Design Criteria

- Must support 1,200 lb payload
- Use existing truck brakes and emergency brake
- Must be less than 12.5' long
- Greater than 12.5' inches of ground clearance
- Able to divide vehicle into front and rear sections
- Noise must meet OSHA standard.
- Hand rotated throttle.
- Have a working disengagable able driveline for use as PTO.
- Can climb 10% grade fully loaded.
- Powered reverse
- Bed must allow safe ingress/egress for 9 children.
- Lowered bed allows for easy child transfer.
- Anti-rollover height on shoulder height of the driver.
- Allow 5-7 inch drop for children's legs.
- May not use a motorcycle front suspension.
- Have a minimum of 2 inches of travel.
- Withstand heavy impact forces due to rugged terrain.
- Minimize machined parts for easier manufacturability.

Cost & Weight Analysis

<table>
<thead>
<tr>
<th>Item</th>
<th>Price</th>
<th>Weight (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuff Torq Transmission</td>
<td>$500</td>
<td>50 lb</td>
</tr>
<tr>
<td>Carrier Tires</td>
<td>$200</td>
<td>20 lbs</td>
</tr>
<tr>
<td>Engine outputs</td>
<td>$1000</td>
<td>1000 lbs</td>
</tr>
<tr>
<td>Drive Axle</td>
<td>$250</td>
<td>25 lbs</td>
</tr>
<tr>
<td>Gear Reduction</td>
<td>$50</td>
<td>5 lbs</td>
</tr>
<tr>
<td>Gear Reduction (Reverse)</td>
<td>$20</td>
<td>2 lbs</td>
</tr>
<tr>
<td>Input Shaft Diameter</td>
<td>0.75 in</td>
<td></td>
</tr>
<tr>
<td>Output Shaft Diameter</td>
<td>1.18 in</td>
<td></td>
</tr>
<tr>
<td>Max. Allowable Tire Diameter</td>
<td>35 in</td>
<td></td>
</tr>
<tr>
<td>Rated Axle Output</td>
<td>35 lbs</td>
<td></td>
</tr>
<tr>
<td>Peak Axle Output</td>
<td>35 lbs</td>
<td></td>
</tr>
<tr>
<td>Max. Max. Travel Speed</td>
<td>40 mph</td>
<td></td>
</tr>
<tr>
<td>Max. Input Speed</td>
<td>700 rpm</td>
<td></td>
</tr>
<tr>
<td>Rear Axle (from 1990 Chevy S-10)</td>
<td>4.73 in</td>
<td></td>
</tr>
<tr>
<td>Wheel Dimensions</td>
<td>28 in</td>
<td></td>
</tr>
<tr>
<td>Width</td>
<td>6 in</td>
<td></td>
</tr>
<tr>
<td>Suggested Tire Pressure</td>
<td>30 psi</td>
<td></td>
</tr>
<tr>
<td>Calculated Outputs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engine Speed</td>
<td>3000 rpm</td>
<td></td>
</tr>
<tr>
<td>Total Drive Train Reduction</td>
<td>13.31 in</td>
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</tr>
<tr>
<td>Max. Wheel Speed</td>
<td>270.90</td>
<td></td>
</tr>
<tr>
<td>Max. Ground Speed</td>
<td>20.28 mph</td>
<td></td>
</tr>
<tr>
<td>Max. Wheel Output</td>
<td>216.69 lb</td>
<td></td>
</tr>
<tr>
<td>Max. Terrain Slope</td>
<td>20 %</td>
<td></td>
</tr>
<tr>
<td>Max. Friction of Ground</td>
<td>524.44 lbs</td>
<td></td>
</tr>
</tbody>
</table>

Design & Modeling

What are the most common BUV applications?
- Ambulance medical vehicle
- Mobile fighter / malware fighter
- Farm commodities and delivery vehicle
- Material carrier to and from construction projects
- Water distribution (drip irrigation)/water purification
- School bus for children and orphans

