HYBRID APPROACHES TO ORTHOTIC SYSTEMS & APPLICATIONS

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BACKGROUND

- Lifelong involvement in field
- 10 years in rehabilitation medicine
- CO
- Design and development of several devices
- Committee member for composite research in technology transfer

WHAT IS A HYBRID?

A “BRIDGE” BETWEEN TWO DISSIMILAR IDEAS/DEVICE/ MATERIALS.

A MULE
ELECTRIC/GAS CARS
SPACE SHUTTLE
AMPHIBIOUS VEHICLES

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Why do we need to look into hybridization?

- Lack of efficacy in traditional approaches
- Lack of traditional materials

Lack of efficacy with traditional approaches

- Metal and leather
- Thermoplastic
- Laminated
- Metal only

Metal and leather strengths

- Rigidity
- Structural integrity
- Supportiveness
- Comfort
- Durability
- Adjustability

Metal and leather weaknesses

- Cosmesis
- Bulk
- Weight
- Limitations of footwear
- Control of limb/foot
- Social stigma

Thermoplastic Strengths

- Ease of fabrication
- Lightweight
- Ease of adjustments
- More cosmetic
- Increased footwear options
- Unlimited design options

Thermoplastic weaknesses

- Not rigid enough without excessive thickness.
- Durability
- Flexibility decided by trim lines
- Not comfortable (heat build up)
- Material has weight limitations regardless of thickness

Laminated Strengths

- High strength to weight ratio
- Very durable
- Moderately adjustable
- Lighter weight compared to M&L
- More cosmetic due to color choices/designs
- Designs can be user specified
- Very Supportive

Laminated weaknesses

- Not easy to manufacture
- More expensive
- Not as easy to adjust as thermoplastic
- Possible patient compliance issues
- Material limitations

Hybrids allow you to take the best parts from each of these and combine them to create something that's "more than the sum of the parts"

Lower Extremity Example

- Laminated footplate is stronger and more durable than thermoplastic
- Thermoplastic shank section saves weight, allows for more adjustability, and saves cost

Upper extremity examples

- Laminated palmer and forearm sections are more resistant to impact/abuse than aluminum (flexing opposed to bending)

Upper Extremity Example

- Laminated palmer section allows for a custom trimline, where aluminum pieces are pre-cut, limiting your options

Strength without bulk,
support without weight,
and cosmetically appealing.

This ideal can be achieved by
using hybrids

Combine the strength of a M&L, with the durability of laminates, and the cosmesis of thermoplastic

(Shameless product plug)

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Steps to identifying what the hybrid requires

- Establish strength requirements
- Establish weight requirements
- Establish design/function requirements

Strength

- Patient weight
- Patient height
- Patient activity level

Will this patient require the strength of steel? Will aluminum be enough? Will thermoplastic be strong enough? Will the patient require a lamination?

Weight

- How much weight will the patient be able to function with?
- How light can you make the device before you lose strength?
- Will there be a weight issue pertaining to patient compliance? (Separate from pure functionality.)

Design/Function

- What outcome are you trying to achieve?
- What outcome is realistic?
- How will your design affect the materials that you incorporate?
- How will your materials affect your design?

After you have planned on what the device requirements are, the next step is to decide what materials are most appropriate.

After selection of materials, fabrication procedures follow standard protocols

- Metal bends the same way, regardless of the application
- Plastic melts at the same temperatures
- Laminates go off at the same times

The only difference is how you combine the materials.

Some samples of hybridization (with patient backgrounds)

Background

- Female
- Demanded very low profile
- Needed to be very light weight
- Polio
- From Africa, so heat is consideration
- Used PLS that she overpowered
- High activity level

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Why were the materials chosen?

- Standard PLS not nearly strong enough
- Metal would have not given desired result, and would have weighed too much
- Metal bar would have fatigued over time
- Composite strut combined the strength of metal with the flexibility of thermoplastic

Background

- 11years old
- Female
- 7.5” leg length discrepancy
- High activity level

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Why were the materials chosen?

- Durability of laminated device
- Strength of interface between pylon and AFO required more than thermoplastics could provide
- Strength to weight ratio. Important to keep weight as low as possible to offset weight of prosthetic components
- Cosmesis and comfort were also very important

Background

- Male, mid 40's
- Partial foot amputation resulting from infection
- Did not want a locked ankle
- Desired as natural of a gait as possible
- High activity level/tendency to "beat up" devices

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Why were the materials chosen?

