# HOW TO APPLY THE MULTIPHASE OPTIMIZATION STRATEGY (MOST) IN YOUR INTERVENTION DEVELOPMENT RESEARCH

## Module 1
## MOST is a different way of thinking

## Lesson 4: Comparison of the classical treatment package and engineering approaches

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# So far you have learned how to:

- Define key concepts
  - MOST
  - Intervention
  - Intervention component
  - RCT
  - Classical treatment package approach

# So far you have learned how to:

- Assess what knowledge the classical treatment package approach can and cannot provide

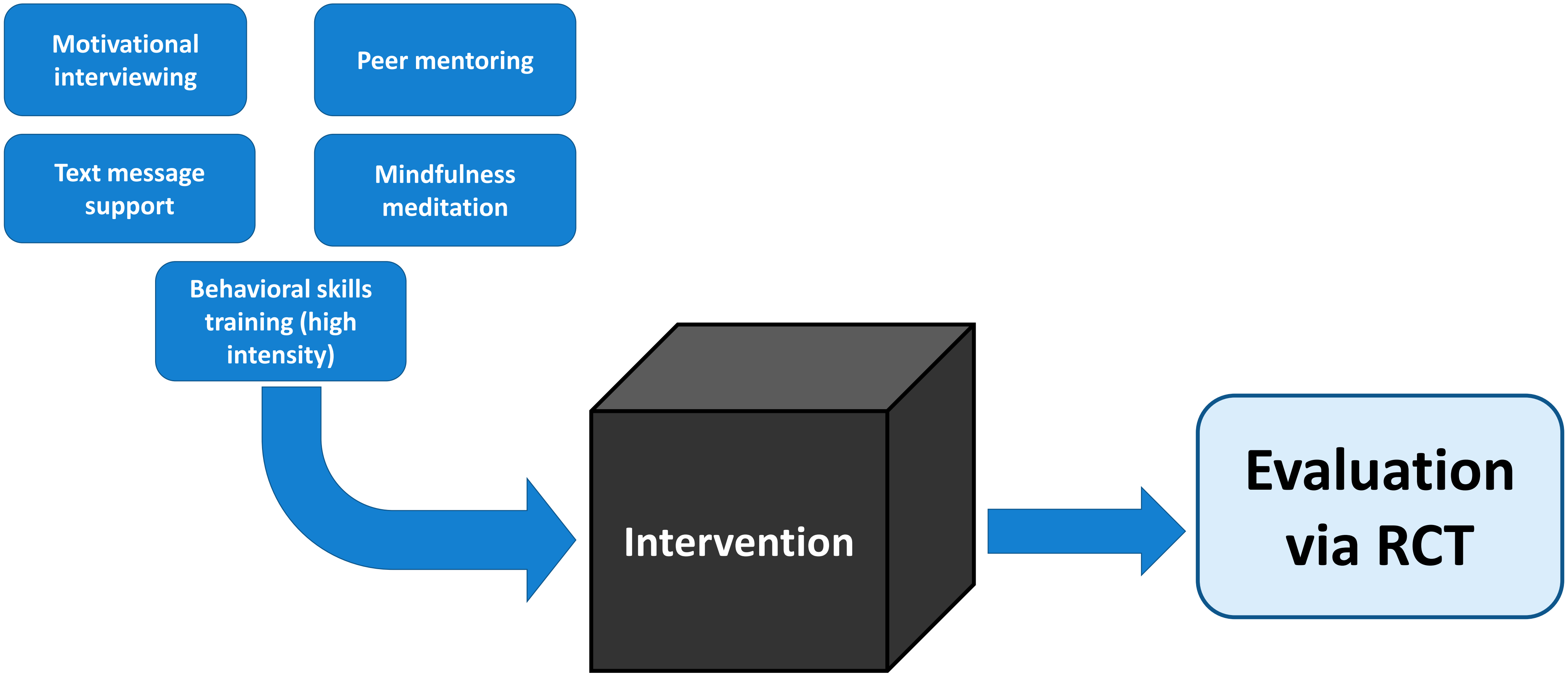
# In this lesson you will learn how to:

- Contrast two approaches to intervention development:
  - The classical treatment package approach vs.
  - How an engineer might go about developing an intervention

# In this lesson you will also learn how to:

- Define additional key concepts
  - Constraint
  - Optimization
  - Candidate component

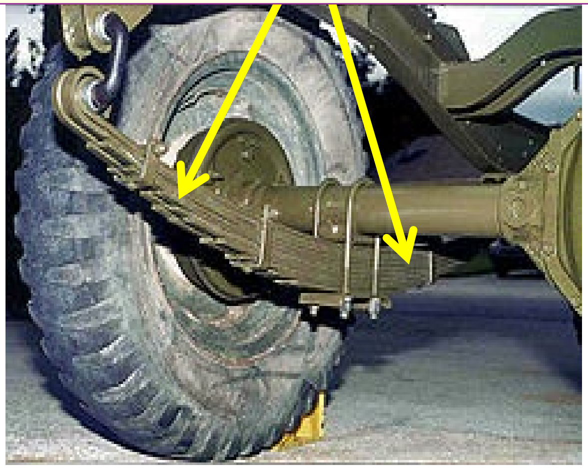
# Classical treatment package approach



# Scenario 2. Developing a way to manufacture truck leaf springs

- Goal: Choose from set of components/component levels to optimize amount of variability in length of leaf springs (less variability is better)

**Leaf Spring**:
part of truck suspension system



Pignatiello & Ramberg (1985) in Wu & Hamada (2011)

