Trimble

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3D Technologies for Milling, Paving, & Compaction

3D Technologies for Milling, Paving, & Compaction

- The evolution of machine control specific to the paving industry is allowing contractors to build roads more accurately than ever before.

- This use of technology in various road building applications provides many benefits to Contractors and Owners.
  - Improved Accuracy
  - Productivity gains
  - Better material yields
  - Helps build a better product

2D and 3D Paving Terminology

- 2D Paving – guidance to grade [thickness] and/or slope
  - 2D is Ground-up
  - 2D Systems typically place a constant thickness over the base
- 3D Paving – guidance to grade [elevation] and slope at a known position using a design/model
  - 3D is Design-down and does not reference the existing surface for guidance

3D AMG In Construction

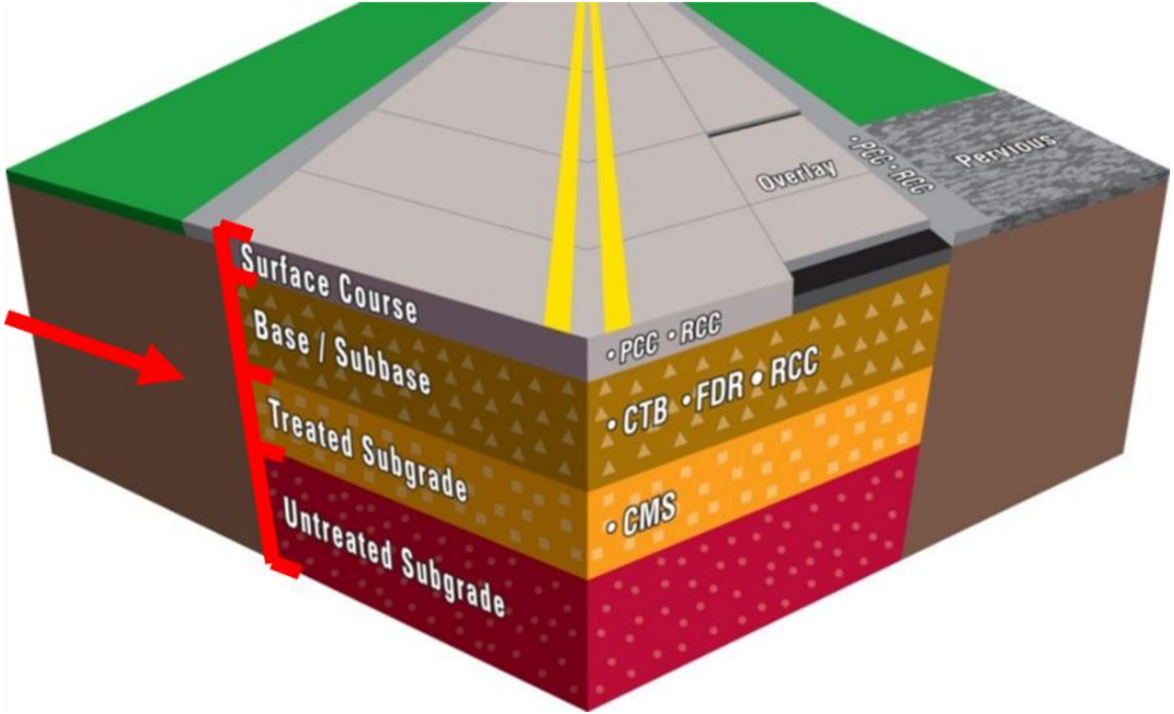
- 3D Automated Machine Guidance [AMG] is a term used with State DOT's and the FHWA
  - References a method of placing and managing materials on a project
  - Utilizes technology to guide a machine while referencing an engineering design
  - Does **<u>not reference anything on the ground for grade control</u>**
- 3D AMG is a process [not just a product]
  - Includes:
    - Survey Control Reference Points
    - 3D Design
    - 3D Technology
    - 3D Support Team

3D AMG In Construction

- 3D AMG Technologies:
  - Precise Real-Time Global Navigation Satellite System [GNSS]
    - 0.1’ [30mm] or better
    - Typically “Golf Ball” accuracy or better
    - Technology used on mass-ex, subgrades, etc…
    - Can be used on a concrete Placer/Spreader
  - Universal Total Stations [UTS]
    - 0.01’ [3mm]
    - Technology use for fine 3D Grading, 3D Milling, 3D Curb & Gutter and 3D Paving

Why use 3D AMG In Construction?