- High strength to weight ratio
- Able to resist impact
- Springlite plate stores energy for toe off assist
- Ankle joints can be adjusted to load footplate at different times
- Ankle joints allow for dorsi/plantar flexion to aid in gait

Background

- Professional football player
- Needed to limit ROM of wrist due to pain associated with osteoarthritis
- Needed to have impact resistant device

Why were the materials chosen?

- High strength to weight ratio
- Able to resist impact
- Ankle joints can be adjusted to control ROM

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Background

- 8 year old
- Female
- SLP radial nerve injury
- Thumb drifts into unopposed deviation
- Moderate activity level

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Why were the materials chosen?

- Cosmesis (color) was important
- Needed very thin, yet rigid device
- Mannerfelt wrist spring was used for extension assist function

Background

- Male
- Partial hand amputation, 1-4th digits, thumb not affected
- Seeking opposition device
- Function more important than cosmesis
- Heavy/abusive user (Farmer)

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Why were the materials chosen?

- Durability was most important feature
- Slightly flexible fingers allowed for grip on objects with various diameters (handles, machinery)
- Lamination could resist impact and outside conditions

Background

- 10 year old male
- Congenital birth defect
- Missing 1-4th digits,partial thumb

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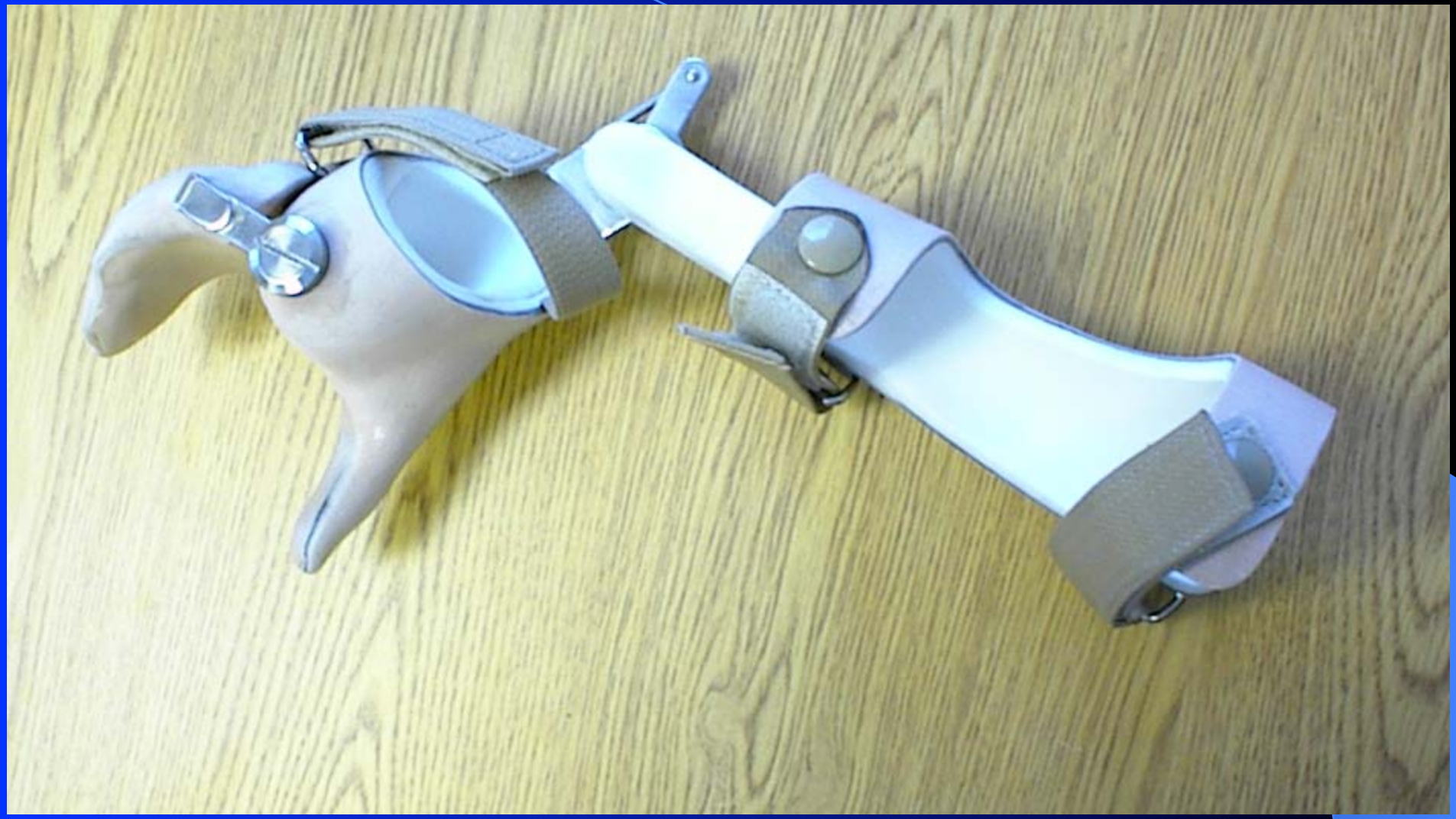