# Scenario 2. Developing a way to manufacture truck leaf springs

- Components (suppose for each one higher hypothesized to be better):
  - Furnace temperature (lower, higher)
  - Heating time (shorter, longer)
  - Transfer time on conveyor belt (shorter, longer)
  - Hold down time in high pressure press (shorter, longer)
  - Quench oil temperature range (lower, higher)

# Suppose an industrial engineer used the classical treatment package approach

- The engineer would construct a new manufacturing process:
  - Higher furnace temp +
  - Longer heating time +
  - Longer conveyor belt time +
  - Longer time in high pressure press +
  - Higher quench oil temperature range

# Suppose an industrial engineer used the classical treatment package approach

- Compare this process as a package to the old way, see whether it is demonstrably better
- Conduct post-hoc analyses

# Why engineers usually do not use the classical treatment package approach

- If the new process IS better, doesn’t indicate which components make a difference
- If the new process IS NOT better, doesn’t indicate which (if any) of the components did effect an improvement

# Why engineers usually do not use the classical treatment package approach

- When repeated, no guarantee of systematic incremental improvement, so not a good long-run strategy
- Does not take cost or other constraints into account

# Imagine this conversation between our engineer and the plant owners:

- Engineer: *I've developed an EXCELLENT manufacturing process for leaf springs! The springs coming off the assembly line are nearly identical! You need a microscope to see the differences in length!*
- Plant owners: *That is great! What is the per-spring cost?*

# Imagine this conversation between our engineer and the plant owners:

- Engineer: *$100,000 per spring.*
- Plant owners:  *These springs retail for about $50.  We cannot afford to pay more than $40/spring for manufacturing.  We won't be using your manufacturing process, and YOU ARE FIRED!*

# Constraints and why the “best” is not always preferable

- There is a **constraint** on manufacturing cost; it cannot exceed $40
- The plant owners and the engineer should have established this much earlier (and in reality would have)

# Constraints and why the "best" is not always preferable

- So the engineer's job is to develop a manufacturing process that produces the least variability in length without exceeding a budget of $40
- Will this be the best possible manufacturing process? USUALLY **NO**

# Scenario 2: What WOULD an engineer do?

- Start with a clear idea of the goal, including any constraints
  - In our example:  Least variability WITHOUT EXCEEDING cost of $40/spring
- Using the resources available, design and conduct an efficient experiment to gather needed information

# Scenario 2: What WOULD an engineer do?

- Based on the results of experiment, select components/component levels to balance leaf spring variability and cost to achieve the stated goal. **THIS IS OPTIMIZATION**

# Scenario 2: What WOULD an engineer do?

- **NOTE: IN THIS EXAMPLE THE OPTIMIZED PROCESS IS NOT THE ONE THAT RETURNS THE LEAST LEAF SPRING VARIABILITY** (we already know that one is too expensive)
- Instead, optimized is THE BEST WE CAN AFFORD
- Only after optimization would the engineer directly compare new, optimized process to old process

# Definition of optimization

- Optimization is a broad concept
  - Different definitions used in different fields, different contexts
- Optimization usually involves balancing competing considerations
  - Usually pluses (intervention effectiveness) against minuses (expense, staff time, participant burden, etc.)

# Definition of optimization

- STRONGLY suggest defining optimization wherever you use it

# Definition of optimization of an intervention used in MOST

- Optimization of a multicomponent intervention is the process of identifying an intervention that provides the best expected outcome obtainable within key constraints imposed by the need for affordability, scalability, and/or efficiency.

# Back to Scenario 1: If behavioral scientists thought like engineers

- Would optimize the HIV intervention
- Start with a clear idea of the goal, including constraints
  - e.g. most effective WITHIN implementation cost of < $300 per participant

# Back to Scenario 1: If behavioral scientists thought like engineers

- Would consider each component a candidate for inclusion in the intervention

- Using resources available, design an efficient experiment to gather needed information (usually individual/combined effects of components)

# Back to Scenario 1: If behavioral scientists thought like engineers

- Based on the results of experiment, optimize the intervention by selecting from the candidate components/component levels to balance effectiveness and cost to achieve the stated goal
- Only THEN evaluate the optimized intervention in an RCT if indicated

# Why do we refer to selecting components/component levels?

- Recall the candidate components in Scenario 1:
- Motivational interviewing (no, yes)
- Peer mentoring (no, yes)
- Text message support (no, yes)
- Mindfulness meditation (no, yes)
- Behavioral skills training (low intensity, high intensity)

# Why do we refer to selecting components/component levels?

- It is always a matter of selecting component levels
  - If the levels are (no, yes) and no is selected, the component is not included
  - If the levels are e.g. (low intensity, high intensity), the component is going to be included at one of those levels.

# Why do we refer to selecting components/component levels?

- We refer to selecting components/component levels because most people find the idea of selecting components more intuitive

# MOST is a framework for enabling behavioral scientists to think like engineers and optimize their interventions

- MOST integrates ideas from behavioral science, engineering, multivariate statistics, decision science, and health economics
- MOST is a work in progress – it’s an active area of methodological research

# In this lesson you learned how to:

- Contrast two approaches to intervention development:
  - The classical treatment package approach vs.
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# In this lesson you learned how to:

- Define key concepts
  - Constraint
  - Optimization
  - Candidate component

# In the next lesson you will learn how to:

- Further clarify the concept of optimization
- Define intervention EASE and relate it to optimization

# Literature Cited


- Pignatiello, J. J., Jr., & Ramberg, J. S. (1985). Discussion of “off-line quality control, parameter design, and the Taguchi method” by Kackar, R.N. *Journal of Quality Technology*, 17, 198–206.
- Wu, C. J., & Hamada, M. S. (2011). *Experiments: Planning, analysis, and optimization*. Hoboken, NJ: Wiley.