Improving the Flow of Knowledge in Product Development

Patricia Ranch

Today's Agenda

1. Organization Overview
2. Product Development Process
3. Strategy for Knowledge Capture and Transfer
4. Knowledge Capture using A3 Reports
5. Maintaining Knowledge Management Process
6. Continuous Improvement of Knowledge Transfer
7. Critical Success Factors for Knowledge Management

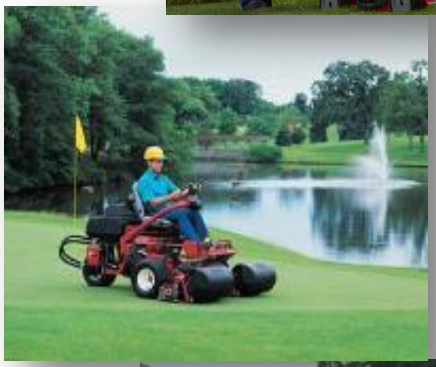
TORO.

Overview


Global Leader in Turf and Landscape Maintenance
Since 1914, we've built our reputation on superior customer care and constant innovation.

Residential, Professional, Commercial Divisions





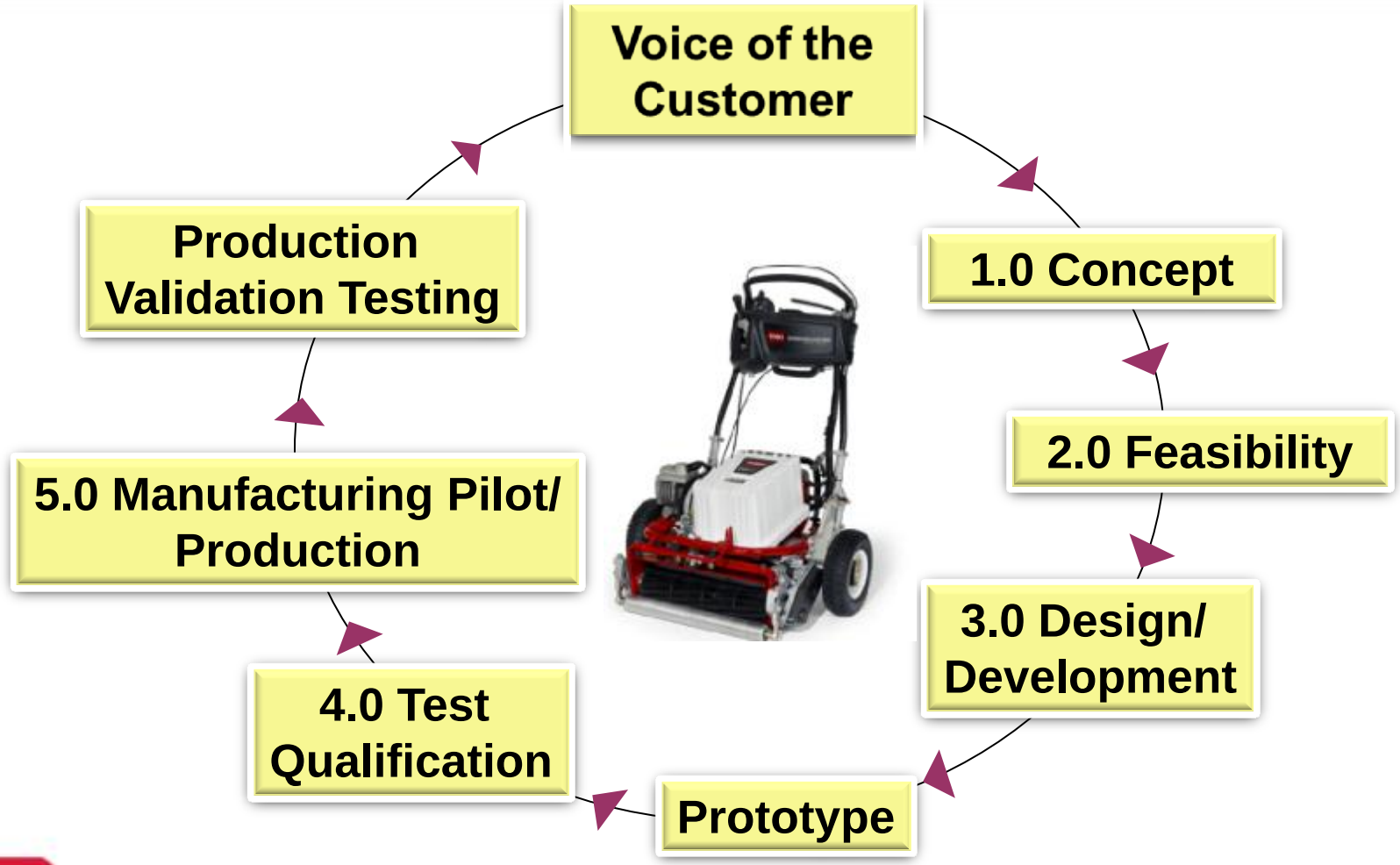

New Product Development

Customer

