IPRO 348 Final Report
Summer 2011

The Universal Car Project
Applying Open Source Concepts to a Global Automobile Design Platform

Advisor: Blake Davis (INTM)

1. **Executive Summary**

The goal of the Universal Car Project (UCP) is to create a standardized global vehicle platform. The platform will be open-source, available not only to automobile manufacturers but to whomever may be interested in creating a custom designed vehicle. The UCP will be similar to how people can build their own computers today; someone is able to buy RAM/Memory from company X, a motherboard from company Y, and a case from company Z and all the parts are compatible with each other. The vision of the UCP is to take the same principles and apply it to the automotive design and manufacturing industry.

The UCP IPRO team will form a Universal Car Organization (UCO), which will set the standards for the basic platform. The Universal Car Project will specify the locations of the mounting points for the engine, transmission, and suspension along with the weight rating for the chassis. The standard chassis will allow changes in wheelbase and width, allowing the designer to modify the basic chassis to meet their needs. Once the universal platform is achieved and the basic chassis is finalized and maintained, third party individuals, companies, and countries will be able to choose the automotive parts branding the vehicle for its specific need. This "open source" design technique will be available to anyone with a free license from the UCO. This freedom to design a vehicle from the ground up - which allows for novel design concepts specifically tailored to the demands of the consumer - could prove to be a breakthrough in the automotive industry.

The Universal Car Project provides opportunities for contributors ranging from individuals and hobbyist groups to fully operating automotive companies. This collective strategy has the capability to enhance the potential of developing countries that lack the capital, resources, or manufacturing to have their own domestic automotive company. In a rapidly expanding market, the need for compatibility is paramount in an ever-increasing choice of components. With ongoing support and interest, the UCP has the potential to expand the automotive industry on domestic and foreign levels as well as create new markets and opportunities to those regions that are underserved by the general automotive market.

As a first semester IPRO, this project is still in its infancy and still working toward the creation of the Universal Car Organization, which will set the universal standards and regulate the safety and quality of all vehicles produced using the open-sourced platform. The IPRO this semester accomplished two major goals. The first goal achieved was launching a website and utilizing several social media channels to help gain interest for the project. The website explains the concept of the UCP, consolidates data pertaining to the UCP, and provides a forum in which interested parties may discuss their ideas. The second goal achieved was the design of a prototype universal chassis based on extensive research of current vehicles. This was done to help visualize the overall concept and to be used as a springboard for future discussion on the UCP. These accomplishments are only stepping stones leading to the ultimate overall goal of the organization. The future IPRO groups will have a leading edge to then focus on networking, gathering contacts, gaining exposure and building on the universal car design.

2. Purpose and Objectives

The automotive industry spends billions every year and within the next 10 years an estimated $1.15 trillion will be spent on research and development. One of the reasons the cost is so high

is the current trend of secrecy and proprietary designs between the major automobile manufacturers. The transition to an open-source concept will significantly reduce research costs. Developers would be able to use ideas and technology from previous R&D projects so that they would not have to reinvent the wheel or resort to corporate espionage. A viable business model can be developed to sustain open-source innovation while still benefiting the developers, possibly in the form of royalties.

In addition to resources saved, developing nations can benefit from such an advancement in the automotive manufacturing process. Countries that do not have the manufacturing capabilities or capital to sustain a domestic automotive market can buy "certified universal chassis" in bulk along with other required automotive components, such as engine, suspension and body, which will coalesce into a final product. The country will have the capability to choose the automotive components that best suit the needs of its market, which will differ from region to region. The country can then sell the completed vehicle to the market after getting the final product certified by its safety standards.

Eventually, car hobbyists and enthusiasts alike will start modifying, designing, and creating their own automotive components or their dream vehicle. These vehicles can range from any where from a small sports car to a lightweight alternative fuel vehicle to a small pick-up truck.

To accomplish this open source idea, the Universal Car Project (UCP) aims to create a standardized global vehicle platform. The UCP will be similar to how people can build their own computers today. An example of this is how someone is able to buy RAM/Memory from company X, a motherboard from company Y, and a case from company Z and all the parts are compatible with each other. The vision of the UCP is to take the same principals and apply it to the automotive design and manufacturing.