- To build better pavement structures!!!



Results of better Pavement Structures using 3D

- Smoother
  - Easier to control vehicles at higher speeds
- Safer
  - Better drainage, reduce ponding/hydroplaning
  - Better traffic control
- Longer lasting
  - Lower maintenance costs
  - Decrease premature failures from undulating surfaces
  - Less impact, especially with heavier loads
- Taxpayers enjoy driving on smooth roads ☺

Typical Paving Challenges

- Traditional methods require
  - Placing, Grading and Maintaining “piano wire”/stringlines
  - Managing Trucks and Machines around placed stringlines
- Material yields
- Material costs
  - Cost of AC [Asphalt Cement]
  - Limited aggregate resources
  - Transportation and Production Costs
- Maintaining:
  - Thickness
  - Grade
  - Cross-slope
  - Smoothness
- Project Deadlines
  - High penalties for going over
- Longitudinal Waves & Differential Compaction (Smoothness) -Additional paving/levelling course
- Additional grinding/milling
  - After paving is completed and to meet smoothness spec

Stakeholder Goals

Owner	• Road quality [smoothness, road lifetime, minimal thickness of layers] at minimal cost
Main Contractor	• Meet smoothness • Meet completion deadline
Paving / Milling Contractor	• Minimize material usage • Meet smoothness and minimal thickness specs • Often paid by square meter/yard and then wants productivity • Meet completion deadline

Equipment Manufacturers Technology Offerings

VOLVO Construction Equipment

CATERPILLAR®

Wirtgen

VÖGELE

GOMACO

G&Z

Power Curbers & Power Pavers

TEREX®

HAMM

SAKAI Masters of Compaction

BOMAG FAYAT GROUP

DYNAPAC FAYAT GROUP

SOMERO® ENTERPRISES, INC

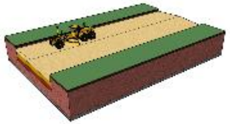
SUMITOMO

LeeBoy

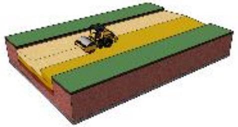
3D Milling

3D Milling in the construction and road resurfacing workflow

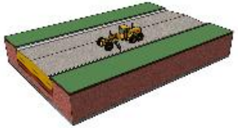
Construction of new roads



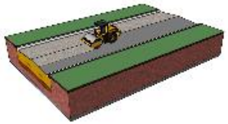
Subgrade & Finegrading



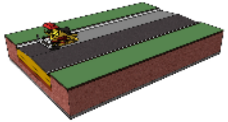
Soil Compaction



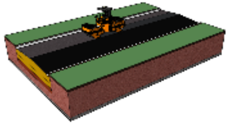
Base Grading



Base Compaction



Asphalt Paving



Asphalt Compaction

Resurfacing or Reconstruction of existing roads

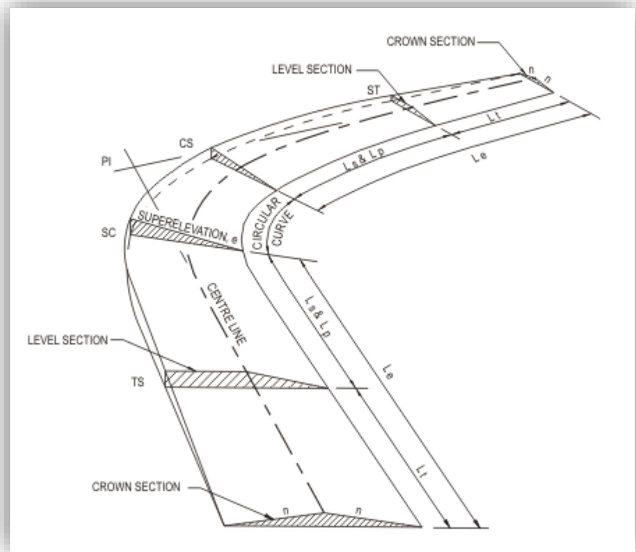
3D Milling

Why 3D Mill?