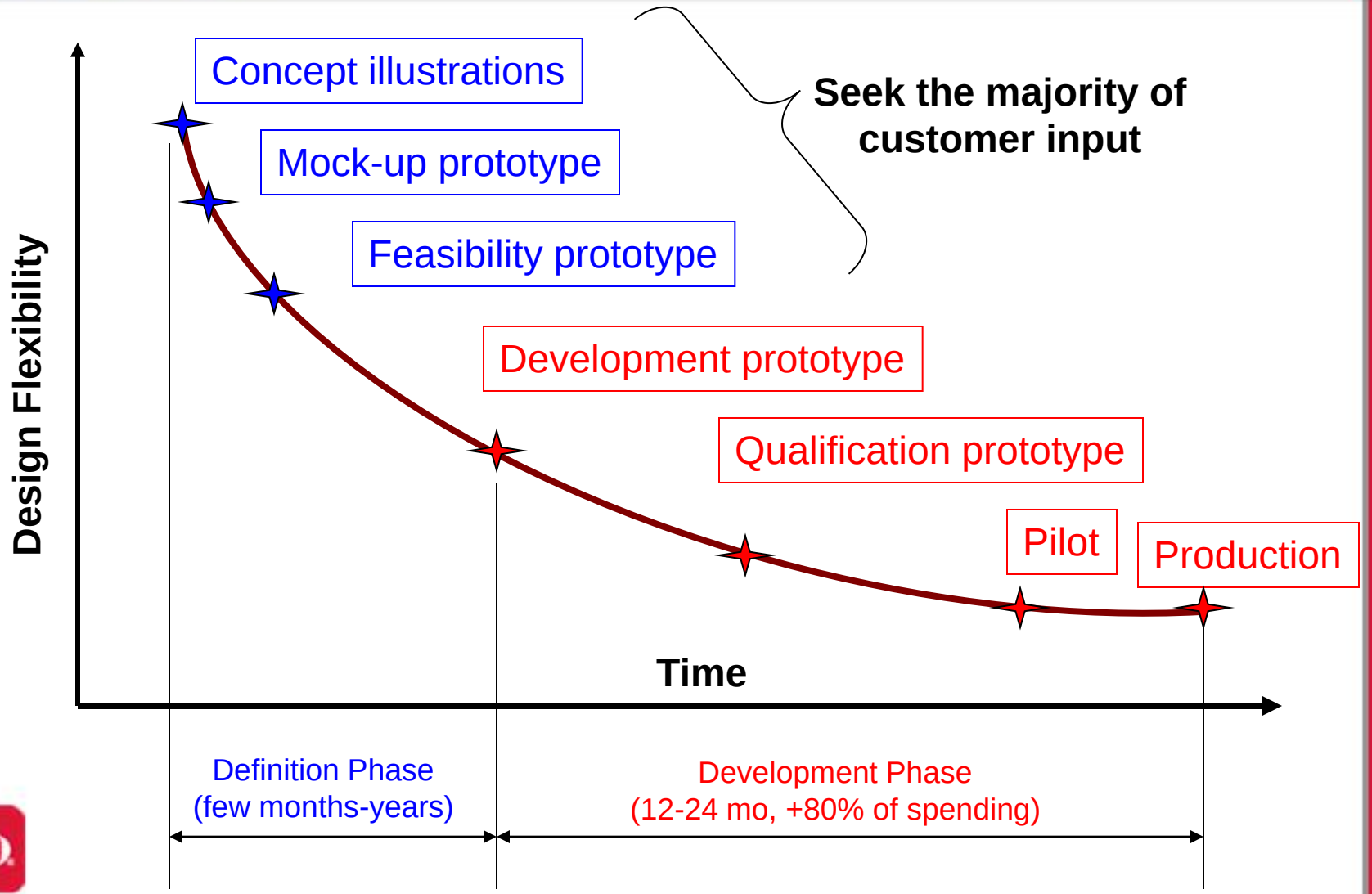
Need ▸ Marketing ▸ R&D ▸ Design

▸ Prototype ▸ Test ▸ Production ▸ Customer

New Product Development Gate Process



New Product Development Process



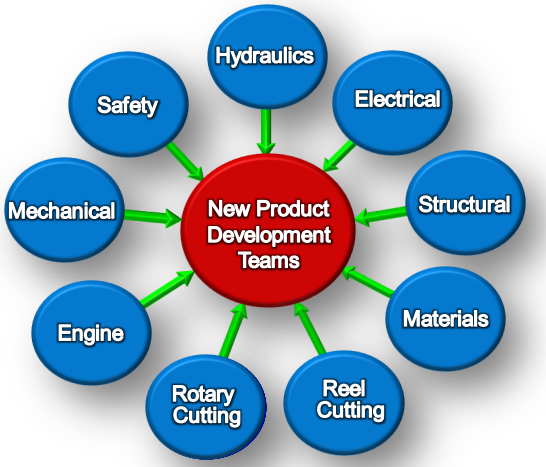
Knowledge Capture
&
Transfer Strategy

Dave Klis

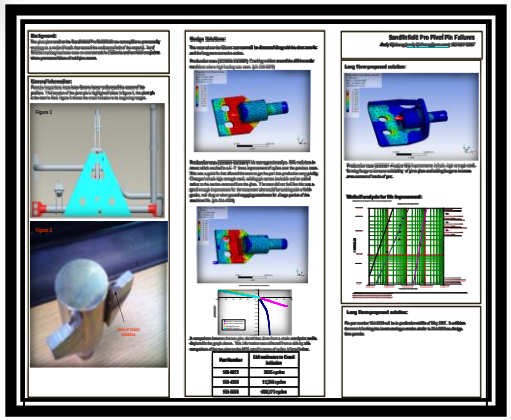
Visionary

Toro Knowledge Management Strategy

Specialization Groups



A3 Reports



SharePoint Knowledge Site

Knowledge Transfer Project Definition

Observation:

1. Engineers encountering the same problems over and over
2. Loss of knowledge due to retirement

Mission:

To avoid re-engineering

Action:

Develop a process to capture and communicate key solutions

Business Metrics:

