Virtual Design Review 2

Team 09: Sprag Clutch Addition to Reciprocating Lever Transmission

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Project Recap

- Addition of sprag clutches to RLT

- Longer crank arms and sprag clutches have potential to increase efficiency

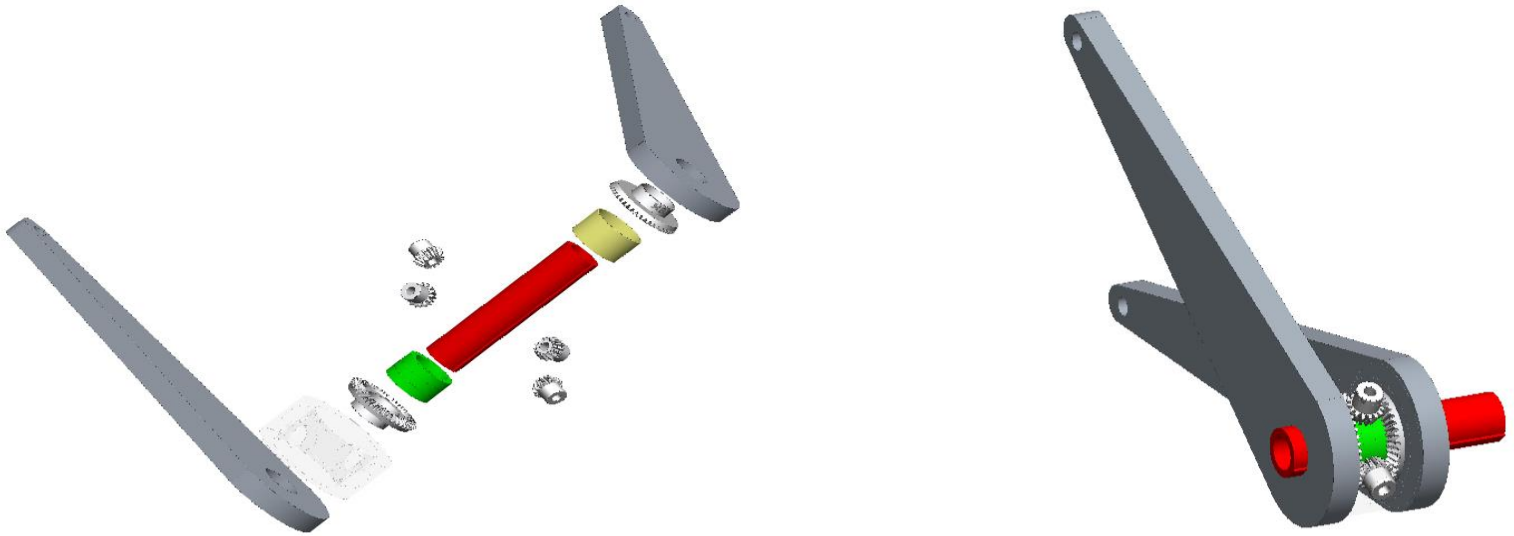


Figure 1. RLT CAD Model.