- Increased production, lower cost
  - Only mill whats needed
- Increased smoothness
  - Remove longitudinal waves
- Decreased asphalt usage
  - No need to fill in low spots [leveling course]
- Change/Fix Cross-Slopes
  - New State/Federal Specs
- Mill complex designs
  - Transitions, supers, drainage, etc.
- No Stringline or wire required
  - Reduce costs
  - Better truck/traffic management
  - Safer

Why 3D Mill? – Con't

- Variable depth and slope milling enables one to:
  - Remove more or less material as per project specifications
  - Provides uniform surface for pavement



Guide Policy for Geometric Design of Freeways and Expressways - NAASRA 1976

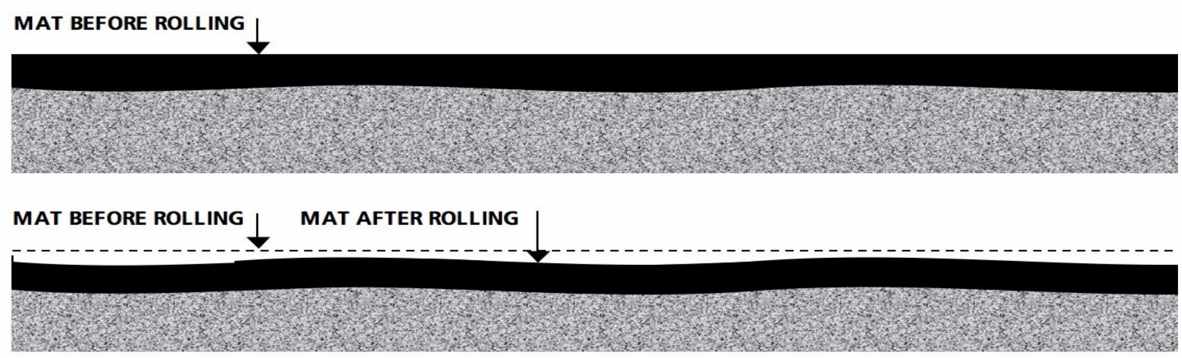
3D Milling – Pavement Preservation

3D Milling – Pavement Preservation

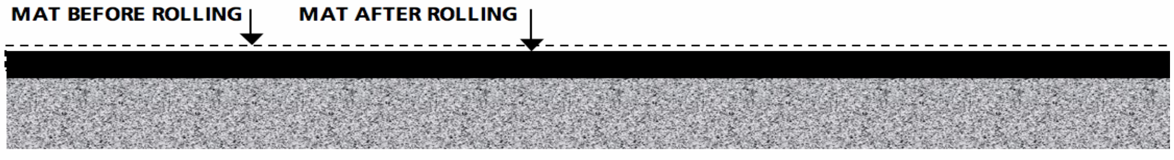
Other Advantages of 3D Milling

- Increased Smoothness

The issue of differential compaction when paving:

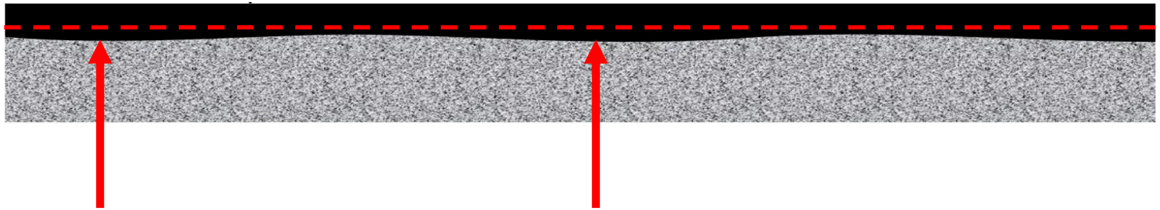


3D milling takes away the issue:



Other Advantages of 3D Milling – Con’t

- Decreased asphalt usage



- 3D Milling minimizes asphalt usage

3D Paving

Why 3D Pave?