The long term goal of the UCP is to create an organization that will monitor the quality of the vehicle parts, set safety standards that must be met, and set the standardized mounting points for various parts. This global organization will be the Universal Car Organization (UCO) and will act in a way similar to The United States Federal Aviation Administration (FAA). UCO will make sure vehicle chassis and parts conform to the safety, quality, and standardized mounting point standards they set.

This IPRO set several objectives to accomplish this semester. The first objective was to create a website that will act as an online encyclopedia for the Universal Car Organization. The website should contain a brief description of our organization, contain the standards set forth by the Universal Car Organization, contain updates from our organization, and most importantly, create and maintain a forum. The forum will take suggestions, input, and answer questions and concerns from our community. This will allow the UCP to move in the direction that best suits our customer base. The second objective was to drive online traffic to our website and drive traffic to the website through as many mediums as possible. This was done by using social media (Facebook, Twitter, and YouTube) and contacting various automotive and technology publications, car hobbyist groups, and auto blogs to increase awareness. The third objective was to create a prototype Universal Car Project Chassis. This would require researching the main automotive parts directly connected to the vehicle chassis in order to create the standard

mounting points for the UCO. The last objective was to establish contacts within the automotive manufacturing industry and other manufacturing industries, such as the aviation and farming industry. This would allow us to gain firsthand knowledge and experience to improve the Universal Car Project.

3. Organization and Approach

The IPRO team was organized into two sub-teams: the Tech Team and the Engineering Team.

Tech Team

The Tech Team was responsible for the development of various websites used to attract likeminded individuals and other organizations to our project and organization. Several websites - a home webpage forum (universalcarproject.com), Facebook page, YouTube clips, and Twitter - were created to "get the word out" about our goals while sharing information on our progress and gathering feedback from outside source. The Tech Team researched and developed internet-wide presence of our project and such things as a website, discussion boards and a presence on various social media platforms. Unfortunately, due to the time constraints during an 8-week IPRO semester, preconfigured webdesign tools were used to fully complete our internet presence. The main goal of the team was to create a presence that conveys all the research that is being done by the engineering team.

The first step was to gather research for attaining a domain and web hosting for our website. This task was completed the week of June 16, 2011 and from there we proceeded on the development cycle of our website. The steps subsequent to attaining the domain and web hosting were divided into three stages: design, implementation, and testing. While the website was in the beginning of the development cycle, the testing group set up a Facebook page to attract exposure the week of June 16, 2011. Website maintenance was an ongoing process throughout the whole project as well as the content management and maintenance of the webpage. The home page of the website was created a week after the hosting was attained. The main component of the website, the forum, was done in the same week as the design of the home page, the week of June 26, 2011. The testing team's main priority was to provide a thorough quality assurance testing process to enhance the website to the fullest extent.

Our initial plan was to set up a Wiki community for the Universal Car Organization the week of June 26, 2011, but this wasn't a possibility due to lack of resources. This has become a main priority for the future of this organization after the UCO establishes a presence in the automobile industry. The last steps in the development cycle were testing and content management and this was done through both groups to better enhance our credibility with the website. The design and implementation were completed by the week of June 26, 2011 and the testing was an ongoing process throughout the whole project.

Engineering Team

The Engineering Team was responsible for identifying the main components attached to a

vehicle chassis, the various types and dimensions of chassis, the main components range of dimensions and how they are attached to a chassis, and then creating a prototype universal chassis from the research collected. All teams members used secondary sources, such as journals, online databases, and websites, to obtain most of the data needed during the research phase. A couple of team members went out into the field and physically measured various parts in order to obtain the data needed that could not be found any other way. The research phase tasks were all to be completed by July 5th. Once all the research phase was completed, one team member focused on using the data collected to create a prototype universal chassis. A 3-D model of the prototype universal chassis was created using Solidworks. The 3-D model was used to make a 3-D printed model to showcase and to be put up onto the websites to invoke discussions about the project. The prototype model stage was to be completed by July 21st.