Design Features:
- Ruggedly Simple

Unique reverse suspension arm design utilizes a shock spring and a small aircraft suspension. The design allows for easy replacement and simplified terrain variability. The low-cost application with emergency stops allows for the vehicle to be driven — even without the shock ring. A shock absorber is also added in order to reduce oscillation incurred during fast travel. Simple set screws on the front axle allow for ease in changing the shock size.
Basic Utility Vehicle

Design Competition
April 17, 2008

Designer | Design Area
--- | ---
Joel Fiechter | School Bus & Electrical
David Pyle | Drive & Powertrain
Pete Schmitt | Steering & Suspension
Eric Wulf | Frame & Brakes

Challenge

Design a 3-wheel vehicle based on the rear clip of a small pick-up truck. Design a school bus attachment which connects to the rolling chassis. The bus is intended to serve school children and orphanages in Africa. In addition to low cost, design emphasis is on the steering and front suspension. Design for small scale assembly operations in Africa. Volume is one vehicle per day. Minimize factory investment.

What is BUV?

Mission
To improve lives in developing countries by facilitating the spread of simple vehicles that can be assembled “almost anywhere, by almost anyone.”

Vision
The BUV will go:
...where the streets have no name
...where roads don’t exist
...where people need help

Goal
To jumpstart an industry to bless the working poor

Design Objectives

- Minimize Cost
  - Minimize total lifetime cost of ownership.
  - Utilize off-the-shelf components or recycled components where possible.
  - Optimize design to allow for micro-factory (650,000 production factory investments and sustainability).

- Optimize Performance
  - Simplicity of design to allow for performance and fewer failures in off-road terrain.
  - Versatile front suspension to allow for better travel over rugged terrain.
  - Allowing for easy turning for increased maneuverability.

- Vehicle Safety
  - Emphasize safety in all aspects of design.
  - Protect operator and passengers from all moving parts.
  - Minimize center of gravity to prevent overturn, but provide roll protection in case of emergency.

- Manufacturability
  - Simplicity of design to allow for easy assembly, maintenance, and repair.
  - Minimize the number of part numbers, part count, and number of common tools required to simplify purchasing, logistics, and serviceability.
  - Require only two people to assemble vehicle.

Acknowledgements

Agricultural & Biological Engineering Support
- Dr. Bonnie Engel, Department Head
- Dr. John Tomes, Technical Advisor
- Dr. Joe Irdayaraj, Academic Advisor

Organizational Support
- Institute for Affordable Transportation (IATC)
- Purdue Industry Support
- Tuff Torq
- Yanmar
- Wescon Products

Others
- BVE Shop: Scott Brand & Gary Williams
- Purdue Quarter-Scale Team
- Purdue Sheetmetal

"Food. Shelter. Transportation...the BUV can be the 'car for humanity', meeting human needs and glorifying our Lord."

www.drivebuv.org
ANSYS® Workbench was used to do stress analysis on the most important parts of the frame. Due to time restraints for the design, key failure points were located and stress analysis was performed on the high-stress areas shown. Multiple iterations were completed of the models in ProEngineer® to determine the optimum amount of steel necessary to allow for rated loads under worst case scenarios. After entering the fabrication stage of our project, we found that the front frame brace (shown above) was not necessary which allowed for more space in the operator area, with less fabrication time and total vehicle weight.

With little time to build, parts were collected and ordered from local suppliers to start fabrication within a week of design completion. Start to finish fabrication time was only weeks. The first week was spent primarily in part allocation. Careful use of limited shop time allowed for all group members to contribute with a focus on their individual design specialty. GTAW (TIG) was completed on the thinner steel components and MAW was utilized for the thicker steel. Fasteners were kept to standard lengths and sizes with limited variation to allow for easier repair. The BUV is now ready for competition and shipment to an impoverished country. In the retrospect, team cooperation, discipline, and dedication allowed for a successful design and build:

Ruggedly Simple. Simply Rugged.