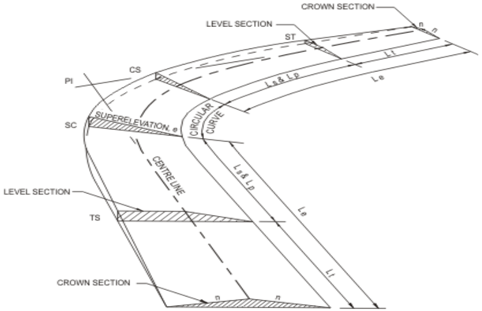
- Achieve the highest accuracy and smoothness levels
  - Better material management
  - Better material yields
- Eliminate the stringlines:
  - Reduce staking labor, downtime and errors
  - Reduce costly rework
  - Finish the project faster
  - Better machine management on and off the grade
- Pave variable depth and slope including complex designs
- Use an “Uncompacted Design” to help differential compaction issues
  - For most applications, includes “levelling course” in the same pass

Contractor Paving Challenges – 3D Paving

- What are the Paving Challenges a contractor is trying to accomplish when considering 3D paving?
- 5 specific challenges:
  - Thickness
  - Elevation Grade
  - Cross-slope or Straight Edge
  - Differential Compaction/Longitudinal Waves [Smoothness]
  - Compaction/Density [mass/volume, lbs/ft3 or kg/m3]

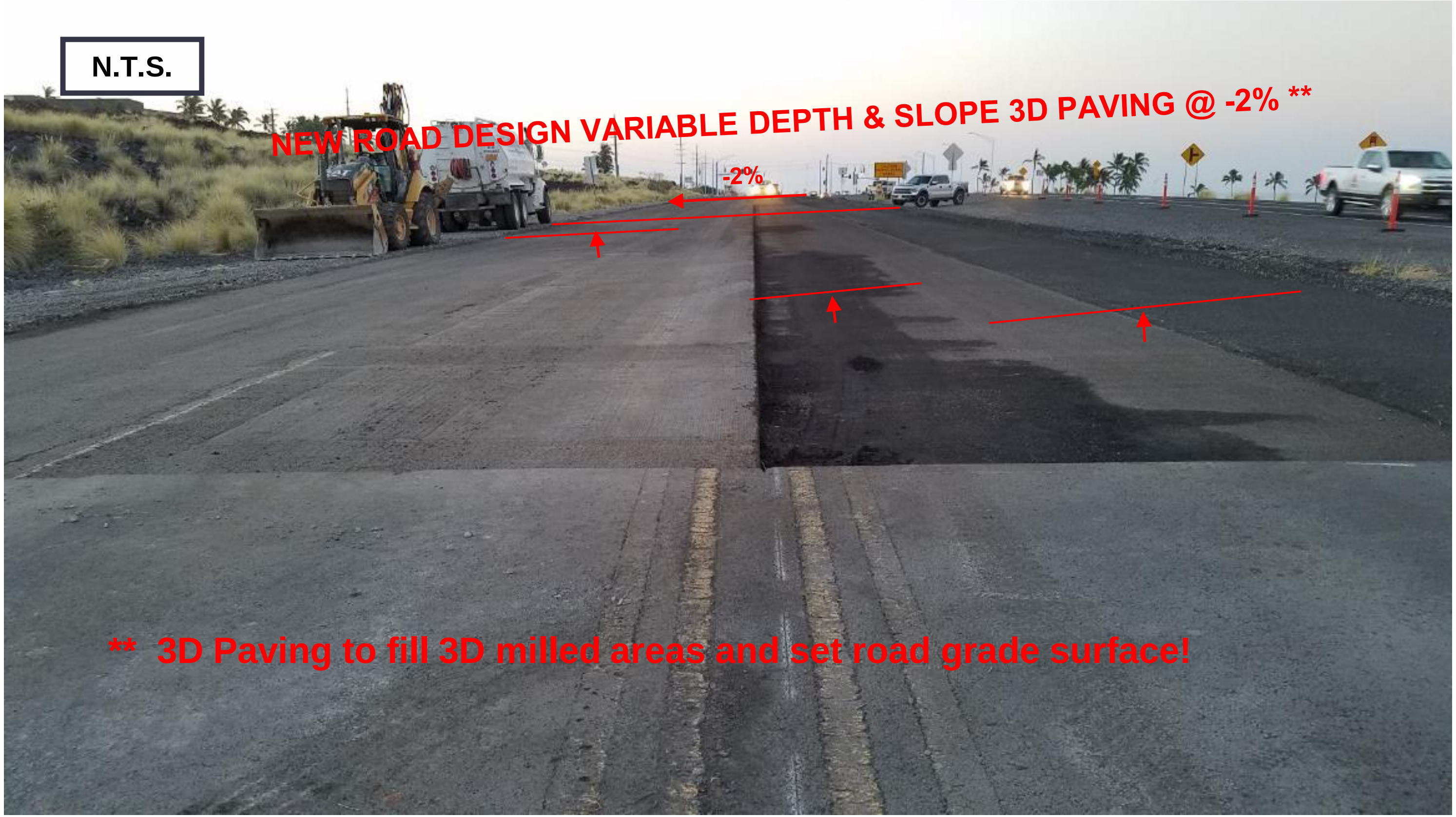
What Are the Applications of 3D Paving?

