TOYOTA Safety

NIOSH Prevention Through Design Conference: A New Way of Doing Business

Incorporating Safety and Ergonomics in the Toyota Manufacturing Design Process

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Bill Horsford, PhD
Project General Manager, TEMA PE-Environmental and Safety

“Always Ask: Is there a safer way?”
Background:

- **Recognized benefits of a collaborative partnership** to improve the assessment, management, analysis and control of workplace conditions related to the safety and health of employees.

Purpose:

- Work cooperatively through the Partnership to **identify research priorities, perform analysis on current workplace practices, develop intervention methods and facilitate communication** and implementation of effective workplace injury prevention on topics.
Agenda

• Toyota Background
  - Operations
  - Safety and The Toyota Way

• Risk Management System
  - Production Preparation Model and Activity
  - Plant Operations

• Summary
Background
Toyota North American Operations

Toyota Motor Engineering & Manufacturing (TEMA)
- Engineering, design, development, R&D, and manufacturing
- Supports operations at 14 NA manufacturing plants in US, Canada, & Mexico

Toyota Motor Sales
- Sales
- Marketing
- Parts & Services
North American Engine & Unit Plants N=7

Canadian Autoparts Toyota, Inc.  
- Aluminum Wheels

Bodine Aluminum  
- Engine Parts

TABC, Inc.  
- Sheet metal components  
- Weld sub-assemblies  
- Steering columns  
- Catalytic converters

Toyota Motor Manufacturing West Virginia, Inc.  
- Engines

Toyota Motor Manufacturing Alabama, Inc.  
- Engines
North American Manufacturing Operations
Workplace Safety Overview

WORKPLACE SAFETY

THE TOYOTA WAY

RISK MANAGEMENT & PREVENTION
Toyota Guiding Principles

- Contribution towards sustainable development

Foster a corporate culture that enhances individual creativity and teamwork value, while honoring mutual trust and respect between labor and management.

We strive to provide fair working conditions and to maintain a safe and healthy working environment for all our employees.

Wherever we do business, we actively promote and engage, both individually and with partners, in social contribution activities that help strengthen communities and contribute to the enrichment of society.
The Toyota Way

- Ensuring Toyota DNA in global manufacturing environment

Continuous Improvement

- Challenge
- Kaizen
- Genchi Genbutsu

Respect For People

- Respect
- Teamwork
Toyota Safety Philosophy

Safe Work
Reliable Work
Skilled Work

Safe work is the door to all work. Let us pass through this door.

Toyota’s Basic Safety Principle

“Safety is management itself. It is everyone’s responsibility from top management to individual workers, to place safety first.”

Eiji Toyoda
Toyota Safety Vision and Mission

Vision:
To be the safest automobile manufacturer in North America

Regional Focus

Ensuring safe equipment and process design
Developing world class safety management systems
Creating a positive safety culture by managing The Toyota Way

This is the foundation for all the work we perform

Mission:
Risk Management System
Injury Reduction vs. Risk Management

“Zero” Recordable Injuries

Risk Assessment

Toyota Problem Solving

“Safety Eye” Hazard Identification

Risk Management

Prevention
Design / PE Production Model

Feedback for Kaizen

1. Vehicle Design Process
2. Process Confirmation
3. Machine Risk Assessment
4. Equipment Kanban and Job Hazard Analysis
5. Process Risk Assessment
6. Toyota Safety Management System, Monitoring and “Critical Eye”
Safety and Health Management System

Design / PE
Provision of safe-to-make products and processes

Plant
Honest observance to job standard for production

Toyota Safety Management System

Accident-Free Product Design
- Product Spec

Accident-Free Process Design
- Process Spec

Job Standard
- Observation Record

Monitor / Measure
- JIS

Element Trng
- Individual Record

Actual Work
- Work Record

Work Record
- Worksite Analysis

Feedback

Process Design
- Process Spec

Product Design
- Product Spec

Individual Record
- Work Record

JIS
A. Established roles and gated management process}

Roles and Responsibilities

Operating Procedure
B. Established ergonomic design criteria

42 elements covering 6 categories (Toyota specific):
Force, Weight, Posture, Tools, Equipment, & Environment