Systems Engineering Approach: V-Model

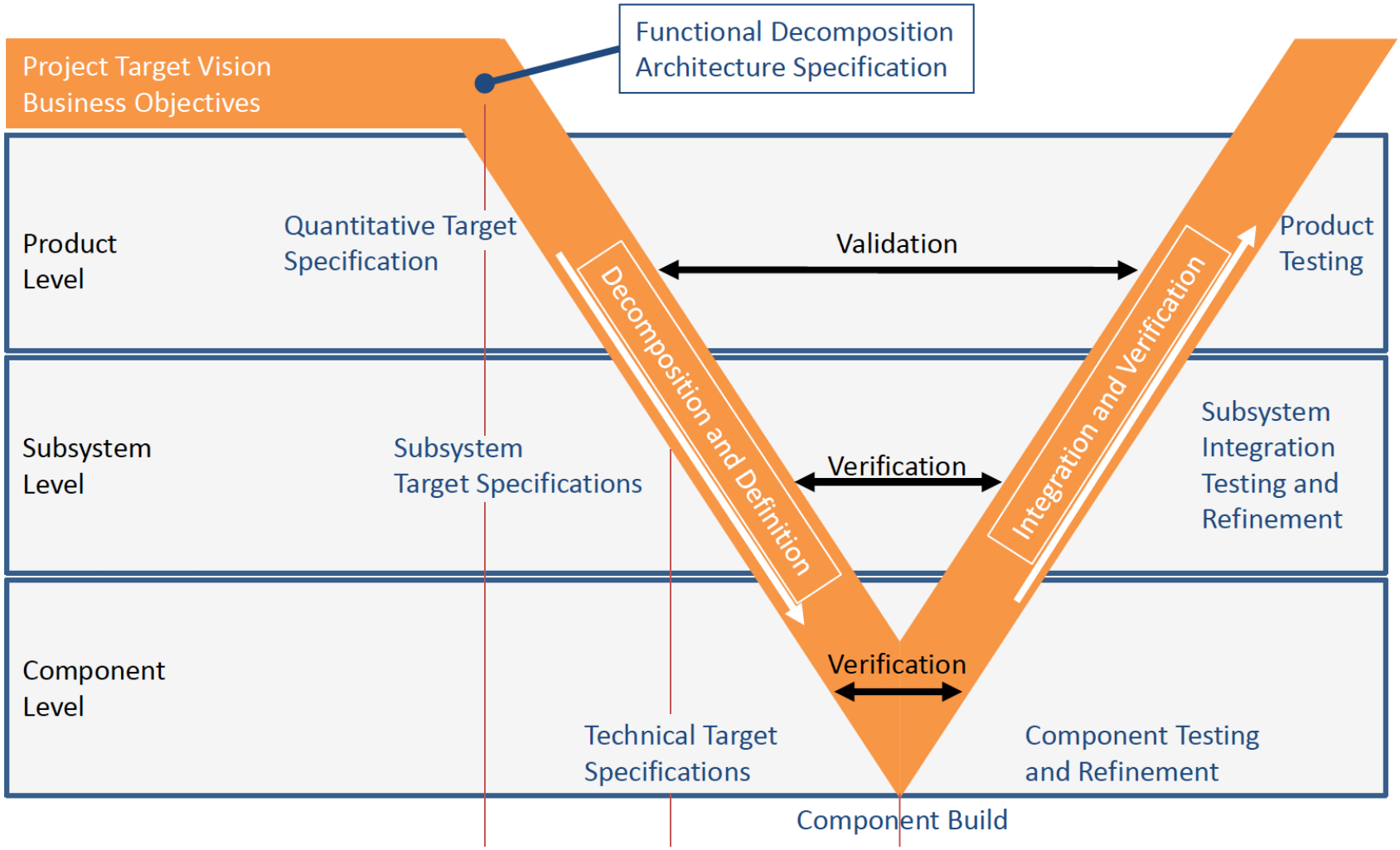


Figure 2. V-Model.

Target Catalog

Table 1
Metrics

Metric	Yes	No
Power Increase	X	
Improvement of Gear Meshing	X	
Longer Crank Arms	X	
Addition of Sprag Clutches	X	

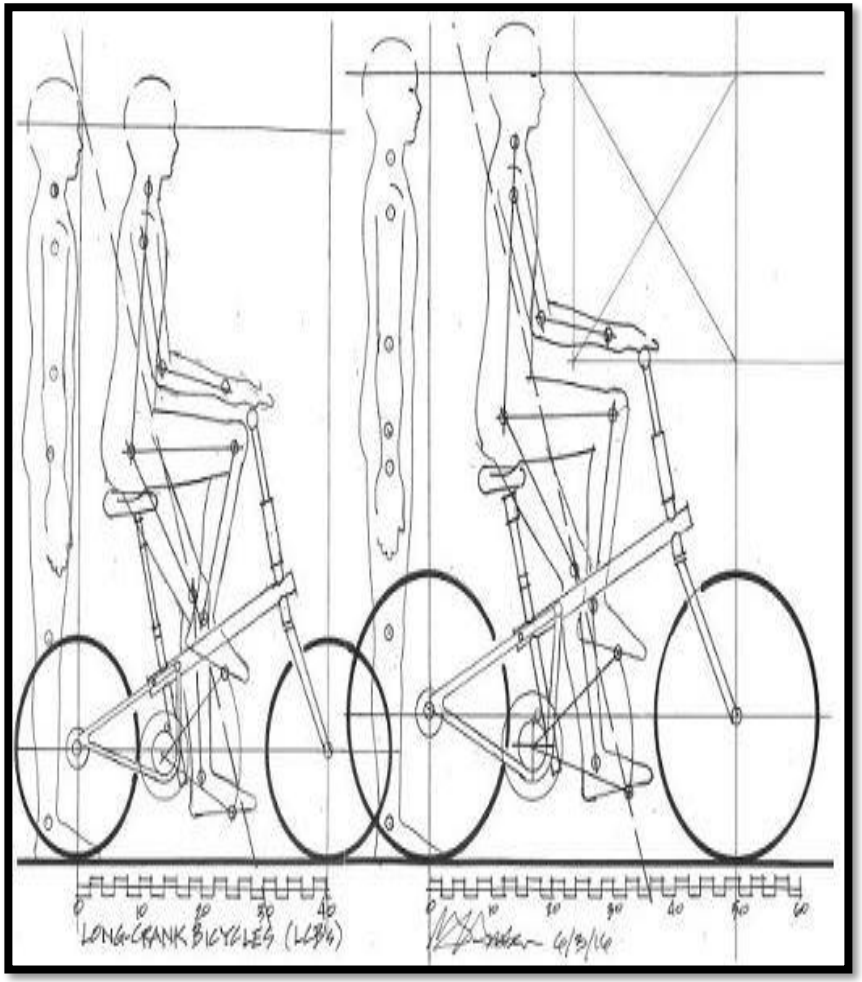


Figure 3. Bicycle utilizing RLT drawn by Gordon Hansen, AICP.

Target Catalog Cont.

