Design & Modeling

What are the most common BUV applications?

- ambulance medical vehicle
- mobile fogger / malaria fighter
- farm commodities and delivery vehicle
- material carrier to and from construction projects
- water distribution (drip irrigation) / water purification
- school bus for children and orphanages

Design Criteria

Frame	Drive train	Bed/safety	Front suspension
•Must support 1200 lb payload •Use existing truck brakes and emergency brakes •Must be less than 12.5 ft long •Greater than 12.5 inches of ground clearance •Be able to divide vehicle into front and rear sections	•Noise must meet OSHA standard. •Governed speed of 20 mph on grass. •Hand mounted throttle. •Have a working disengage able driveline for use as PTO. •Able to climb 20% grade fully loaded •Powered reverse	•Bed must allow safe egress/ingress for 9 children. •Padding must be provided to prevent injury during a crash. •Lap belts for every child and the driver. •Anti roll protection higher than 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.

Driveline Calculations

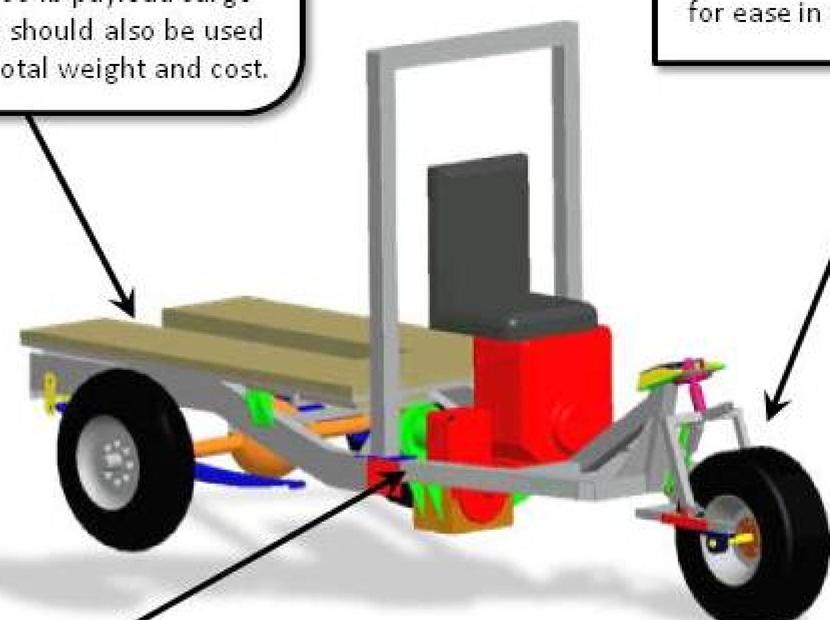
Engine (Yanmar L100V, 4-stroke, 10 hp Diesel Engine)			
No. of Cylinders	1		
Bore x Stroke	3.39	x 2.95	in³
Displacement	26.5	in³	
rpm	3600	3200	2500
hp SAE	9.1	8.7	7.4
Torque (ft-lb, theoretical)	13.3	14.3	15.5
Continuously Variable Transmission (Comet 780/790 Series)			
High-End Reduction	0.65	:1	
Low-End Reduction	3.31	:1	
Drive Pully Diameter	7.25	in	
Driven Pully Diameter	8.5	in	
V-Belt Size	1.1875	in	
Transmission (Tuff Torq KT35 w/ differential lock)			
Gear Reduction (Forward)	7.5	:1	
Gear Reduction (Reverse)	15.3	:1	
Input Shaft Diameter	0.75	in	
Output Shaft Diameter	1.18	in	
Max Allowable Tire Diameter	25	in	
Rated Axle Output	360	ft-lbs	
Peak Axle Output	1930	ft-lbs	
Max Travel Speed	20	mph	
Max Input Speed	3700	rpm	
Rear Axle (from 1990 Chevy S-10)			
Gear Reduction	2.73	:1	
Wheel Dimensions			
Outside Diameter	28	in	
Width	6	in	
Suggested Tire Pressure	30	psi	
Calculated Outputs			
Engine Speed	3600	rpm	
Total Drivetrain Reduction	13.31	:1	
Max Wheel Speed	270.50	rpm	
Est. Max Ground Speed	20.28	mph	
Max Wheel Output	176.69	ft-lb	
Max Terrain Slope	20	%	
Max Force at Ground	151.44	lbs	