4. **Analysis and Findings**

At the beginning of the project, the team decided that it would be best to create a website that would host a discussion forum of the "universal car" topic that may attract interested people and seek expertise comments to various technical questions listed within the forum. The main purpose of this site was to establish a web presence and gain some exposure in the automotive industry. The site will also display goals and information on the project in addition to links to other well credible sources and other UCP social media platforms like Facebook, Twitter, and YouTube. The Facebook site was created and "spiced-up" attracting over 25 "Likes" in only a couple short weeks. This was an accomplishment for the team since this allowed us to earn a personal Facebook domain name. The resources that were used in the development cycle of the website were GoDaddy.com for the web hosting and domain name, the WordPress framework for the design and implementation of the website, and PHPBB for the discussion board interface.

The website contains all the basic pages needed to function as discussion board, forum, and informative link for organizing all of our content on a universal platform. The website was created in a way that a user would be created to partake in the discussion board and forum. The accounts in the discussion board are administrator, moderators, and users. The coding team used the WordPress framework to implement the website with the use of plugins and add-ons. The visual design aspect of the website is based on a predesigned template for a simple professional aesthetic and appeal. The website implementation process was done by both subgroups with divided tasks. The coders were in charge of learning the WordPress framework and establishing functional pages. The testers were in charge of content management and quality assurance testing.

A very important aspect of making a website successful is directing traffic towards it. To that end, the Tech Team sought to optimize the website for search engines such as Google. A portion of Search Engine Optimization includes having external links to the website. That process has been started with a link on the local SAE chapter's website. The testing team and coding team were both in charge of attracting exposure to the site by directing traffic through different automotive websites.

The Engineering Team focused researching the dimensions for engines and suspensions, and how they attach to a chassis first. The engine mounts are found to be dead nuts centered on the engine

attached to a cross member. After researching the positioning of engines of different sizes, it was decided that mounting points for the engine mounts should be 15" from the front of the chassis in order to accommodate a V8 engine. If made any smaller it won't be able to mount this engine size and would severely limit the universality of the car. There should be an additional two mounting points on each side with 1.5" spacing which will allow the cross member to be adjusted in order to mount the smaller engines.

The main suspension types researched were leaf springs and MacPherson Struts. A large range of sizes for both types were found, so the team chose the range of dimensions that would standardize the parts. For leaf springs, the team chose a 56 inch (eye-hole to eye-hole) leaf spring to be the largest and a 44 inch leaf spring to be the smallest for the standardized mounting points. This was done because a 56 inch leaf spring is used for small trucks and SUVs while a 44inch leaf spring is used on smaller cars. By using these two size leaf springs as the standard mounting points, most other leaf springs can be attached the our universal chassis through a separate mounting bracket that would uses these current mounting points. The MacPherson Strut had an average 10 inch lower control arm and 24 inch shock length. From these standardized mounting points the team set, the prototype chassis were able to be designed then. The prototype chassis were designed only to be used as reference guides and to help visualize our idea to potential partners for the UCP.

With a prototype universal chassis created, a 3D animation was created. The animation was created to show the changes that could be made to the overall chassis to fit different needs of the customer. The universal chassis dimension changes that could be made were to the wheelbase, the overall chassis length, and the overall chassis width. The models for the animation were created using 3D Studio Max and the output was rendered as a video file. The final video was modified using Windows Movie Maker to add titles, music, and special sound effects. The animation was created as a visual aid to better portray the flexibility of the universal car chassis. The video shows how the chassis can be used as a platform to construct different types of vehicles, ranging from an SUV to a sports car to a truck. The video also shows how various engines and suspensions can be used on the chassis with the use of the standardized mounting points.

The Engineering Team also researched the safety standards a vehicle must meet in the United States along with what obstacles there would be with importing or exporting a chassis to or from the United States. The main obstacles the team looked into importing or exporting a chassis to or from the United States were taxes, tariffs, and standards the chassis would be subject to from other countries. Each country in the world has a wide range of taxes, tariffs, and standards on vehicle chassis and parts that a future team would need to narrow down specific countries that would be main contributors and focus research there. One team member acquired about the safety standards checklist all vehicles must past to be considered road worth in Illinois. This team member contacted various parties within the Illinois State Police Department and Secretary of State Office but eventually had to submit a freedom of information act to the Illinois State Police Department for the checklist.