### Design Guideline

<table>
<thead>
<tr>
<th>Category</th>
<th>Criteria</th>
<th>Measurement</th>
</tr>
</thead>
</table>
| **F1**  | Push with thumb<br>
- Pushing with thumb where surface area is 30mm (approx area of a finger tip) is not recommended<br>
- The structure of the finger/thumb tip is not suitable for absorbing high contact stresses, which can result in injury to the nerves, tendons and ligaments<br>
- Where forces exceed guideline, alternatives may be to reduce the required force or to improve the grip surface area to allow greater force to be generated safely.<br>
| m3 kg | 1 kgf | Grommet | Measured using a push/pull gauge. Should reflect production conditions complete line of force. |
| **F2**  | Pinch Grip<br>
- Force required to grip manipulate / operate an object/tool held in a pinch grip (item is “pinched” between the thumb and fingers(s))<br>
- Pinch grips require 5 times greater muscular effort than power type grips<br>
- High force pinch grips can typically cause injury to the tendons in the hand, forearm & elbow & muscle fatigue in the hand & forearm.<br>
- Design should consider the structure of these joints from injury<br>
| m3 kg | 1 kgf | Clamp (clip) | Measured using a push/pull gauge. Should reflect production conditions complete line of force. |
| **F3**  | Push or pull with 2 or more fingers<br>
- A force that must be generated to complete an operation where the force can only be applied using the fingers/thumb.<br>
- The structure of the finger/thumb tip is not suitable for absorbing high contact stresses, which can result in injury to the nerves, tendons and ligaments.<br>
- Where forces exceed guideline, alternatives may be to reduce the required force or improving the grip surface area to allow greater force to be generated safely.<br>
| m3 kg | 1 kgf | Grommet (dia.>30mm) | Measured using a push/pull gauge. Should reflect production conditions complete line of force. |
| **F4**  | Push or pull with one hand<br>
- A force that must be generated to complete an operation where the force can only be applied using a single hand.<br>
- The structure of these joints from injury<br>
- Numerical values correspond to knee & shoulder heights & for standing work; otherwise anatomical references should be used.<br>
- Where forces exceed guideline, alternatives may be to reduce the required force or creating an improved handhold where greater force can be safely generated or the use of a tool or fixture.<br>
| m7 kg between 635 (knee) & 1255mm (shoulder) or<br>
| m4 kg  | 6 kg if work ht. <635 (knee) or<br>
| m7 kg between 635 (knee) & 1255mm (shoulder) or<br> | 7 kg between<br> | 1255mm (shoulder)<br> | Measured using a push/pull gauge. Should reflect production conditions complete line of force. |
| **F5**  | Lateral push/pull forces<br>
- A force that must be generated to complete an operation where the force can only be applied using either a power grip or flat hand.<br>
- The forces applied at the hand can generate significant moment arms and loading on the wrist, elbow and shoulder. Reducing the forces at the level of the wrist, elbow and shoulder will protect the structure of these joints from injury.<br>
- Forces applied at the hand can generate significant moment arms and loading on the wrist, elbow and shoulder. Reducing the forces at the level of the wrist, elbow and shoulder will protect the structure of these joints from injury.<br>
- Design should consider how force must be applied. Where force is/loads can exceed the recommendations, limiting the use of 2 hands will help alleviate stress on one arm.<br>
| m7 kg between 635 (knee) & 1255mm (shoulder)<br> | 6 kg if work ht. <635 (knee) or<br> | 7 kg between<br> | 1255mm (shoulder)<br> | Measured using a push/pull gauge. Should reflect production conditions complete line of force. |
| **F6**  | Push or pull with both hands or palms<br>
- A force that must be generated to complete an operation where the force can only be applied using both hands or palms.<br>
- The forces applied at the hand can generate significant moment arms and loading on the wrist, elbow and shoulder. Reducing the forces at the level of the wrist, elbow and shoulder will protect the structure of these joints from injury.<br>
- Consideration must be given to the interface between the hand and object. Poor grip or unequal division of forces between the hands can impede performance.<br>
- It is preferable for forces to be generated between knee and shoulder heights, where body weight can also be used.<br>
| m10 kg between 635 (knee) & 1255mm (shoulder)<br> | 6 kg if work ht. <635 (knee) or<br> | 7 kg between<br> | 1255mm (shoulder)<br> | Measured using a push/pull gauge. Should reflect production conditions complete line of force. |
| **F7**  | Strike with hand<br>
- Force that must be generated to complete an operation where the force can only be applied using either a power grip or flat hand.<br>
- Where forces exceed guideline, alternatives may be to reduce the required force or creating an improved handhold where greater force can be safely generated or the use of a tool or fixture.<br>
| m7 kg between 635 (knee) & 1255mm (shoulder)<br> | 6 kg if work ht. <635 (knee) or<br> | 7 kg between<br> | 1255mm (shoulder)<br> | Measured using a push/pull gauge. Should reflect production conditions complete line of force. |
| **F8**  | Control Operation Forces<br>
- Where forces exceed guideline, alternatives may be to reduce the required force or creating an improved handhold where greater force can be safely generated or the use of a tool or fixture.<br>
- Design should reflect the use of other assistive devices. (e.g., vehicle brake pedal, foot switch, etc.)<br>
| m7 kg between 635 (knee) & 1255mm (shoulder)<br> | 6 kg if work ht. <635 (knee) or<br> | 7 kg between<br> | 1255mm (shoulder)<br> | Measured using a push/pull gauge. Should reflect production conditions complete line of force. |
| **F9**  | Maximum Grip Force<br>
- Power Grip<br>
- Force required to grip manipulate / operate an object/tool measured at the hand<br>
- High grip forces cannot be done repetitively without increased risk of hand, wrist or forearm injury. The grips are capable of generating/maintaining high forces for extended periods.<br>
- Design should be to minimize the required grip force. For example, high friction finishes or end grips can be utilized to hold and manipulate an object or tool<br>
| m4.5kgf | Grip teeth &<br> | manipulating<br> | wire harness<br> | Measured using a push/pull gauge. Should reflect production conditions complete line of force. |
**Ergonomic Design Requirements**