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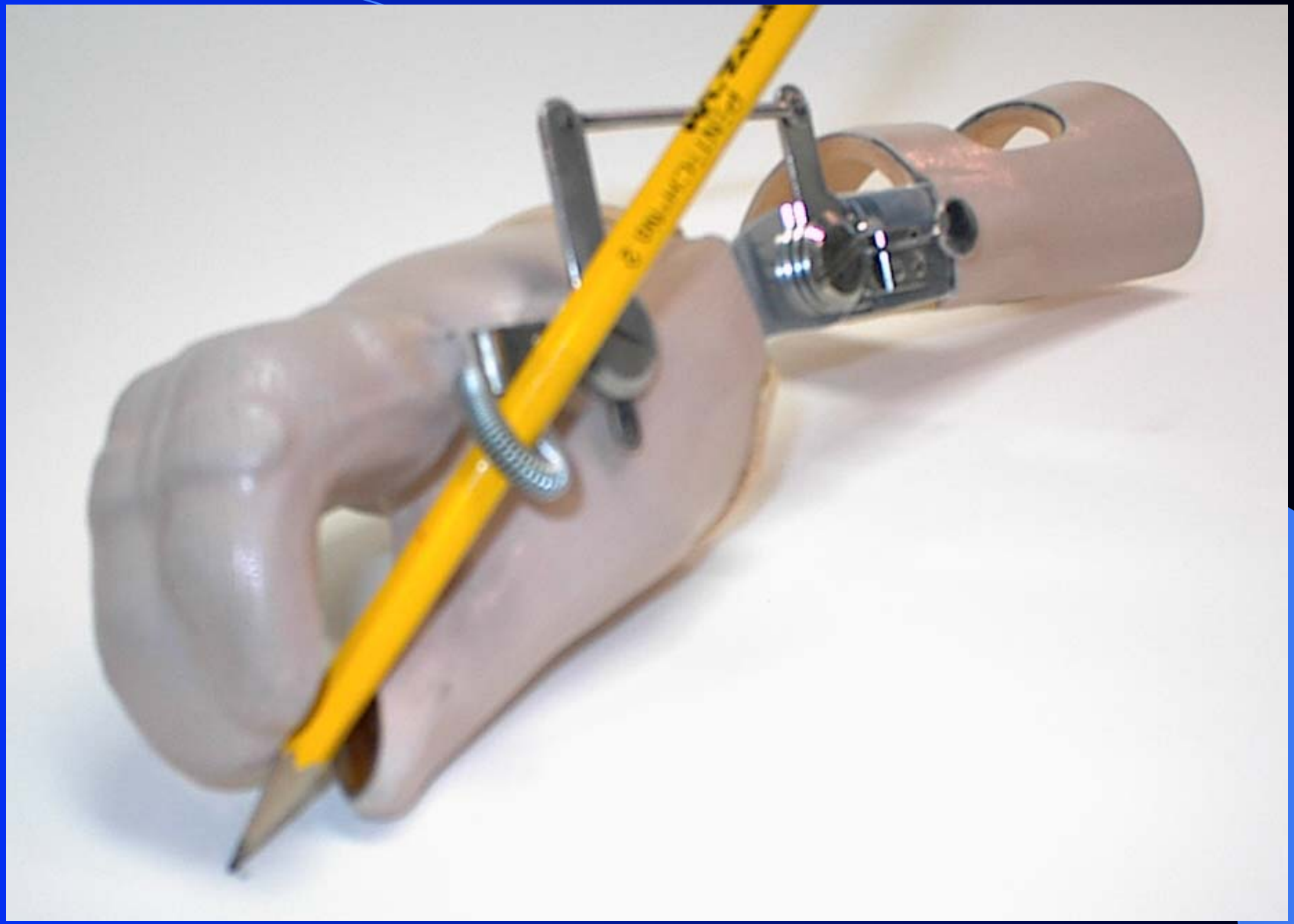
Why were the materials chosen?