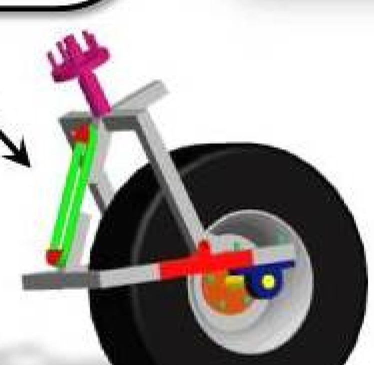
Cost & Weight Analysis

ITEM	PRICE	WEIGHT (lb)
Rear Frame & Axel (1990 Chevy S-10)	$ 160.00	500
Tuff-Torq Transmission (KT35)	$ 30.00	80
Lanmar Diesel Engine (10 HP)	$ 400.00	140
Competition Entry Fee	$ 110.00	-
Drive belt (Gates Sportline 6007 52")	$ 52.65	2.5
Steel (front frame/suspension)	$ 100.00	160
Comet/Salsbury CVT	$ 50.00	8.5
Driver's Seat	$ 15.00	7.5
Lumber (3/4" plywood)	$ 58.44	15
Toggle Switch	$ 6.33	-
Battery Cables	$ 20.66	0.5
Brake line fittings	$ 13.30	-
Reflectors/brake lights	$ 13.98	-
Battery	$ 26.99	5
Paint	$ 5.97	-
TOTAL	$ 1,063.32	919

Unique reverse suspension arm design utilizes a shock ring from a small aircraft suspension. This elastic band allows for easy replacement and simplistic terrain versatility. This 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 front tire.

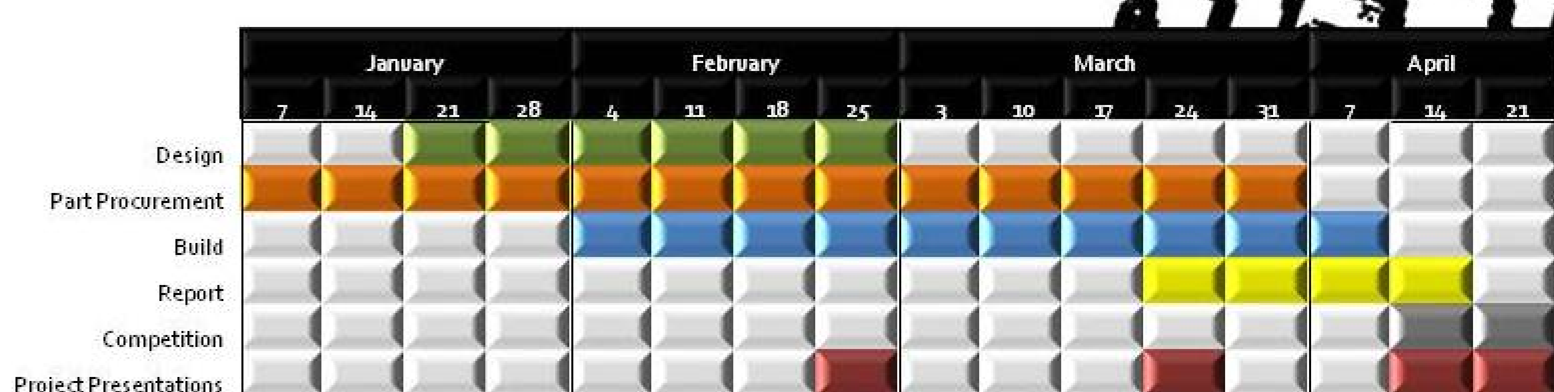
The lowered bed design shown here is to provide a lower center of gravity when hauling 9+ children to and from school. Side panels will then be utilized to convert this drop into a flat bed for max 1,200 lb payload cargo transport. Wood should also be used to minimize the total weight and cost.





