<td>Number of gears</td>
<td>105</td>
<td>0</td>
<td>-</td>
<td>s</td>
</tr>
<tr>
<td>Smoothness of shifting</td>
<td>99</td>
<td>0</td>
<td>s</td>
<td>-</td>
</tr>
<tr>
<td>Tube (frame) strength</td>
<td>62</td>
<td>0</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Rim strength</td>
<td>54</td>
<td>0</td>
<td>-</td>
<td>s</td>
</tr>
<tr>
<td>Tire durability</td>
<td>100</td>
<td>0</td>
<td>s</td>
<td>-</td>
</tr>
<tr>
<td>Price range</td>
<td>36</td>
<td>0</td>
<td>-</td>
<td>s</td>
</tr>
<tr>
<td>Meets government safety standards</td>
<td>9</td>
<td>0</td>
<td>s</td>
<td>s</td>
</tr>
</tbody>
</table>

Sum of Positives (+): 271, 373, 530, 230
Sum of Negatives (-): 285, 345, 393, 556
Sum of Ss (Sames): 601, 439, 234, 371

Next, the team used a **Process FMEA** to identify potential problems with the selected design concept.

They also used **HOQ 2** to translate functional responses into design characteristics for the selected design concept.

HOQ 2 is very similar in structure to HOQ 1.
Case Study: Build a Better Bicycle

A partial list of design requirements for the bicycle has been added. Separate houses may be built for each subassembly, particularly with “complex” products.

<table>
<thead>
<tr>
<th>Category</th>
<th>ID</th>
<th>Functional Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good Bike</td>
<td>1</td>
<td>Top speed on flat terrain 5%</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Total weight 8%</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Ride comfort index 8%</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Gear range 2%</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Meets government safety standard 1%</td>
</tr>
<tr>
<td>Wheel/Tire</td>
<td>6</td>
<td>Wheel size 6%</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Rim strength 5%</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>Tire durability 9%</td>
</tr>
<tr>
<td>Gear System</td>
<td>9</td>
<td>Number of gears 9%</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>Smoothness of shifting 9%</td>
</tr>
<tr>
<td>Seat</td>
<td>11</td>
<td>Seat comfort index 8%</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>Seat adjustments 9%</td>
</tr>
<tr>
<td>Frame</td>
<td>13</td>
<td>Frame size options 0%</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>Rake (frame) strength 3%</td>
</tr>
</tbody>
</table>
For both subassemblies and components, we use HOQ 2 to identify design characteristics (DCs) to satisfy functional responses (FRs) from HOQ 1.

This information is used to start building transfer functions.

Case Study: Build a Better Bicycle

At a conceptual level, one can think of a single transfer function that relates all FRs (Ys) to all DCs (Xs):

\[(Y_1, Y_2, \ldots, Y_n) = f_{\text{physical}}(X_1, X_2, \ldots, X_p)\]

Analogously, a single transfer function may be used to relate all DCs (Xs) to all Process Variables, or PVs (Vs):

\[(X_1, X_2, \ldots, X_p) = f_{\text{process}}(V_1, V_2, \ldots, V_q)\]

By synthesizing these transfer functions, the designer will be able to track the effects of changes across the design to see their effect on the high-level FRs.
Case Study: Build a Better Bicycle

**Example.** Consider our bicycle example.

A customer requirement is that *the bike rolls easily.*

This desire is translated to a high-level functional requirement for the bicycle assembly, called rolling resistance (or rolling friction): \[ Y = \text{Rolling Resistance} \]

Rolling resistance depends on the coefficient of rolling resistance, which is a property of the wheel assembly.

The coefficient of rolling resistance is affected by tire material, tire contact area, flex in sidewalls, level of inflation, tread thickness, size of wheel.

So rolling resistance is affected by the *design of the tire and of the hub, rim, and spokes.*

For the spoke, hub, and rim subassembly, certain critical parameters that drive rolling resistance include:

- \[ Y_{21} = \text{Rim circumference} \]
- \[ Y_{22} = \text{Rim width} \]
- \[ Y_{23} = \text{Rim geometry} \]
- \[ Y_{24} = \text{Rim width uniformity} \]

These are **high-level design characteristics (DCs)** that affect the **high-level functional response**, Rolling Resistance.

But these are also FRs at a lower level, namely for the rim subassembly. This is why these are denoted as Ys and why the subscript 2 appears in the notation for these FRs – they are at a second level in the hierarchy.
Case Study: Build a Better Bicycle

One might begin the process of deriving transfer functions by relating each of the four $Y_2$'s to critical design parameters for the spoke, hub, and rim subassembly.

For example, the second-level DCs on the previous slide are:

- $X_{21} =$ Spoke length
- $X_{22} =$ Spoke strength
- $X_{23} =$ Hub geometry
- $X_{24} =$ Rib material

Transfer functions for the $Y_2$'s would include these as arguments ($i = 1, 2, 3, 4$):

$$Y_{2i} = f_{2i}(X_{21}, X_{22}, ..., X_{24})$$

Transfer functions can be used to model both the mean and the variance for the functional responses.

Sources of transfer functions:

- Physical laws
- Engineering relationships
- Functional approximations to physical measurements
- Statistical models

$$Y = b_0 + b_1X_1 + b_2X_2 + b_3X_1X_2$$
The team also begins to identify the manufacturing approach:

- The manufacturing approach is selected and detailed, and **design for manufacturing** concepts are applied.
- A **process FMEA** is used to evaluate the selected process.
- **HOQ 3** is used to identify key process output variables (KPOVs).
- **HOQ 4** is used to identify key process controls, or key process input variables (KPIVs).

**Case Study: Build a Better Bicycle**

The key tools used by a design team during the IDOV process are summarized here.
Case Study: Build a Better Bicycle

Are you sure this is what the customer wants???

DFSS assures that a disconnect does not occur between the customers and the designers.

About NHG
www.northhavengroup.com

North Haven Group (NHG) is a limited liability company registered in the state of New Hampshire, providing comprehensive consulting and training for industry and service organizations.

NHG provides worldwide consulting and support for Six Sigma quality programs to improve manufactured products and business processes.

With over 60 years of combined experience, the partners of NHG provide a unique combination of outstanding academic credentials and expertise in the application of statistical techniques and continuous improvement methods.