- Urethane "fingers" are durable and slightly tacky for better control of objects
- Lamination allowed for strength of dual hinge design
- Prosthetic core of fingers kept weight down

Background

- Partial hand amputation due to peripheral vascular disease caused by smoking

  (and he still smokes after we made another for his other hand.)
- 45 year old male
- Seeking basic prehension abilities
- Moderate activity level



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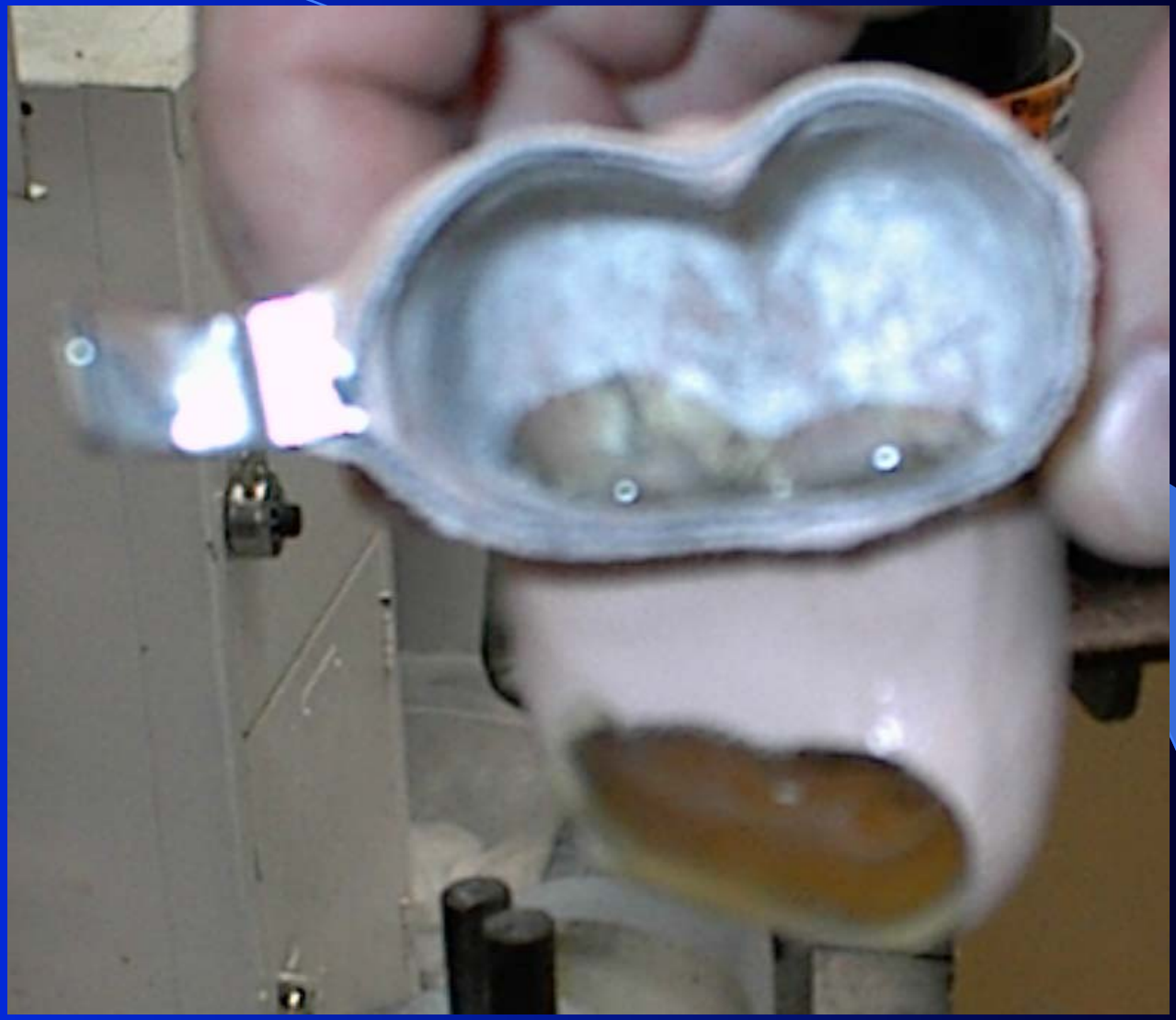

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Why were the materials chosen?

- Urethane "fingers" are durable and slightly tacky for better control of objects
- Lamination allowed for strength
- Prosthetic core of fingers kept weight down

Background

- Male
- Height 6’0
- Weight 310#
- Degeneration of the Subtalar and mid-tarsal joints
- Moderate activity level with size of patient as consideration

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Summary

- No one material is perfect for every device
- If one material isn't functioning, try two, or more, if necessary
- Don't limit yourself on design, or material
- Be as creative as necessary, there is no rule saying you can't think in a different way

Imagination

Drives

Innovation

Thank you!