New Product Warranty, Field Campaigns, Product Performance Issues

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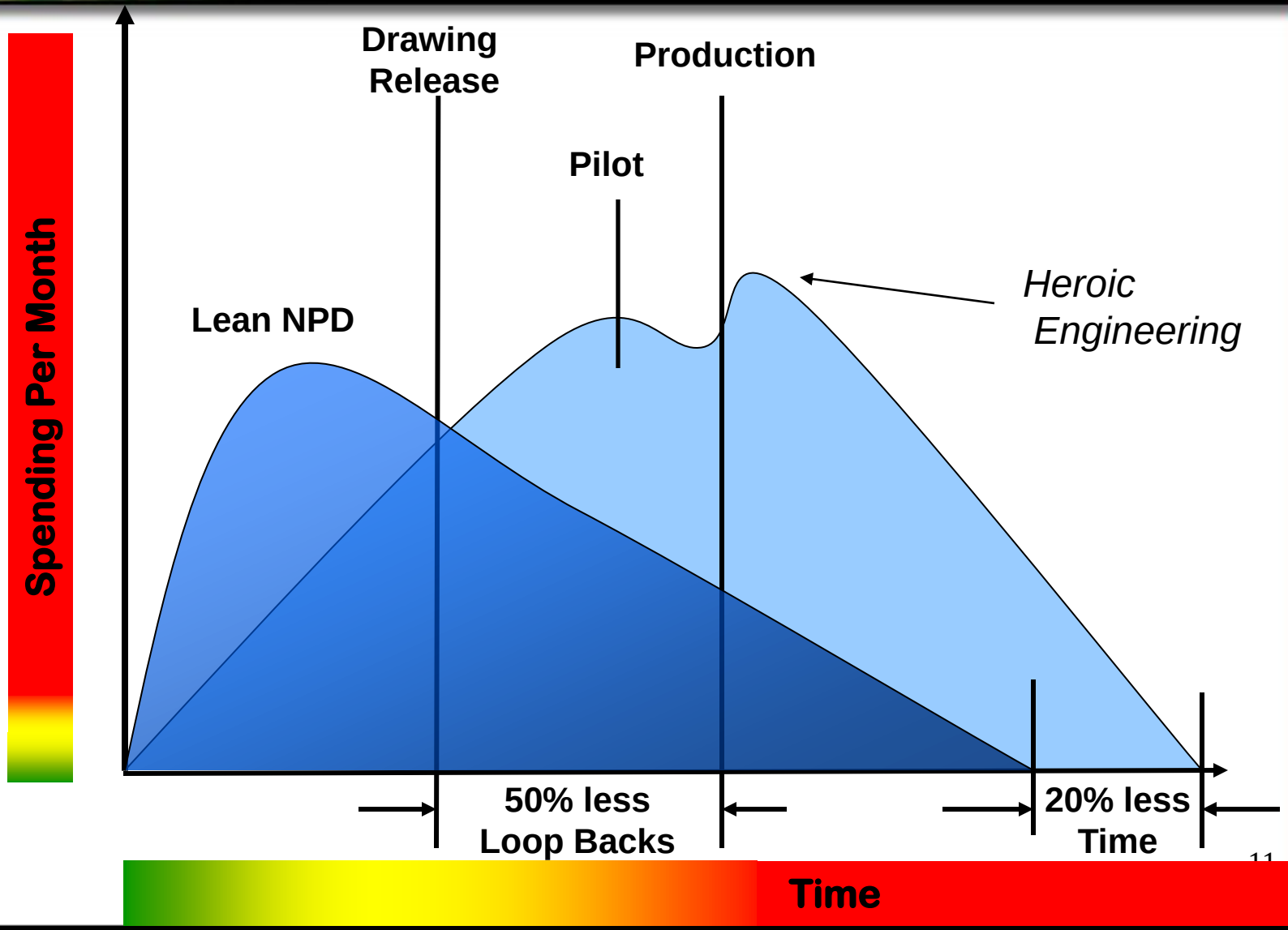
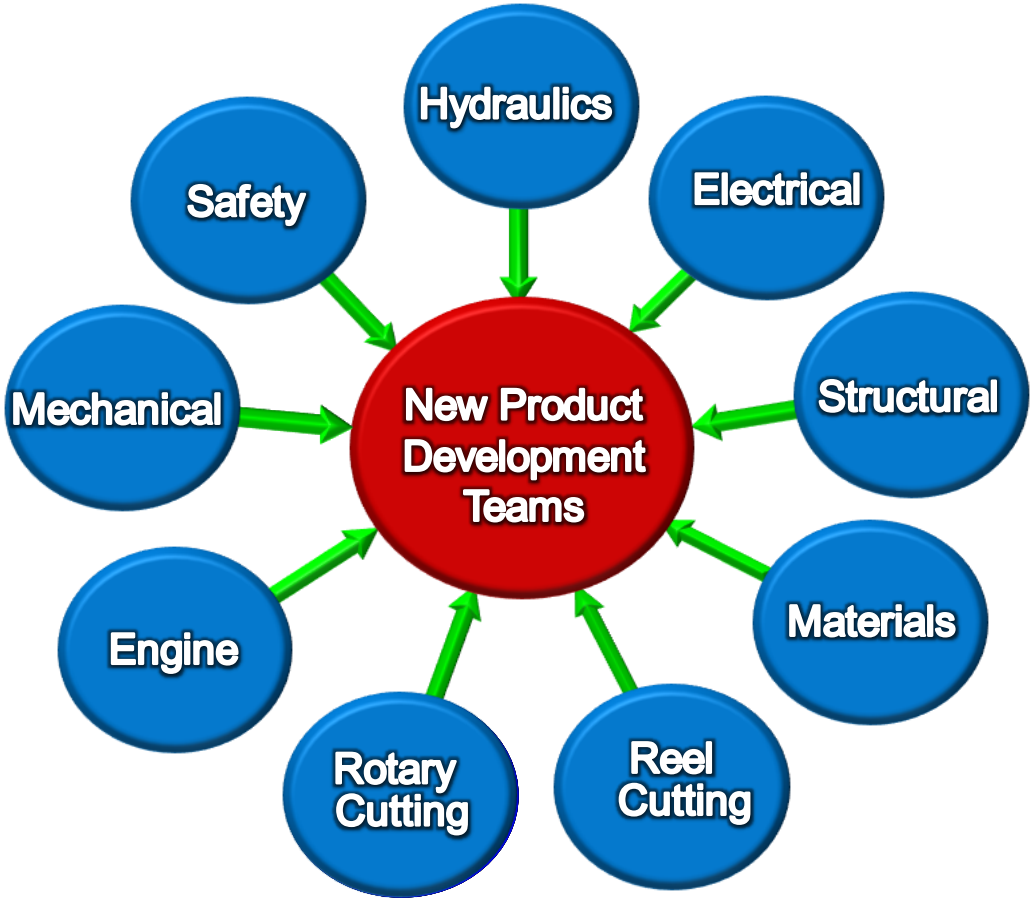
Moving the Mountain