**B. Example:**

**Guideline Example - Hand Force:**

Push or pull with ≥ 2 fingers (Pinch grip)

≤ 4 kgf (8.8 lbf)

Applies to: Clips, electrical connectors

Push or pull with 1 hand (Power grip)

≤ 7 kgf (15.4 lbf) if hand between knee (635 mm or 25”) & shoulder (1255 mm or 49”)

≤ 6 kg (13.2 lbf) if hand below knee (635 mm or 25”) or above shoulder (1255 mm or 49”)

Applies to: Hoses, interior garnishes

**Guideline Example – Part Weights:**

< 5 kg (11 lb) OK to lift manually; > 15 kg (33 lb) need automation, assist, or other countermeasure

≥ 5 kg (11 lb) and ≤ 15 kg (33 lb) - must do a NIOSH Lifting Equation. Lifting Index > 1.5 requires countermeasure
Ergonomic Design Requirements

B. Example:

Access Holes
## C. Role based training and progressive skill development

### Training Curriculum

<table>
<thead>
<tr>
<th>Module</th>
<th>Questions Answered</th>
<th>Topics Covered</th>
</tr>
</thead>
<tbody>
<tr>
<td>101 Introduction to Ergonomics</td>
<td>What is TEA? Policies? How does ergonomics relate to Toyota and its processes? What are ergonomic practices? What are ergonomic guidelines? Where are the ergonomic guidelines located?</td>
<td>• TEA Ergonomics Policy requirements • TPS and PCOA • Definition of ergonomics • Common practices • Definition of WAVEs • Ergonomic HZL</td>
</tr>
<tr>
<td>201 Introduction to Assessment</td>
<td>What is the job improvement process? How do I complete a TEA assessment? How do I select data? What criteria for data collection equipment? What types of controls are there?</td>
<td>• Measurement techniques • Equipment protocol • Teams perform questionnaire</td>
</tr>
<tr>
<td>202 Ergonomic Guidelines</td>
<td>What documents are required?</td>
<td>• Documentation (if required) • TEA documentation • Guidelines • Procedures</td>
</tr>
<tr>
<td>204 Engineering for Managers</td>
<td>How do I manage and support ergonomics? What do I do, when, why? What relative to the company's plan?</td>
<td>• Risks and responsibilities • Team &amp; Cross-functional planning • Strategic and tactical planning plan</td>
</tr>
<tr>
<td>301 Assessment 1</td>
<td>How do I complete a TEA assessment?</td>
<td>• Toyota Experience Based Assessment (TEA) • Cost justification module • STEP™ methodology • Payback period</td>
</tr>
<tr>
<td>302 Cost Justification</td>
<td>How do I determine a business plan?</td>
<td>• Cost justification module • STEP™ methodology • Payback period</td>
</tr>
<tr>
<td>303 Assessment 2</td>
<td>How do I assess non-cyclical or non-standard jobs? What tools are available?</td>
<td>• SEEP™ (Systematic Risk Identification of Ergonomic Factors/Survey) • SYSTEMS (Systematic Risk Identification of Ergonomic Factors/Survey) • BEST™ (Basic Exposure Scoping Technique) • NBSH/NSO (Ergonomic Risk Analysis) • Likely Multiple Tools: (a) Safety &amp; Health (b) Public Health (c) Transportation (d) Environmental (e) Safety &amp; Health (f) Work Physiology</td>
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<tr>
<td>305 Ergonomic Master Class</td>
<td>Advanced data collection techniques beyond the standard tools. How do I evaluate and influence the ergonomics process?</td>
<td>• Advanced Ergo Assessment Methods • Cognitive Ergonomics, or Human Factors • Human Error • Aging Workforce • Work Physiology</td>