The Engineering Team also tried to contact various vehicle manufacturers to help gain insight on the design process. A member of the Tech Team contacted a Senior Project Engineer of General

Motors (GM) to help answer basic questions that arose during the semester. The Senior Project Engineer gave useful information that helped direct the team to its final products. The team also contacted the Subaru Assembly Plant in Lafayette, Indiana. The team attempted to set up a plant tour with a question and answer session with the plant manager but due to time constraints of the semester and plant production, the tour and question and answer session was not able to occur.

As a class, we discussed the ethical dilemmas that might arise from our project. The main ethical dilemmas that our IPRO faced were safety of the end product of our design and the increased use of a scarce natural resource by enabling more carbon based vehicles to be produced. After meeting with the Ethics Librarian, Kelly Laas, and doing research on Cost-benefit Analysis, it was determined that we were not violating any ethical codes by designing this car; because, our car was only as dangerous as the final user wanted it to be and vice versa could be as safe as the final user wished it to be. The second ethical point was justified in a more circular way in that the UCP is geared towards developing nations and economies who though they often own the scarce resource do not get to reap the benefits of it as Western and other developed nations do. Therefore it would not be ethical to impose green energy standards onto a developing nation the way they should be imposed on developed nations. The final positions were reached after meeting with Kelly Laas and reading journal articles she printed out as well as independent research, specifically on the failed design of the Ford Pinto's gas tank and the damages the design caused in order to increase profits by cutting costs.

5. Conclusions and Recommendations

The ultimate goal of this project is obviously not completed. As the first team of this IPRO, substantial progress has been made in implementing the idea of open-source automotive design to create the universal car. An initial design and scaled prototype of the universal chassis has been created. It is highly recommended that further research and changes in the chassis design be made according to feedback from the website forums and other contacts in the automotive industry. Additional mounting points can be designed to fit new types of auto-parts into the chassis. Further research in the market for the UCP is recommended. It is also recommended for students with a business or entrepreneurial background to develop a viable economic system to sustain the open source.

Once this IPRO semester has been completed, the advisor, Professor Davis, will have to find students to maintain website, answer the emails. A current problem with the website is that it requires a person that is proficient in web-design to consistently manage the UCP website. Future IPRO's will have to contact and meet with representatives from the major automotive companies to sell our idea and form a relationship with them.

Since we basically have one foot in the door with GM and Subaru, the next IPRO will be able to schedule tour visits and a Q&A sessions with the companies. There, IPRO students can gather a great amount of information concerning vehicle manufacturing, marketing, foreign relations, etc. Also, the Universal Car Project presentation can be shared with these companies letting them know our goals and aspirations which will lead to inquiring their input or suggestions.

6. **Appendix**

Appendix Index

I. Team Task List and Breakdown

Tech Team Task List

Team Member	Tasks	Projected Due Date
Karthik Prabhu	Generate Contact List	June 12, 2011
	Contact GM & Ford	June 19, 2011
	Midterm presentation	June 28, 2011
	Press Release	July 24, 2011
	Final Project Report	July 29, 2011

Team Member	Tasks	Projected Due Date
Dwayne Sanders	Facebook Page Development	June 12, 2011
	Website Implementation	June 22, 2011
	Website Maintenance	July 29, 2011
	Press Release	July 24, 2011
	Final Project Report	July 29, 2011

Team Member	Tasks	Projected Due Date
Erfan Setork	Website Research	June 12, 2011
	Website Implementation	June 22, 2011
	Website Maintenance	July 29, 2011
	Press Release	July 24, 2011
	Final Project Report	July 29, 2011

Team Member	Tasks	Projected Due Date

Daniel Dobbin	Website Research	June 12, 2011
	Website Implementation	June 22, 2011
	Website Maintenance	July 29, 2011
	SAE Correspondent	July 21, 2011
	Final Project Report	July 29, 2011