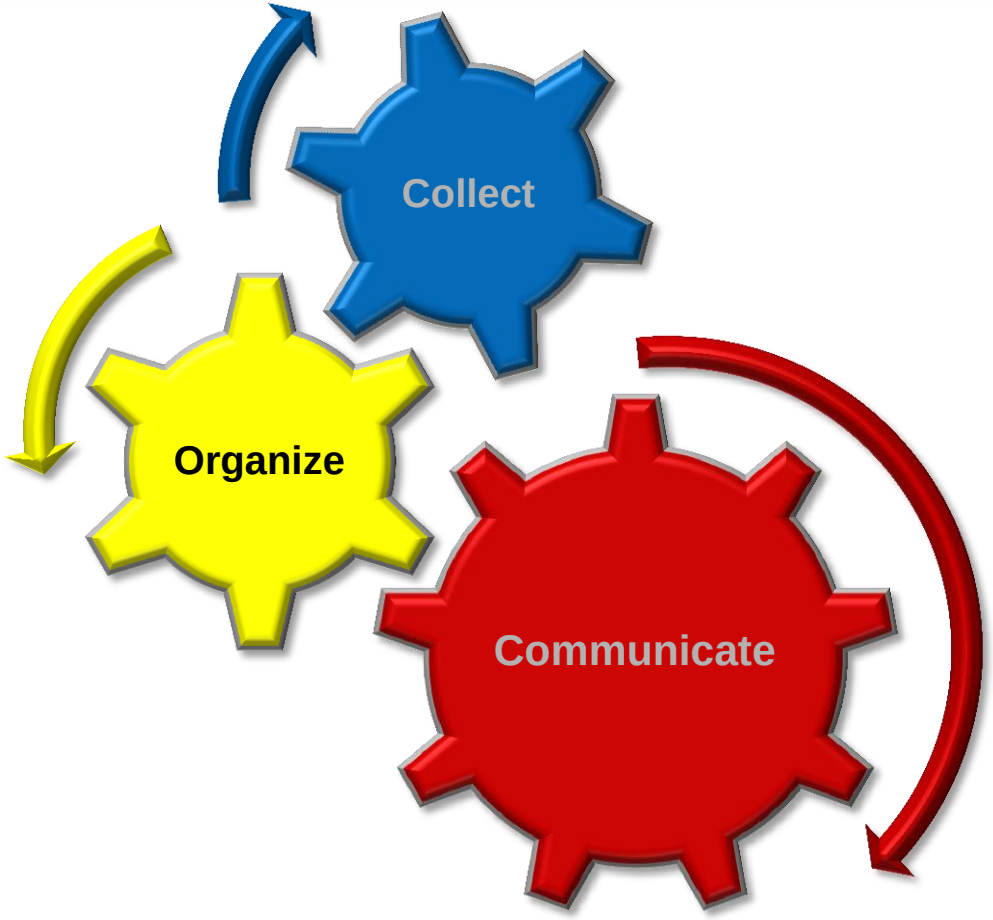


Knowledge Capture & Transfer at Toro

Specialization Groups



Specialization Group Mission



Engineering Knowledge

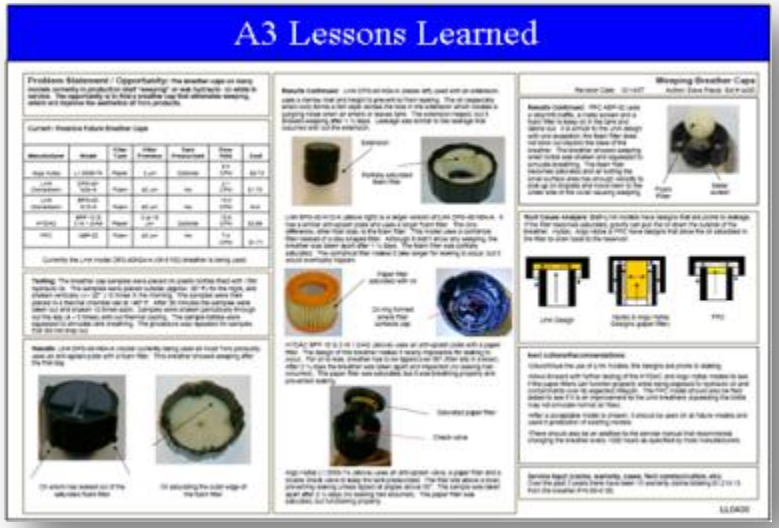
Integration of Specialization Knowledge into New Product Development

Specialization Groups Provide

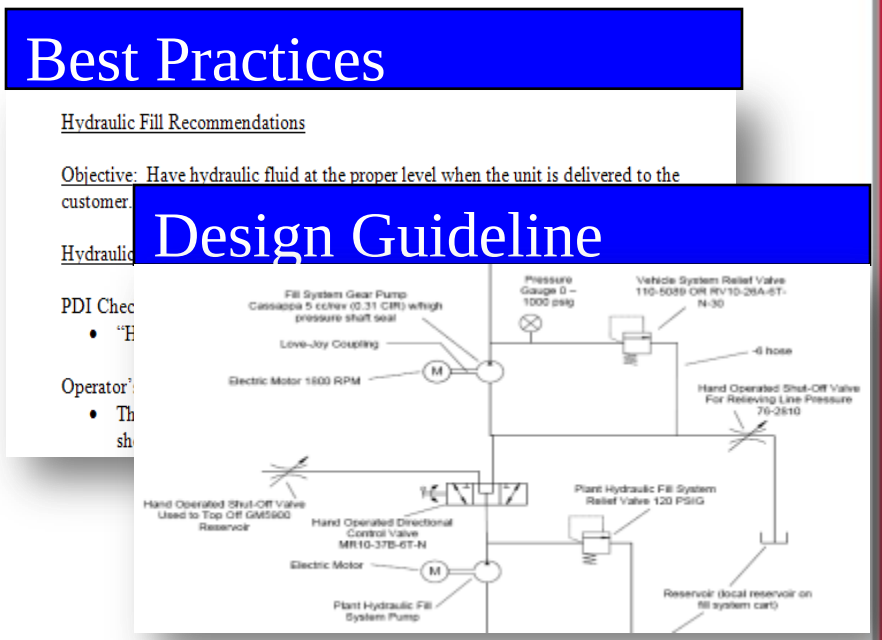
- **Agreed upon formal and informal activities with product teams**
- **Early guidance on design decisions**
- **Support for decisions on supplier selection, application reviews, risk assessments, test planning, etc.**
- **Required to confirm their engagement with Specialization Groups**

Specialization Groups
Other Responsibilities

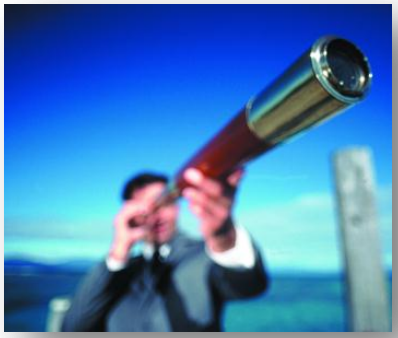
Provide subject matter input into A3s



Develop Best Practice, Design Guidelines & Checklists



Provide Technological Leadership in their specialty



Specialization Leadership Group

- **Members:**
  - Toro Engineering Directors
  - Sponsors of Specialization Groups
  - Some Leaders of Specialization Groups

- **Objectives:**

  Provide support and direction for the Specialization Groups by:
  - Reviewing progress on critical initiatives
  - Progress sharing by Specialization Groups
  - Effectiveness assessments with project team leaders
  - Provide guidance/requirements for new charters

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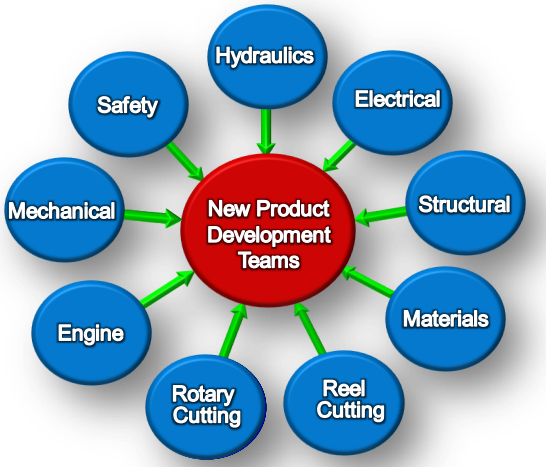
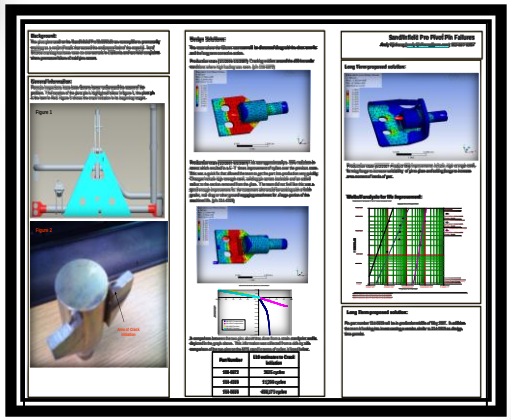
Toro Knowledge Management

