Practical Utility Platform (PUP)
Affordable Transportation, Agricultural Mechanization, Portable Power, and Utility Vehicle

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Purdue Utility Project

Potential Users:
• Smallholder farmers
• Community Based Organizations (CBO/NGOs)
• Cooperatives
• Individual entrepreneurs & small business owners
• Municipalities

Additional Applications:
• Crop Harvesting
• Urban waste collection
• Delivery & taxi services
• Portable electricity generation/welding
• Hydraulic press for clay bricks & biomass briquettes
• Refrigeration transport box
• Emptying pit latrines & sewage pumping in urban areas

Maize grinding

Water pumping

Planting

Tillage

3-pt hitch implements

Material transport

People transport

Rural ambulance
Empowering communities to meet challenges of
• Transportation
• Water
• Crop Production
• Food Security
• Poverty
• Energy

A low-cost mobile platform that is suitable for off-road conditions, able to carry a payload of 700-900 kg (1500–2000 lbs), pull implements, and power attachments using the on-board engine. The Purdue team focuses on designing a system that is locally owned, manufactured, and maintained in sub-Saharan Africa.
Typical Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Description</th>
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<tbody>
<tr>
<td>Empty Weight</td>
<td>&lt;500 kg</td>
</tr>
<tr>
<td>Payload</td>
<td>700-900 kg</td>
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<tr>
<td>Transmission</td>
<td>Belt clutch, 5sp w/reverse (option: hi-low range for 10sp)</td>
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<tr>
<td>Engine</td>
<td>Any 4-8 kW small engine</td>
</tr>
<tr>
<td>Length/Width</td>
<td>3.8m/1.2m</td>
</tr>
<tr>
<td>Top speed</td>
<td>30-50km/hr (configurable)</td>
</tr>
<tr>
<td>Brakes</td>
<td>Hydraulic brakes on each wheel</td>
</tr>
<tr>
<td>Suspension</td>
<td>Coil springs on each wheel (torsion bar for high roll stiffness)</td>
</tr>
<tr>
<td>Frame</td>
<td>Lightweight truss, entirely from 30x30mm angle iron, all locally sourced</td>
</tr>
<tr>
<td>Required Tools/Skills</td>
<td>Constructed by cutting and welding angle iron, limited bolted joints, with no custom tooling required</td>
</tr>
<tr>
<td>Estimated Cost</td>
<td>Less than $1200 USD in materials, plus labor, and licensing if necessary</td>
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Design Process

Modeling & Analysis
From the mechanical to the economics, the entire system is modeled and simulated:

- End-user needs and preferences
- Local materials and resources
- Driveline & Frame
- Ergonomics & Safety
- Manufacturing, Labor, Tools
- Operating Costs, Business plan

The Partnering Process

- Joint needs assessment
- Brainstorm possible solutions
- Refine solutions and find optimal design
- Analysis and modeling of entire system
- Build and test; use data to refine design
- Travel and collaborate with partners to build and test on-site for implementation and field studies
- Disseminate results
Maize Grinder

- Design criteria
  - Low cost
  - Built with locally available materials
  - In-country processing
  - Grind maize to the required particle size
    - Equivalent distributions as commercially available ground grains
  - Powered by small (<7 kw) power source
    - Easy attachment to PUP engine shaft or electric motors

The plate mill is made of angle iron and steel plate. Power is transferred to the grinder via a belt driving the pulley at a 4.6 ratio.

Plates are cut using a hand grinding wheel. The left plate rotates with the shaft, the right plate is attached to the frame.

The rotating shaft feeds the corn into the plates.
Maize Grinder

- At a grinder speed of 300 rpm throughput is approximately 0.2 kg/min.
- A second pass did not significantly reduce the particle sizes.
- Prototype cost $148

Particle size distribution of store bought and ground corn meal
Water Pump

- Water pump designed to be built using locally available resources and using the PUP as a power source

- Centrifugal Pump design
  - High flow rates
  - High operational speeds allows direct coupling to engine
  - Challenges include complex geometry and a need to prime the pump
Water Pump

- The prototype pump did increase the kinetic energy of the fluid, but not enough to achieve the estimated pressure head of 10m.
- The pump was unable to prime properly.
  - When trying to prime the pump, it was unable to pull water from the bucket.
  - One issue that may have caused this is the diameter of the pipe.
- Prototype cost $186 USD
Tillage Caddy

- 3-point caddy designed and tested with two category 1 tillage implements
  - tested the PUP’s capabilities to pull tillage implements
- Uses same local resources and construction methods as the PUP
- Prototype caddy cost $260 USD
Tillage Caddy

- Testing of cultivator and disk
  - Included testing in heavy sod residue to imitate no-till conservation agriculture
  - The cultivator was set to a depth of 6.5cm and did an excellent job of burying sod and mixing soil.
  - The disk cut through residue well, but did not incorporate the residue into the soil like the cultivator.
Planter

• Design
  – Constructed using locally available resources
  – Two-row seeder, expandable design
  – Interchangeable seeder plates for different seeds

• Key Parts/Components:
  – Soil Opening and Closing
  – Frame and Axle Assembly
  – Drive Mechanism
  – Seed Metering
Planter

• Operation
  – Soil is opened by two pieces of flattened angle iron
  – Once seed is dropped, two pieces of angle iron push soil back
  – Press wheels compact the loose soil, improving seed to soil contact.
  – One press wheel drives a bicycle chain, which drives the horizontal driveshaft.
  – This driveshaft is connected to the seed hopper via handmade gears. This gear turns a shaft connected to the seed plate, delivering the seed.
Ambulance Modification

- Transport vehicle for injured or pregnant people
- Able to travel on poor roads not accessible by car
- Tire strap suspension system
  - tire straps strung across the bed support a stretch to provide an affordable shock absorbing system
Associated Projects

- Market strategy
- Micro-financing
- Micro-factory design and layout
- App & web based training material
  - Construction and operation
- Conservation agriculture implements
- Electric driveline & FWD transmission versions
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PUP
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