- Any project where a contractor uses stringline or wire for elevation grade
- Variable depth and slope paving applications
  - Airports, roads and commercial surfaces
  - Base material [gravel, etc…]
  - Asphalt
  - Roller Compacted Concrete [RCC]
  - Concrete Treated Base [CTB]



3D Paving Applications

3D Paving – Pavement Preservation



3D Paving – Pavement Preservation

Paving – Pavement Preservation

3D Paving – Managing Differential Compaction

Managing Differential Compaction

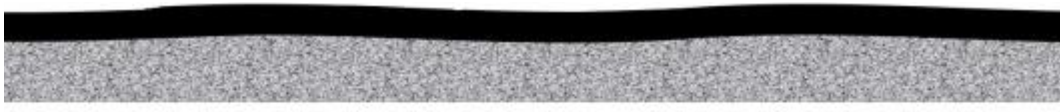
- 3D Designs describe the final finished surface
- 3D AMG systems use vertical offsets to build up to this surface
- Final asphalt lift is designed to finish at this design surface
- If existing paving surface is not to grade or not level, low areas will compact more
  - Paved surface will have longitudinal waves affecting smoothness
- Traditional practices are to place multiple lifts hoping the waves are reduces and or eliminated by final lift
  - ~60% to 80% of waves reduced per lift

Managing Differential Compaction

- 3D paving can help manage differential compaction
  - Using a paving machine guidance Uncompacted Design
- Paving machine guidance Uncompacted Design uses 3 key components:
  - Existing Surface
  - Design Surface [e.g.: first lift of compacted asphalt]
  - Compaction Factor
    - E.g.: 2” compacted, placed at 2.5”
    - Compaction Factor = 2/2.5 = <u>0.80</u>
- 3D Paving goal is to place “levelling course” at the same time as design grade
  - Compacted material is placed at grade

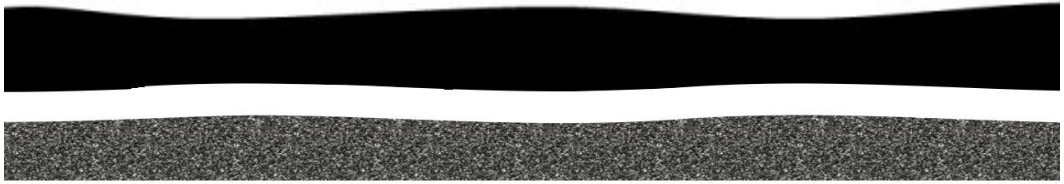
Using an Uncompacted Design

Original surface with longitudinal road waves

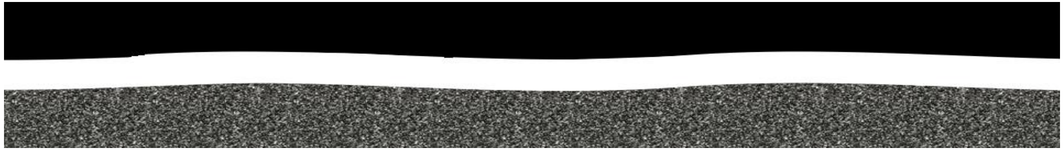


New road design with compaction factor (e.g. 0.80)