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### Training Matrix

<table>
<thead>
<tr>
<th>Module</th>
<th># Hours</th>
<th>ESU/Top Team</th>
<th>Pilot Team</th>
<th>Production</th>
<th>Design Engineer</th>
<th>Safety Personnel</th>
<th>Management</th>
<th>GL</th>
<th>TL</th>
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<tr>
<td>101 Intro to Ergonomics</td>
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<td>201 Introduction to Measurement</td>
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<td>202 Ergonomic Design Guidelines</td>
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<td>203 Injury Investigation</td>
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<td>204 Ergonomics for Managers</td>
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<td>301 Assessment 1 (TEA)</td>
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<td>401 Assessment 2</td>
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<tr>
<td>501 Ergonomics Master Class</td>
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</tbody>
</table>
D. Feedback loop to the vehicle designers at earliest “concept” phase

Collection of historical concerns

DIR = Design Investigation Request
E. Digital visualization

Simulation

Modeling
Vehicle Design Process

E. Example:

Engine Compartment

Modular Headliner
A. Pilot team utilization
B. Simultaneous engineering and vehicle confirmation trials
## C. Problem registration and countermeasure tracking

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</thead>
<tbody>
<tr>
<td>1</td>
<td>FA E-01</td>
<td>Manual Tray Transfer</td>
<td>1. TM manually slides approx. 20 kg trays with a push force of 5-6 kg at high frequency of 13 trays per minutes. Push force is within guideline, but 3 injuries related to process.</td>
<td>1. Automate process. Tray move on a powered conveyer, or 2. design rail system with trays, similar to East Port (approx. $425,000), or 3. Replace trays with lighter material</td>
<td>Equipment</td>
<td>Shoulder/Neck</td>
<td>Less than or equal to 15 N</td>
<td>Weight: $30.4$ (Force: 5-6 kg) $(13.9)$</td>
<td>6</td>
<td>$126,985</td>
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<td>Red</td>
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<tr>
<td>2</td>
<td>FA W-09</td>
<td>Spot Build Process</td>
<td>1. TM carries heavy weight without an assist</td>
<td>1. Install assist to lift part only if the additional time to use an assist do not affect Takt time (approx. $65,000 for two assist)</td>
<td>Equipment</td>
<td>Shoulder/Neck</td>
<td>Weight of Part</td>
<td>NIOSH Lifting Index: Green 1 Yellow 1.5 Red 1.5</td>
<td>Weight: $9.1$ (NIOSH Lifting Index: 1.25)</td>
<td>1</td>
<td>$45,000</td>
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<td>Yellow</td>
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<td>3</td>
<td>FA E-01</td>
<td>Install Fr Rotor</td>
<td>1. TM must reach 660 mm to carry the part that weighs 5 kg and place it on the equipment.</td>
<td>1. Install Assist (approx. $25,000)</td>
<td>Equipment</td>
<td>Shoulder/Neck</td>
<td>Weight of Part</td>
<td>NIOSH Lifting Index: Green 1 Yellow 1.5 Red 1.5</td>
<td>Weight: Big</td>
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<td>$43,585</td>
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</table>
D. Visualization and executive obeya (review)