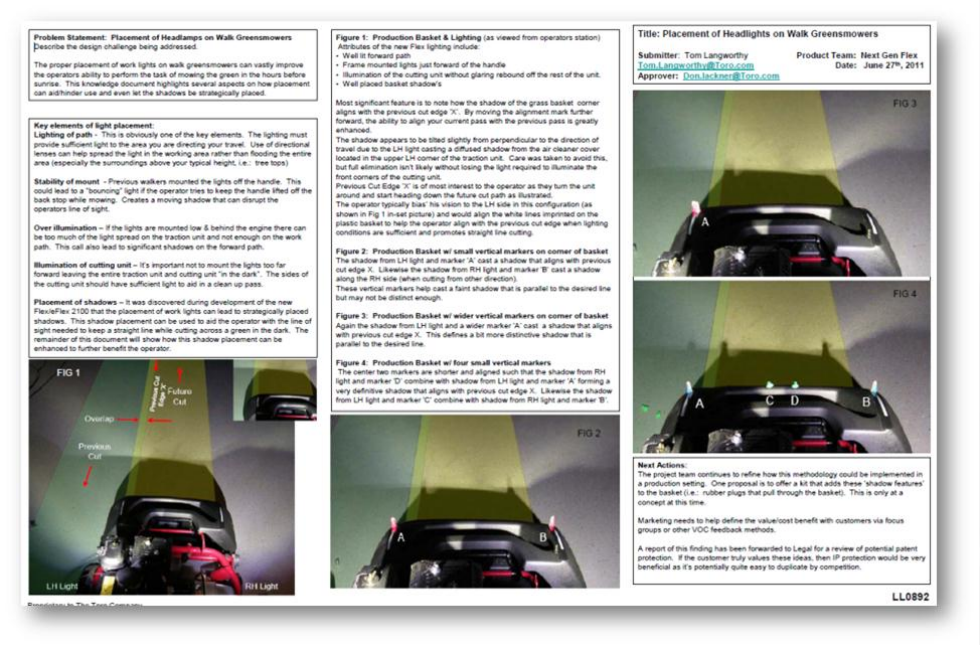
Specialization Groups



A3 Reports



SharePoint Knowledge Site



Problem Statement: Placement of Headlamps on Walk Greensmowers
Describe the design challenge being addressed.

The proper placement of work lights on walk greensmowers can vastly improve the operators ability to perform the task of mowing the green in the hours before sunrise. This knowledge document highlights several aspects on how placement can aid/hinder use and even let the shadows be strategically placed.

Key elements of light placement:
Lighting of path - This is obviously one of the key elements. The lighting must provide sufficient light to the area you are directing your travel. Use of directional lenses can help spread the light in the working area rather than flooding the entire area (especially the surroundings above your typical height, i.e.: tree tops)

Stability of mount - Previous walkers mounted the lights off the handle. This could lead to a "bouncing" light if the operator tries to keep the handle lifted off the back stop while mowing. Creates a moving shadow that can disrupt the operators line of sight.

Over illumination – If the lights are mounted low & behind the engine there can be too much of the light spread on the traction unit and not enough on the work path. This call also lead to significant shadows on the forward path.

Illumination of cutting unit – It's important not to mount the lights too far forward leaving the entire traction unit and cutting unit "in the dark". The sides of the cutting unit should have sufficient light to aid in a clean up pass.

Placement of shadows – It was discovered during development of the new FlexiFlex 2100 that the placement of work lights can lead to strategically placed shadows. This shadow placement can be used to aid the operator with the line of sight needed to keep a straight line while cutting across a green in the dark. The remainder of this document will show how this shadow placement can be enhanced to further benefit the operator.

FIG 1
Future Cut
Overlap
Previous Cut
LH Light
RH Light

Figure 1: Production Basket & Lighting (as viewed from operators station)
Attributes of the new Flex lighting include:
- Well lit forward path
- Frame mounted lights just forward of the handle
- Illumination of the cutting unit without glaring rebound off the rest of the unit.
- Well placed basket shadow's

Most significant feature is to note how the shadow of the grass basket corner aligns with the previous cut edge 'X'. By moving the alignment mark further forward, the ability to align your current pass with the previous pass is greatly enhanced.
The shadow appears to be tilted slightly from perpendicular to the direction of travel due to the LH light casting a diffused shadow from the air cleaner cover located in the upper LH corner of the traction unit. Care was taken to avoid this, but full elimination isn't likely without losing the light required to illuminate the front corners of the cutting unit.
Previous Cut Edge 'X' is of most interest to the operator as they turn the unit around and start heading down the future cut path as illustrated.
The operator typically bias' his vision to the LH side in this configuration (as shown in Fig 1 in-set picture) and would align the white lines imprinted on the plastic basket to help the operator align with the previous cut edge when lighting conditions are sufficient and promotes straight line cutting.

Figure 2: Production Basket w/ small vertical markers on corner of basket
The shadow from LH light and marker 'A' cast a shadow that aligns with previous cut edge X. Likewise the shadow from RH light and marker 'B' cast a shadow along the RH side (when cutting from other direction).
These vertical markers help cast a faint shadow that is parallel to the desired line but may not be distinct enough.

Figure 3: Production Basket w/ wider vertical markers on corner of basket
Again the shadow from LH light and a wider marker 'A' cast a shadow that aligns with previous cut edge X. This defines a bit more distinctive shadow that is parallel to the desired line.

Figure 4: Production Basket w/ four small vertical markers
The center two markers are shorter and aligned such that the shadow from RH light and marker 'D' combine with shadow from LH light and marker 'A' forming a very definitive shadow that aligns with previous cut edge X. Likewise the shadow from LH light and marker 'C' combine with shadow from RH light and marker 'B'.

FIG 2
A
B

Title: Placement of Headlights on Walk Greensmowers

Submitter: Tom Langworthy
Tom.Langworthy@Toro.com
Approver: Don.lackner@Toro.com
Product Team: Next Gen Flex
Date: June 27th, 2011

FIG 3
A

FIG 4
A
C
D
B

Next Actions:
The project team continues to refine how this methodology could be implemented in a production setting. One proposal is to offer a kit that adds these 'shadow features' to the basket (i.e.: rubber plugs that pull through the basket). This is only at a concept at this time.

Marketing needs to help define the value/cost benefit with customers via focus groups or other VOC feedback methods.

A report of this finding has been forwarded to Legal for a review of potential patent protection. If the customer truly values these ideas, then IP protection would be very beneficial as it's potentially quite easy to duplicate by competition.