Team Member	Tasks	Projected Due Date
Andrew Dicosola (Team Leader)	Website Research	June 12, 2011
	Website Implementation	June 22, 2011
	Website Maintenance	July 29, 2011
	Poster/Brochure Design	July 26, 2011
	Final Project Report	July 29, 2011

Engineering Team Task List

Team Member	Tasks	Projected Due Date
Justin Dickman	Team Leader	7/29/2011
	Chassis Research	7/21/2011
	Final Report	7/29/2011
	Chassis Design	7/15/2011
	3D Modeling	7/23/2011

Team Member	Tasks	Projected Due Date
Sooraj Kumar	3D Animation	7/26/2011
	Researched Suspensions	7/15/2011
	Initial Chassis Research/Design	7/13/2011
	Logo	7/21/2011
	Met with Joe about Prototypes	7/5/2011

Team Member	Tasks	Projected Due Date

Kaleo Pedrina	Transmission Research	7/19/2011
	Project Plan	7/15/2011
	Brochure/Poster	7/29/2011
	Final Presentation	7/29/2011
	Custom Vehicle Inspection List	7/19/2011

Team Member	Tasks	Projected Due Date
Bahar Aynaci	Wheel Size Research	7/19/2011
	European Car Company Research	7/17/2011
	Tax Research	7/17/2011
	Looked up similar projects	7/15/2011
	Brake System Research	7/13/2011

Team Member	Tasks	Projected Due Date
Chris Williams	Meeting Minutes	7/29/2011
	Ethics Research	7/21/2011
	Engine Mount Research	7/19/2011
	Final Presentation	7/29/2011
	Subaru Tour Arrangements	7/17/2011

II. Budget

Item	**Amount**
Prototyping Supplies	**$800**
Software	**$200**
Travel	**$400**
IPRO Day Materials	**$100**
Team Building Session	**$100**
Total	**$1,600**

III. References

Other Projects

Stanford Solar Car Project, an entirely student-run, non-profit organization	http://solarcar.stanford.edu/blog
DIY sports cars	http://thearticlewriter.com/autowriter/fun-project-build-your-own-sports-car/
Electric Vehicle Association of Greater Washington, D.C.	http://www.evadc.org/build_an_ev.html
Record holding solar car project	http://www.xof1.com/
Dale Vince's wind powered car project	http://www.treehugger.com/files/2009/04/dale-vince-wind-powered-car.php
Wind Powered Car That Moves Faster Than The Wind	http://www.fasterthanthewind.org/
Solar powered commuter vehicle	http://www.sunstang.ca
The CityCar electric automobile, developed and prototyped by Smart Cities	http://cities.media.mit.edu/projects/citycar.html
The OScar Project	http://www.theoscarproject.org/
The University of Michigan Solar Car Team	http://solarcar.engin.umich.edu/the-car/

Research

Universal Transmission Mounts	http://www.energysuspension.com/universal-products/motor-transmission-mounts.html
Regulations and Standards	http://autorepair.about.com/gi/dynamic/offsite.htm?site=http://www.nhtsa.dot.gov/cars/rules/
Licensing and Insuring Homebuilt Cars	http://www.rqriley.com/license.htm
Uni-Chassis Example	http://theodore-associates.com/unichassis.html
Uni-Chassis Info	http://ev.sae.org/article/9522
Import Regulations for Most Countries	http://www.japanautotrading.com/Import%20regulations.pdf
Federal Motor Vehicle Safety Standards and Regulations	http://www.nhtsa.gov/cars/rules/import/fmvss/index.html
EPA Kit Car Policy	http://www.epa.gov/otaq/imports/kitcar.htm
Suspension Types	http://www.carbibles.com/suspension_bible.html
US Import Taxes	http://www.importexporthelp.com/importing-cars.htm
US Import Taxes	http://www.foreignborn.com/visas_imm/entering_us/7importingyourcar.htm
Compilation of Foreign Motor Vehicle Import	http://www.drivetrain.com/parts_catalog/suspension_and_steering/leaf_springs.html
Leaf Spring Dimensions	http://littlekeylime.com/MrN/mrnimages/leaf_springs.png
leaf Spring Dimensions	http://www.thesuspensionking.com/catalog/tables/amc_rear.php
leaf Spring Dimensions	http://www.4x4spot.com/misc__spring_information.htm
leaf Spring Dimensions	http://www.pirate4x4.com/forum/showthread.php?t=773585
Sample Chassis Pic	http://www.sriiimotorsports.com/images/570_Bart_66_chassis_blk_1.jpg
Sample Chassis Pic	http://www.thunderranch.com/images/550/550frame.jpg
Sample Chassis Pic	http://www.freepatentsonline.com/6513242-0-large.jpg
Sample Chassis Pic	http://www.automobileaddiction.com/images/CHASSISASSEMBLY.jpg?772
Macpherson Strut Diagrams	http://www.wilcoxbrosco.com/pdf/MacPStruts.pdf