- **Concept**
- **1**
- **2**
- **3**
- **4**
- **5**
- **6**
- **SOP**

**Milestone Report**

- **Closed**
- **Open**

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<thead>
<tr>
<th></th>
<th>Closure at K4</th>
<th>Closure at SE</th>
<th>Closure at Genzu</th>
<th>Closure at CV1</th>
<th>Closure at CV2</th>
<th>Closure at JA</th>
<th>Closure at ECI</th>
<th>Closure at 1A</th>
<th>Closure at 2A</th>
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**Obeya Meeting**

**Problem Escalation**
Process Confirmation

D. Results:

Install Forces Meeting Ergo Guideline (%)

Intro of Guidelines into early design - 2003

<table>
<thead>
<tr>
<th>New Model Introductions</th>
<th>1</th>
<th>2</th>
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</table>
A. Consider equipment hazards/risks to determine controls

### Machine Risk Assessment

#### Hazard Identification

<table>
<thead>
<tr>
<th>Exposures</th>
<th>Probability of Occurrence</th>
<th>Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insignificant</td>
<td>Insignificant</td>
<td>S0 Minor</td>
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</table>

#### Risk Assessment

<table>
<thead>
<tr>
<th>Severity</th>
<th>Exposure to Hazard</th>
<th>Probability of Occurrence</th>
<th>Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insignificant</td>
<td>Insignificant</td>
<td>F2 Frequent</td>
<td>S1 Major</td>
</tr>
<tr>
<td>Low / Med</td>
<td>Insignificant</td>
<td>F1 Infrequent</td>
<td>S2 Permanent Injury or Death</td>
</tr>
<tr>
<td>Medium</td>
<td>Medium</td>
<td>F1 Infrequent</td>
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<tr>
<td>Medium</td>
<td>Medium</td>
<td>F2 Frequent</td>
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<td>Med / High</td>
<td>High</td>
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<tr>
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<td>Very High</td>
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#### Control Measures

- **Result**: ISO 13849-1, RIA 15.06, ANSI Z244, NA

- **Control Measures**
  - CR
  - DM
  - SM
B. Multi-phase equipment evaluation, confirmation and approval during installation and commissioning.

### Kanban Checksheet / Punchlist

#### Activity CONTROL

- **I) Installation**
  - Contractor(s)
  - Manual & Automatic operation, function & adjustment (70%)
  - Process equipment tuning & adjustment to achieve quality (60%)
  - Support (5%) *1, *2

- **II) Construction Mgmt.**
  - Manual & Automatic operation, function & adjustment (10%)
  - Process equipment tuning & adjustment to achieve quality (60%)
  - Support (5%) *1, *2

- **III) Seibi**
  - Manual & Automatic operation, function & adjustment (20%) *1
  - Process equipment tuning & adjustment to achieve quality (60%)
  - Support (5%) *2, *3

- **IV) Engineering**
  - Over-all
  - Support (5%)
  - Over-all
  - Support

- **V) Pilot & Line Operation**
  - Support
  - Over-all
  - Transfer

#### Conditions of Transfer (representative)

- **I) Safety**
- **II) Basic Function**
- **III) Product Quality**
- **IV) Mass Production**

- Installation Check
- Power On
- Preliminary Spare Parts List
- Initial Buy Off
- All Functional Items OK
- OK for production to run
- Ready for handover
- Final dwg. As built & part list
- All Items for Machine are Complete

- Engineering
- Construction
- Contractor(s)
- PE Leader
- AHJ
- Facility
- Safety
- Engineering
- Construction
- Seibi
- PE Leader
- Pilot Maintenance
- Environmental
- Safety
A. Reinforce incident prevention through job design