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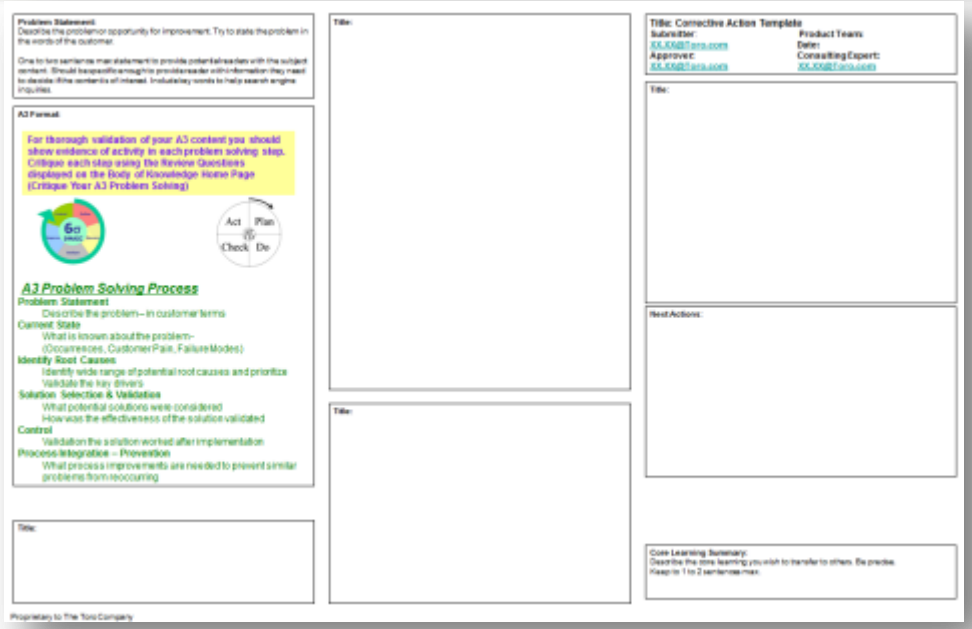
Knowledge Capture A3 Reports

A3 Reports



Key Elements of an A3 Report

- 11x17 paper
- Visual Content
- Problem Statement and Section Titles
- Problem Solving Process & Tools
- Title and Author contact information

Problem Solving A3 Report

Problem Statement:

When operating two-stage snowthrowers in wet sticky snow conditions, the snow discharge chute can sometimes plug with snow. Usually this occurs because the impeller is trying to force more snow through the chute opening than it can handle, compacting the wet sticky snow into a clump. When plugging occurs, the operator must stop the machine and use a tool such as a clean-out stick to safely clear the clump of snow from the chute opening.

Current State:

In the past, an attempt was made to solve this problem by metering (limiting) the amount of snow entering the impeller by using a drum auger (a round metal cylinder inside the auger flighting). See picture on right.

While effective, the drum was costly and caused the snowthrower to want to ride-up over hard-packed or dense snow. To counter the tendency for the front end to lift, the operator typically lifted upward on the handles, which reduces traction, causing the tires to slip.

A more recent innovation used a bypass chamber to recycle excess snow entering the impeller back into the auger path. The bypass chamber (see arrow in picture below) consisted of a molded lower chute with a cavity above the impeller and adjacent to the chute opening. A lot of work went into the development of the optimum size and shape of the chamber.

To maintain snow velocity and handle the volume of "bypassed" snow, the chamber had to extend from the chute to the right side of the auger housing. (See left picture).The result was a large expensive molded chamber and a complex lower steel impeller housing and frame, requiring additional frame supports because of the large opening out in the auger housing. While effective in metering the snow, the method was costly to build and difficult to manufacture.

Note: The bypass also greatly improved safety since it moved the pinch point (between the impeller blade and the chute opening) from the edge of the chute opening to the right side of the impeller, but for purposes of this document, we will focus on the metering aspect.

Solution:

On the **Value Two-Stage (VTS) Snowthrower** project, the team wanted to utilize the snow metering and safety benefits of the bypass system, but find a more cost effective and manufacturing friendly solution. After initially considering a proportionately smaller version of the original bypass system, the team decided on a more radical approach where the bypass chamber was contained within the diameter of the impeller. (See pictures above right) This design significantly reduced cost and addressed the manufacturing concerns of the previous system. In most snow conditions, this new bypass system was found to be as effective in metering snow as the original bypass system.

However, when testing in some wet sticky snow conditions (typical of spring snows) the team discovered that the chute could still be plugged if the impeller was intentionally overfed, typically by going too fast for conditions, or artificially loading the impeller by intermittently engaging the impeller drive.

After analyzing other machines in the same conditions, it was discovered that the pitch of the auger flighting also had a significant impact on the amount of snow being metered into the impeller and discharge chute. Our theory is that wider pitch augers (due to the angle of impact of the snow to the auger flighting) tend to mechanically propel a greater proportion of the snow out in front of, and toward the center, of the snowthrower than narrow pitch augers, thereby reducing the volume of snow that was being fed into the impeller.

Our initial prototype, unlike the wide-pitch augers of the other machines we analyzed, used a narrow pitch helical auger flighting with integral bracing (see pictures below) which aggressively force-fed the impeller, much like a screw auger design.

The result (depicted graphically below left), was an auger that aggressively gathered and fed the majority of snow into the impeller, with very little being pushed out in front of the snowthrower, as shown in the picture below right.

Title: Two-Stage Snowthrower Chute Plugging
Submitter: Nathan Friberg
Product Team: Snow
Date: 10-19-2011
Approver: Phil Stalpes
Consulting Expert: John Coughlin

By increasing the auger pitch, (depicted graphically below left) some of the snow is deflected forward of the machine and toward the center, reducing the amount of snow being fed into the impeller. This can be seen in the picture below right. The result of using a wide-pitch auger, combined with a compact bypass system, was elimination of chute plugging in wet sticky snow conditions, while maintaining the safety benefits of the bypass system.

Conclusions:

1. Chute plugging on two-stage snowthrowers typically occurs when:
   a) snow conditions are wet and sticky, typical of springtime snows.
   b) there is more snow being forced through the discharge chute than it can handle. The excess snow then begins to backup, and is compacted by the impeller into a clump, plugging the chute.
2. Open wide-pitch auger flighting, combined with a compact bypass chamber, is an effective means to meter the snow into the discharge chute and eliminate plugging while maintaining the safety benefits of the bypass system.

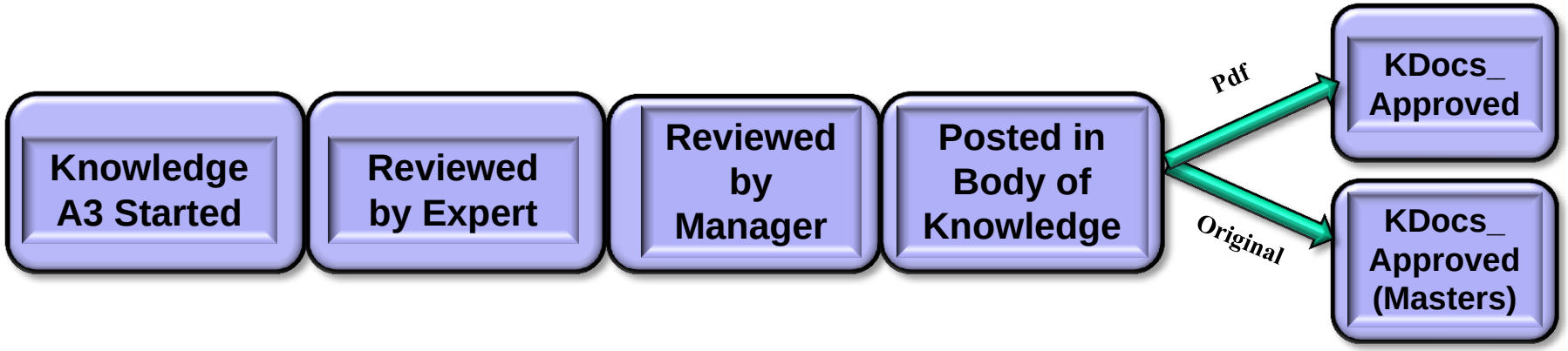
Core Learning Summary:

Plugging of the chute on two-stage snowthrowers in wet, heavy snow conditions can be eliminated by metering the snow intake into the impeller and discharge chute.