3D paved surface before compaction



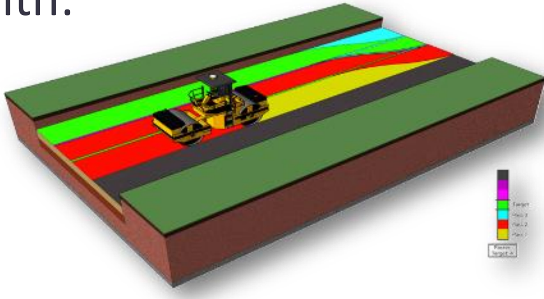
3D paved surface after compaction

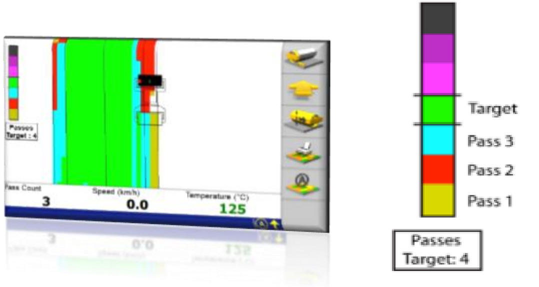


What is Intelligent Compaction [IC]?

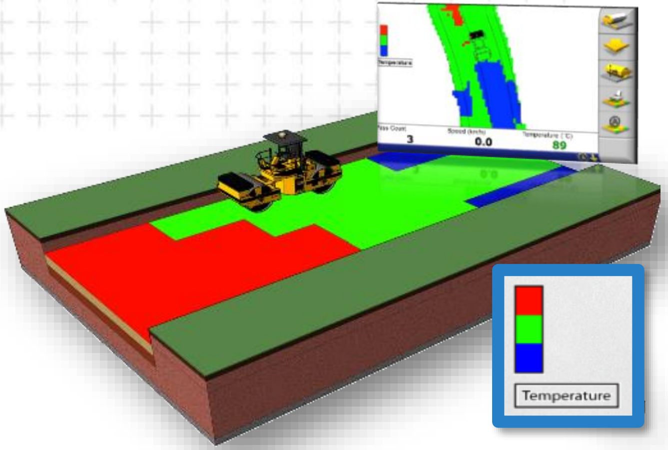
Intelligent Compaction

- Compaction of materials using compactors equipped with:
  - an integrated measurement system
  - an onboard computer reporting system
  - technology based mapping
  - reporting control and management
- IC rollers maintain a continuous record of color-coded plots
- Allows user to view:
  - the precise location of the roller
  - the number of roller passes
  - material stiffness measurement
  - the temperature of the asphalt mat





Intelligent Compaction



- Displays and records:
  - **Pass Counts** of a roller
    - Can be used on entire roller train:
      - Breakdown, intermediate, finish
  - **Temperature** of asphalt surface [asphalt mat]
    - Operator notified if mat temperature is outside of user-defined range
  - **CMV** [Compaction Meter Value]
    - Real time compaction values like CMV alert the operator of problem areas before final inspection
    - CMV is an indication of mat stiffness and is recorded using an accelerometer
    - IT IS NOT DENSITY

Intelligent Compaction

- System can use Real-Time Kinematic [RTK] solutions providing cm level accuracies
- Systems can use 3D project design and linework
  - Helps operator see project areas/limits
  - Helpful during night operations
  - Report using Station and Offsets using Horizontal Alignments
- IC Data is recorded
  - Store site data and data analysis
  - Generate Reports including data for Veta

Who is Pushing for IC?

- United States/North America
  - Federal Government
  - States
  - Counties
  - Cities
  - Provinces

- Government entities are beginning to require contractors to provide IC data for projects through Veta software platform

- Worldwide/Europe/Australia
  - Contractor
    - Warranties

What is Being Specified in IC?

- Common Specifications:
  - Pass count of vibratory roller
    - Sometimes for each roller on the job
  - Temperature mapping of asphalt mat
  - Stiffness values [CMV]
  - RTK precision
  - Ability for the data to be exported from a third party software analysis program and importable into Veta

What are the Benefits of IC?

- Improved Density*
- Increased Productivity
- Reduction of Highway Repair Costs
- Continuous Record of Material Stiffness Values
- Identification of Non-Compactable Areas
- Improved Depth of Compaction

*Remember IC cannot measure density directly, but it can help to achieve it through stiffness measurements

Conclusion

- 3D AMG Technologies provide tremendous benefits to contractors and owners alike.
  - Improved Accuracy
  - Productivity gains
  - Better material yields
  - Reduced costs
  - Helps build a better product
  - Increased lifespan

Questions