This Tuff Torq KT35 Transaxle is utilized in our design as a transmission. Combined with a CVT and front and rear braking linkage, this design allows for a high and low drive speed with an PTO for power accessories such as a generator or remote well.

Design Features: Ruggedly Simple



PURDUE UNIVERSITY

Basic Utility Vehicle (BUV)
Joel Fiechter, David Pyle, Pete Schmitt, & Eric Wulf
ABE (Machine Systems)
April 17, 2008

Basic Utility Vehicle Design Competition

Agricultural & Biological ENGINEERING

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 hope

Basic Vehicles. Changed Lives.

Goal

To jumpstart an industry to bless the working poor

Design Objectives

Minimize Cost	Optimize Performance	Vehicle Safety	Manufacturability
•Minimize total lifetime cost of ownership. •Utilize off-the-shelf components or recycled components where possible. •Optimize design to allow for micro-factory ($50,000) production factory investments and sustainability.	•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. •Allow for easy turning for increased maneuverability.	•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.	•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.

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

Millard Fuller, Founder
Habitat for Humanity

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- Tuff Torq
- Yanmar
- Wescon Products

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

www.drivebuv.org

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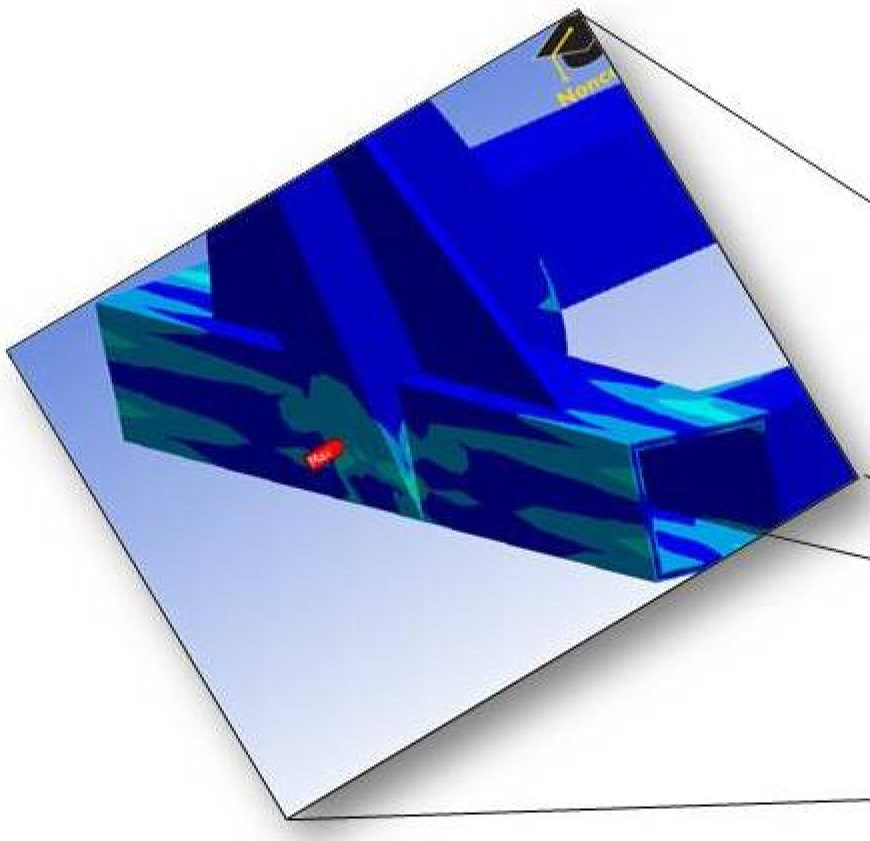
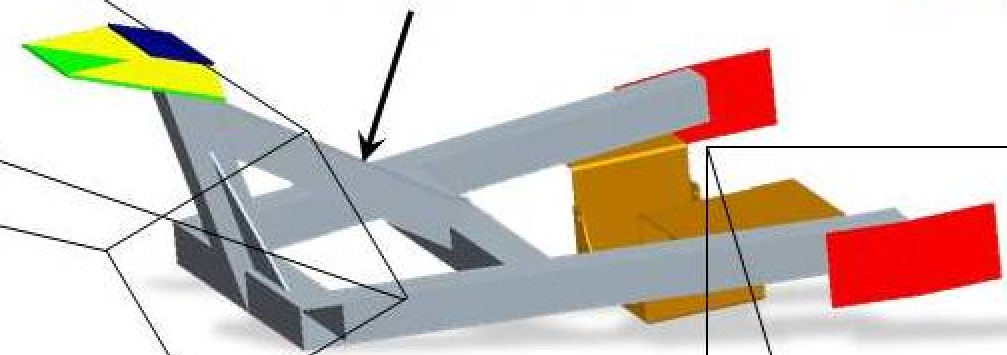
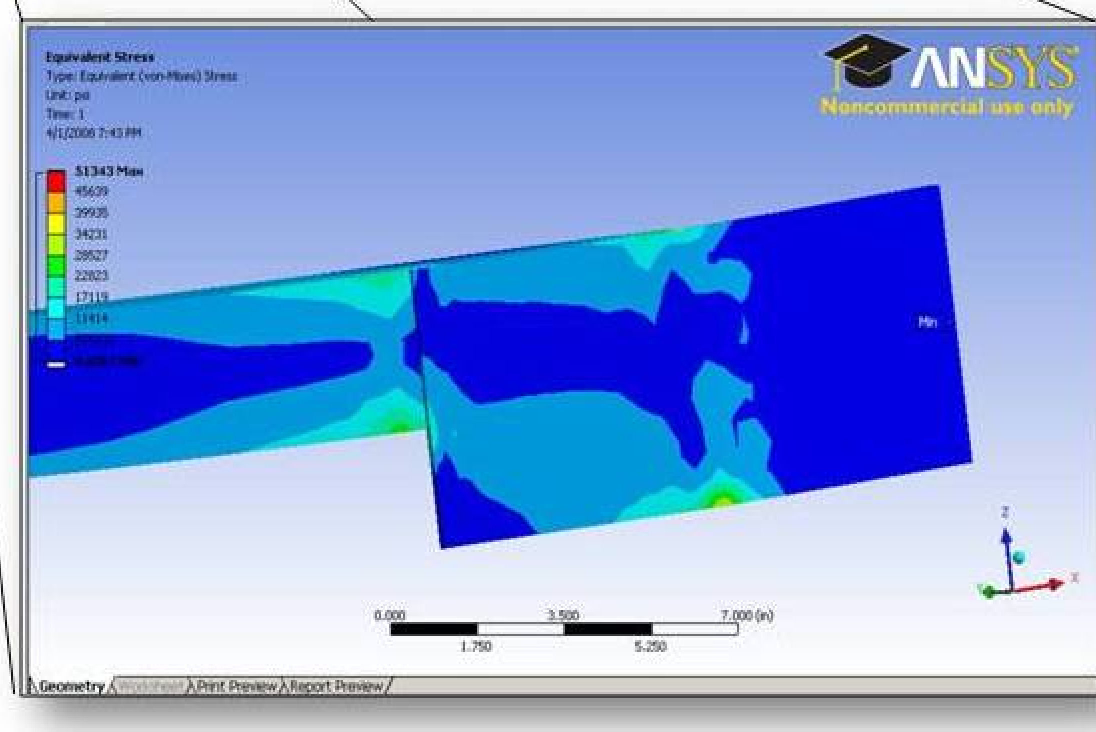
TUFF TORQ · YANMAR · WESCON · BUV

Analysis







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.

AGRICULTURAL & BIOLOGICAL ENGINEERING

Fabrication

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