One safe and cost effective method to meter snow into the impeller and discharge chute is to combine a compact bypass chamber with an open wide-pitched auger flighting system.

LL0906

A3 Approval Process



Key Elements

- Managers to insure expert input is obtained before approval
- Specialization leads determine who is best to provide expert input
- Input must be provided on a timely basis
- Authors encouraged obtain input early in the process.

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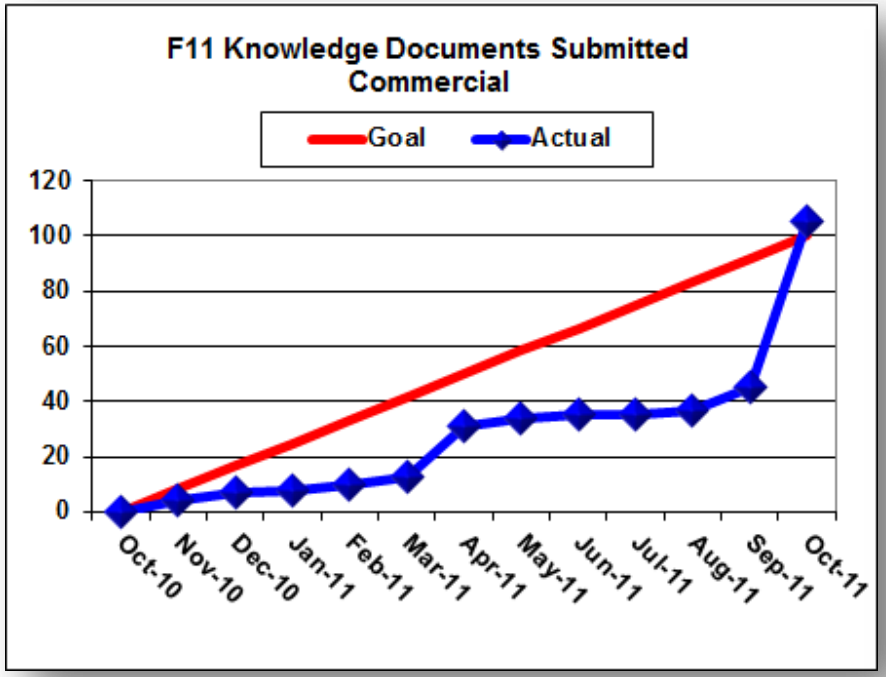
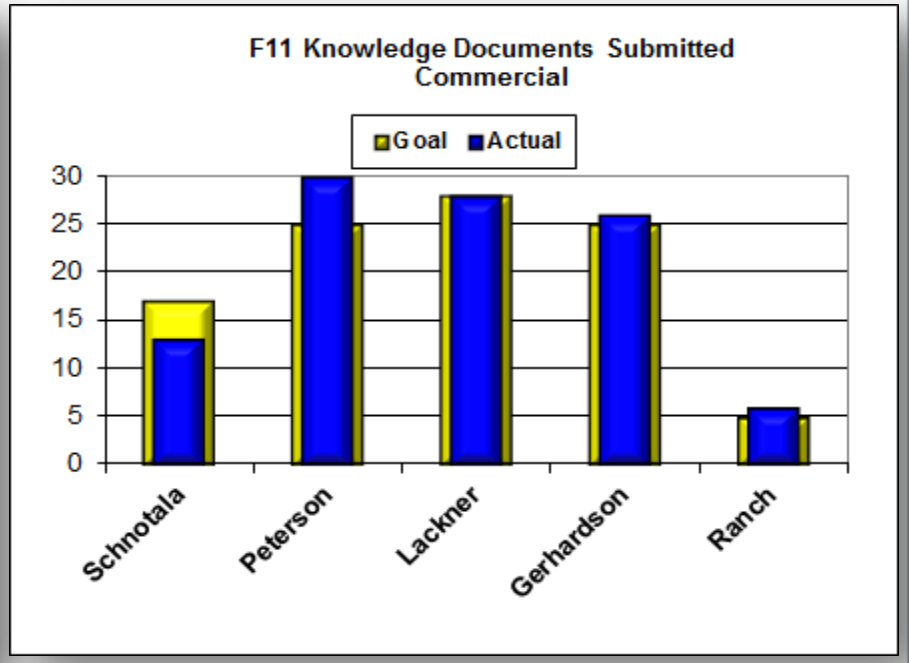
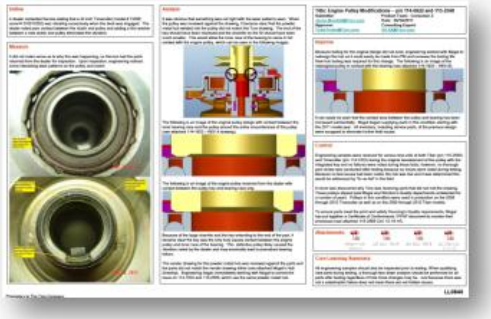
Requirements and Goals