Gross Vehicle Weight Rating for various cars/trucks/suvs	http://www.hoffmanwhite.com/Articles/GVWR%20Vehicle%20Listings.pdf
Gross Vehicle Weight Rating for various cars/trucks/suvs	http://auto.howstuffworks.com/auto-parts/towing/towing-capacity/vehicle/gvwr.htm/printable
Suspension Design	http://performancetrends.com/rc.htm
Suspension Dimensions	http://www.ketcherside.net/chassis.htm
Macpherson Strut control arm lengths	http://www.polyperformance.com/instructions/PPM-8054-JK-REAR-UPPER-CONTROL-ARMS-web.pdf
Jeep Macpherson Strut control arm lengths	http://www.yuccaman.com/jeep/re_db.html
Mustang Macpherson control arm lengths	http://www.yellowbullet.com/forum/showthread.php?t=357852
Wheel technical information	https://www.rsracing.com/tech-wheel.html#backspace
Rear Axle Drum to Drum Measurements	http://www.bigblockdart.com/techpages/drumchart.shtml
General information about parts	http://www.bigblockdart.com/techpages/techindex.shtml
Axle list	http://akb.norbie.net/Public/AxleList.aspx
Suspension Measurements	http://www.quickperformance.com/Technical%20Info/sus_measure.htm
Usefull page finding the width	http://www.hotrodsandhemis.com/deucerearend.html
Wheel to wheel width forsome car model	http://fordsix.com/forum/viewtopic.php?t=48144
Rear Axle Measurements	http://www.roaddevils.com/forum/showthread.php?t=5541
rim/wheel width	http://customwheelsmarket.com/rimwheelwidth1.html
Popular Size Tires and Rims	http://www.gnttype.org/techarea/suspension/Tirechart2.html
how to read tire information	http://www.nationaltire.com/basics/default.asp
tire code and Standard Load Table	http://en.wikipedia.org/wiki/Tire_code
Engine sizes for large number of engines	http://www.carnut.com/specs/engdim.html
Good diagram and drawing of where the engine mounts will typically go	http://www.mudinyerioffroad.com/jks_bmml.htm
Ethical article about car design, specifically the pinto	http://www.weldreality.com/ford%20pinto%20article.htm
Article discussing cost benefit analysis of pinto design	http://www.pointoflaw.com/articles/The_Myth_of_the_Ford_Pinto_Case.pdf

Tech Sources

Godaddy Hosting	http://www.godaddy.com
Wordpress Framework	http://www.wordpress.org
Wordpress Documentation	http://codex.wordpress.org
Suffusion Wordpress theme documenataion	http://aquoid.com/news/themes/suffusion/
MediaWiki	http://www.mediawiki.org/
Our Facebook Page	http://facebook.com/universalcarproject
Our Twitter Page	http://twitter.com/UCarProject
Our Youtube Page	http://youtube.com/Universalcarproject
Our Discussion Boards	http://universalcarproject.com/discuss
Homepage	http://universalcarproject.com
Google analytics	http://www.google.com/analytics/
Phpbb forums	http://www.phpbb.com
SAE website	http://sae.iit.edu
Picasa Web Albums	https://picasaweb.google.com
Google Docs	http://docs.google.com
Web Design Documentation	http://www.w3schools.com