<table>
<thead>
<tr>
<th>Hazard Assessment Tool</th>
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<tr>
<td>Identify Hazards &amp; Controls</td>
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<td>Broad Engagement</td>
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<tr>
<th>Safe Work Practice</th>
<th>Task</th>
<th>Potential Hazard</th>
<th>Preventive Measures</th>
<th>Site Specific Plans</th>
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A-16 Job Safety Assessment (JSA) Job Hazard Assessment (JHA)
Safety and Health Management System

Accident-Free Product Design
- Product Spec

Accident-Free Process Design
- Process Spec

Job Standard
- JIS

Element Trng
- Individual Record

Monitor / Measure
- Observation Record

Actual Work
- Work Record

Toyota Safety Management System

Feedback

Design / PE
Provision of safe-to-make products and processes

Plant
Honest observance to job standard for production
A. Perform risk assessment on routine, non-routine and troubleshooting work to establish safe process design.
B. Multi-facet evaluation of traditional safety, ergonomic & industrial hygiene hazards

**Ergonomics**

**Safety**

**Industrial Hygiene**
C. Hierarchy of controls: Controlling exposure to hazards

Traditional Hierarchy of Exposure Control Practices

- Elimination
- Substitution
- Modification
- Containment
- Ventilation
- Work Practices
- Personal Protection
A. Toyota Safety Management System

1. **Risk Assessment**
   - **STEP1**: Job Identification
   - **STEP2**: Grasp Hazards
   - **STEP3**: Risk Assessment
   - **STEP4**: Significant Risk
   - **STEP5**: Follow-up/Confirm
   - **STEP6**: Implement Kaizen
   - **STEP7**: Kaizen Plan

2. **Risk Control**
   - **STEP5**: JIS Visual control
   - **STEP6**: PPE
   - **STEP7**: Safety Operating Criteria
   - **STEP8**: Perform jobs
   - **STEP9**: Observation/ follow-up
   - **STEP10**: Training

3. **Competency**
   - **F**: Training record
   - **M**: Observation record
   - **D**: Job Performance
   - **S**: Observation/ follow-up

4. **Risk - Rank Down**
   - **F**: Training record
   - **M**: Observation record
   - **D**: Job Performance
   - **S**: Observation/ follow-up
Monitoring Controls

• Utilization of visual management to identify and monitor control measures, risk reduction and critical incidents
"Critical Eye" for Safety

- Train supervisors on hazard recognition and engage team members in continuous shop floor improvement.

Manager's "Eye"
Designation of applicable work

Check/follow-up
- Use of "Safety Time"

Thorough Identification of work
- Mechanism for understanding

By categorization
- STOP 6 plus
- Degree of injury suffered

Activity cycle

Education/training
- Improvement of training system

Drafting/improvement of guideline
- Scope
- Prioritization

Designation of plan
- Equipment/work kaizen
- Rank-down of danger
- Prioritization

Spotting of hidden work

- Prioritization for completion
- Obtaining agreement and understanding of workers

Procuring degree of reassurance that enables work to be assigned with trust

Reasonable guideline that is easy to use on the jobsite

Extraction of problems through closeup observation

• Train supervisors on hazard recognition and engage team members in continuous shop floor improvement.
Design / PE Production Model

Feedback for Kaizen

1. Vehicle Design Process
2. Process Confirmation
3. Machine Risk Assessment
4. Equipment Kanban and Job Hazard Analysis
5. Process Risk Assessment
6. Toyota Safety Management System, Monitoring and “Critical Eye”
Toyota Corporate Safety Policy

Safety is a core value and shared responsibility of all Toyota Motor Engineering & Manufacturing North America, Inc. (TEMA) team members.

Toyota “C A R E S” for Safety:

Compliance with all occupational Safety legislation, regulations, and other requirements;

Accountability from our management team through leadership and participation;

Reporting Safety as a key performance indicator;

Excellence in Safety through continual improvement (kaizen); and,

Sustaining a safe workplace for our team members and promoting Safety beyond our workplace

Through our TEMA Corporate Safety Policy we will strive to be a Safety leader in the automobile manufacturing industry.