2011 Knowledge Documents Scorecard





Encouraging A3 Reports



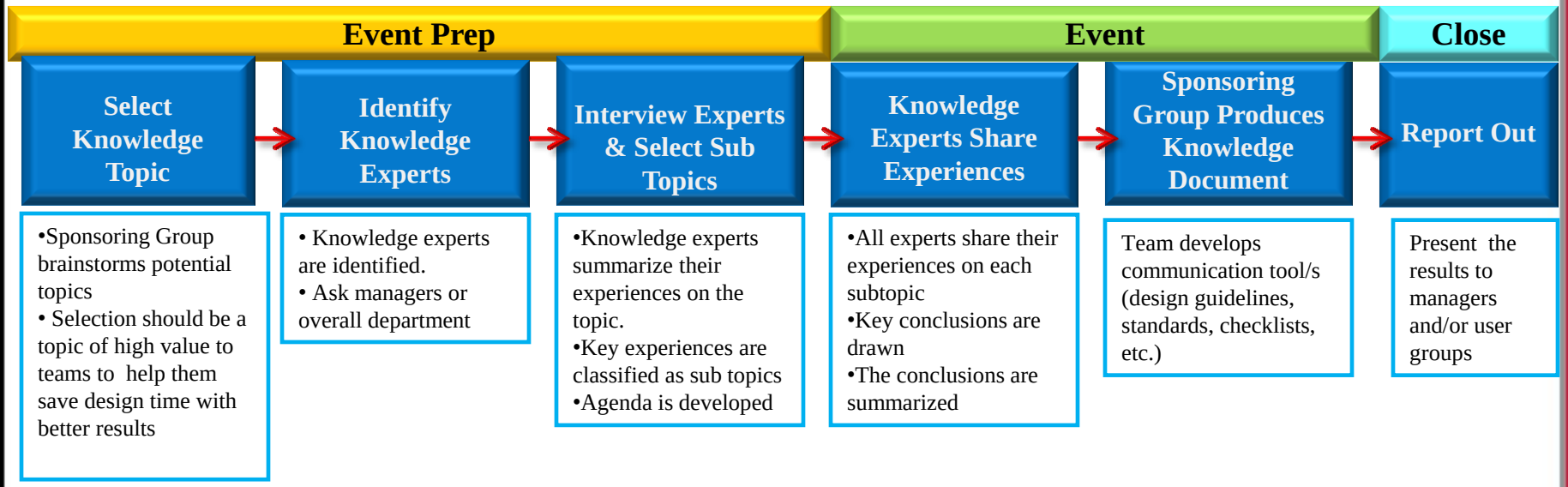
- Vision Statement
- Performance Review Requirements
- Reviews of A3's with Division Leadership
- Reviews of A3's in Department Meetings
- E-mail list of new A3's
- Posting Recent A3's in Department
- Documented Requirements within Engineering Processes

Other Methods of Knowledge Capture

Knowledge Capture Events

Objective: Consolidate and publish key information to assure critical company knowledge is leveraged

- Improve solution quality by using the company's collective experiences
- Reduce development time & investment by not recreating knowledge we already have



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A3 Technical Forums

Twice a year, Engineering Leaders select A3 examples from their area.

The authors review their A3 in a meeting that includes Engineers from all Toro Divisions.

A3 Forum 1/21/2011 Agenda

Introduction

1. **Non Welded Rod to Plate Assembly**
   - Nominator: Vern Ackerman
   - Author Jay Kakuk
2. **Rosenboom vs. Texas Hydraulic Cylinders**
   - Nominator: Don Lackner
   - Author: Chad Moe
3. **Drive by Wire FMEA Current Level Checks**
   - Nominator: Rick Gerhardson
   - Author: Jeff Meyer
4. **Optimization of a Stump Cutter Tooth Pattern**
   - Nominator: Joe Hager
   - Author: John Azure
5. **Ultrasonic Sensor System Study**
   - Nominator: Rick Gerhardson
   - Author: Ray Culp
6. **Greensmower Steering Valve Decision**
   - Nominator: Don Schnotala
   - Author: Andy Kjolhaug
7. **Seat Safety Switch Installation**
   - Nominator: Joe Hager
   - Author: Jeff Stern
8. **Lift Circuit Cavitation**
   - Nominator: Dan Peterson
   - Author: Rich Guertin
9. **Reel Spline Fractures -105-5792 11-Blade Reels**
   - Nominator: Don Schnotala
   - Author: Mike LeClair
10. **Idler Pulley Failures on Consumer Z**
    - Nominator: Chuck Holley
    - Author: Jason Mondati

Wrap Up

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Maintaining the Body of Knowledge using SharePoint

Myteam > Engineering Knowledge

Welcome Paul Kurth | My Links |

Engineering Knowledge

All Sites | Advanced Search

Engineering Knowledge | Business Units | Information | Site Actions

Version: Published (41.0) Status: Published and visible to all readers

Page | Workflow | Tools | Edit Page

View All Site Content

Documents

- Recently Approved Knowledge Docs

Recycle Bin

Engineering Knowledge

Welcome to the Toro Engineering Knowledge Site

This is a collection of Knowledge and Process Improvement ideas learned from Product Development and the Resolution of Product Issues. The "Knowledge Documents" are organized by Specialization team.

The information contained in this Knowledge Site is Proprietary to the Toro Company and is not to be shared with individuals or organizations outside of the Company.

Knowledge Doc Submission and Usage Metrics

Specialization Group Roster Matrix

Specialization Group / Product Team Interface Map

A3 Help and Templates

How to use the Knowledge Document Search Utilities

Division A3 Requirements & Incentive Programs

A3 Approval Process

Links to Specialization Sites

Recently Approved Knowledge Docs

Knowledge Document Search

Search Terms | Submit

Check locations where you want to search!

- (•) Approved
- ( ) Awaiting Approval
- ( ) In Process
- ( ) Achived
- ( ) Test Reports
- ( ) Design Review Docs
- ( ) All Locations

Specialization Team Index

Mechanical	Electrical
Engines	Hydraulics
Materials	Structural
Reel Cutting	Rotary Cutting
Safety	DFMA
Specific Applications	

Help & Template Documents

Process Improvement | Leadership Group

Done | Local intranet | 100%

Use of SharePoint

Advantages:

- Commercially available
- Widely used
- Already in use by Engineering
- Customizable
- Can manage access to information
- Visibility to suppliers through specific sites
- Google-like Search Capability

Continuous Improvement

Improvement: Require Knowledge Capture tied to Engineering Processes

- **Target higher value knowledge captures**
  - Integrate into Engineering process
    - Set New Product Development requirements
      - Gates/Milestones
    - Set Design and Cost Improvement Project requirements
      - Design enhancements
      - Key problem solving projects

- **Drive A3 knowledge into higher level docs**
  - Design Guidelines/ Standards/Checklists
  - Regulatory Requirements
  - State of Technology

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Improve Knowledge Documents
(Quantity, Quality, Relevancy)

- **Management**
  - Set one block of time/month for people to generate K Docs
  - Keep running lists of topics for documentation
  - Reinforce presentation and validation
  - Additional employee problem solving training
  - Assure relevance – core learning identified and value assessed
  - Develop alternative formats
- **Develop more jointly produced Knowledge Docs**
  - Give each participant credit
  - Motivate more peer review in addition to manager and specialization group review (staff review)
- **Develop incentives for submissions/quality**
  - Financial
  - Prizes: Tickets/ gift cards
  - Public Recognition

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Success is Measured Through

- Improving New Product Warranty
- Reducing Rework
- Reducing Time to Market
- Increasing Requests for Design Reviews
- Increasing Testimonials from Engineers
- Improving Feedback from Specialization Groups and Product Development Teams

Critical Success Factors

Critical Factors

- Avoid setting quotas
- Tie A3 reports to processes and replace existing presentations wherever possible
- Encourage A3 mentoring before A3 is complete
- Create Specialization Groups to manage the organization and transfer of specific knowledge
- Require early and frequent team interactions

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Thank You APQC