Sub-system Metrics	Targets
Sprag Clutches	US $300
Shafts	US $100
Crank Arms	2 kg
Housing	4 kg
Number of Sprag Clutches	6
Number of Bevel Gears	2
Number of Pinion Gears	4
Number of Crank Arms	2
Power (50 RPM – 70 RPM)	130 W
Pedal Force (50 RPM – 70 RPM)	200 N
Crank Arm Length	355.6 mm
Output Shaft Diameter	25.4 mm
Cadence	60 RPM

Target Summary

Efficiency Increase by 10%

- *Purpose:* Increase in efficiency would potentially lead to a new manufactured product.
  - *Considerations:* Smooth RLT and sprag clutch interaction.
  - *Plans:* Test power output for bike with and without RLT and compare.

Improvement in Gear Meshing

- *Purpose:* Effective gear meshing would lengthen the life of the gears as well as increase the power output.
  - *Considerations:* Gear ratios, safety factors, bearing fittings in RLT housing, stress analysis on gear teeth.
  - *Plans:* Produce CAD models with new design and run motion tests via CAD software.

Target Summary

Longer Crank Arms

- *Purpose:* Longer crank arms will create a larger moment and lead to more power production.
  - *Considerations:* Crank arm material, crank arm shape design, shear stress analysis, user compatibility.
  - *Plans:* Develop CAD models of crank arms, run stress analysis tests via CAD, implement best design.

Addition of Sprag Clutches

- *Purpose:* Sprag clutches could potentially increase the torque output of the drive train.
  - *Considerations:* Shaft size, RLT housing dimensions, shear force analysis.
  - *Plans:* Spec. out and obtain sprag clutches. Analyze shear force on the shaft with the added sprag clutches.

Concept Generation

- Systems
  - Pedal Return Mechanism
  - Crank Arm
  - Pedal Travel Limiter

System 1: Pedal Return Mechanism

Concept 1: With Gears

- Pros
  - Returns non-driven crank arm using gears
  - Clips are not needed
- Cons
  - Weighs more
  - More complicated design
  - Costs more to manufacture

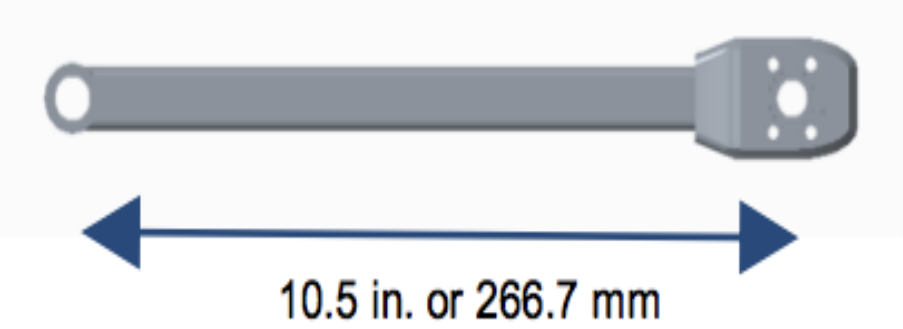
Concept 2: Without gears

- Pros
  - Costs less to manufacture
  - Weighs less
- Cons
  - Requires muscle memory to define pedal angular motion
  - Requires clips or clipless pedals

System 2: Crank Arm

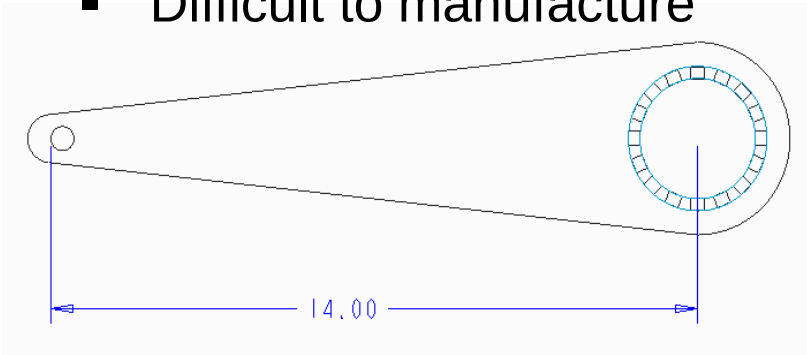
Concept 1: 10.5-inch linear

- Pros
  - Easy to manufacture
- Cons
  - Tabs are weaker



Concept 2: 14-inch tapered

- Pros
  - Generates more torque
  - Splines are stronger
  - Minimizes weight
- Cons
  - Difficult to manufacture



(a). 10.5-inch linear profile crank arm. (b) 14-inch tapered profile crank arm.

Figure 4. Concepts of crank arms.

System 3: Pedal Travel Limiter

Concept 1: Protruding tabs

- Pros
  - Can adjust easier to accommodate rider preference
  - Easier to manufacture
  - Seals internal
- Cons
  - Weaker

Concept 2: Recessed housing

- Pros
  - Stronger design
- Cons
  - More difficult to adjust
  - Difficult to add seal

Thank you!

Any Questions?

Exploded Model View