

Research Unit #10 Economic Analysis of Dual Voltage Automobile Electrical System

Objective:

- System level economic analysis of the dual-voltage automobile electrical system, including manufacturing costs of critical new components and the process of transition.
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Technical Approach:

- Develop manufacturing cost models for the DC/DC converter, the battery and the alternator that can be used to evaluate the impact of various design specifications.
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- Develop System-level cost model capable of providing "point-estimate" and sensitivity analysis results for baseline 14V and proposed 42/14-V systems.
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- Evaluate the economic impact of various transition strategies



Presentation Outline

- Summary of Results: Storage/Generation System
- Cost Modeling Review
 - General review of manufacturing cost modeling
 - Translation of general operating parameters into component design specifications
 - Specifics of battery and alternator models
- Proposed Future Work
 - Expansion of generation/storage system analysis
 - Systems modeling and trade-off/utility analysis



Analysis of Storage/Generation System

- Comparison of one proposed dual 14/42 volt architecture compared with standard 14 volt system
- Proposed 14/42 volt architecture
 - 1 kW centralized DC/DC converter
 - Two batteries, one 12 volt and one 36 volt
 - 42 volt, Lundell style alternator
- Standard 14 volt architecture
 - No DC/DC converter
 - One 12 volt battery
 - 14 volt, Lundell style alternator



Summary of Storage/Generation System Cost Results

- Cost disadvantage for dual voltage system due to the high cost for the dc/dc converter (about \$100)
- Increased cost for two batteries
 - partially offset due to battery optimization
 - 36 volt battery designed for engine cranking, while the 12 volt battery is designed for energy
- Alternator cost essentially unchanged
 - power limitations of Lundell design may require the use of multiple alternators
 - possible cost savings for dual voltage system if the higher voltage allows use of single alternator



Battery Cost Comparisons

	12 Volt Battery	36 Volt Battery	TOTAL BATTERY COST
14 Volt System	\$28	-----	\$28
14/42 Volt System	\$17	\$22	\$39

Battery Descriptions:

14 volt system: 12v, 78 AH, 750 CCA

14/42 volt system: 12v, 60 AH, 300 CCA
36v, 15 AH, 220 CCA



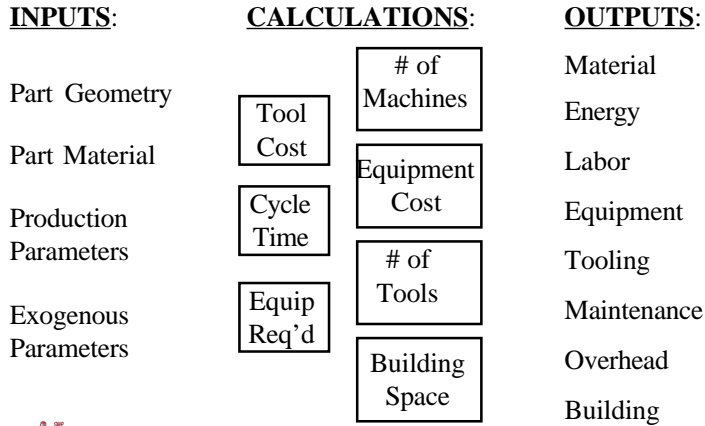
Alternator Cost Comparisons

	2 kW	3 kW	4 kW
14 Volt Alternator	\$60	\$76	\$120*
42 Volt Alternator	\$62	\$78	\$93

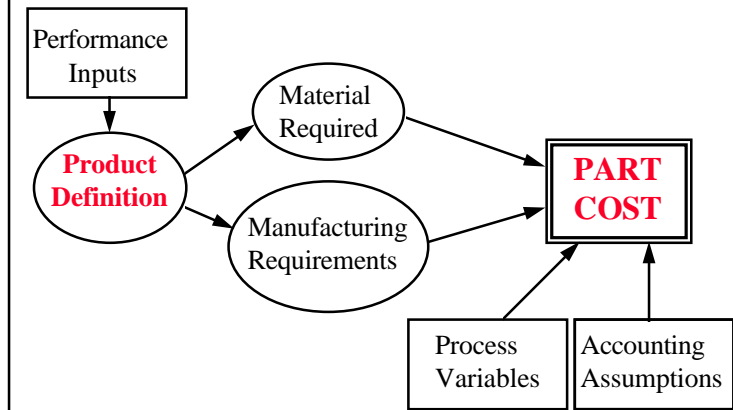
* For the 14 volt alternator, 4 kW is considered to be beyond the power limits of the Lundell Style Alternator. The cost assumes two, 2 kW alternators, will be needed.

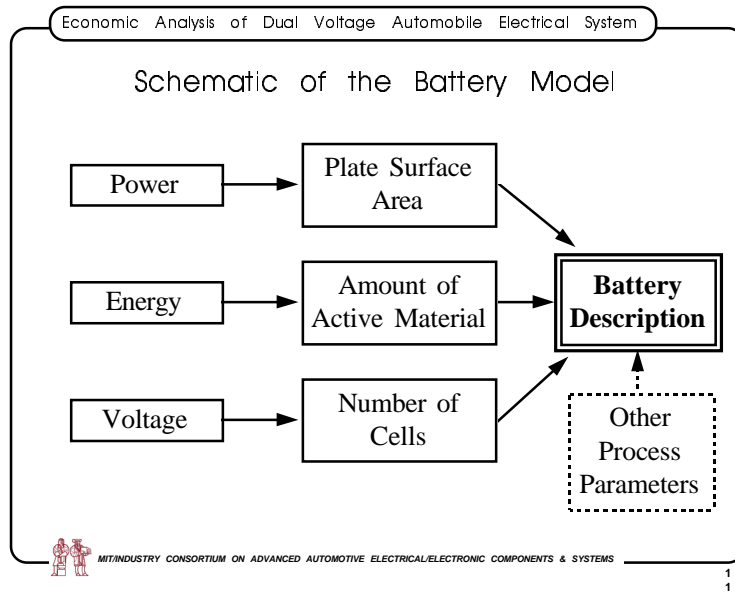


Manufacturing Cost Modeling Overview



Cost Modeling/Product Definition





Economic Analysis of Dual Voltage Automobile Electrical System

Battery Sizing Inputs & Outputs

INPUTS		OUTPUTS	
Voltage	12 v	Battery Height	152 mm
Plate Length	117 mm	Battery Width	165 mm
Plate Width	133 mm	Battery Length	280 mm
Separator Thickness	1.3 mm		
Amp-hr Capacity/Cell	78 Ah	Battery Volume	6.993 cm ³
PAM Energy Density	70 Ah/kg	Battery Mass	22.84 kg
Cold Cranking Amps	750 A		
CCA/sq cm	0.3 A/cm ³		
Acid Specific Gravity	1.24 g/cm ³		

MIT/INDUSTRY CONSORTIUM ON ADVANCED AUTOMOTIVE ELECTRICAL/ELECTRONIC COMPONENTS & SYSTEMS

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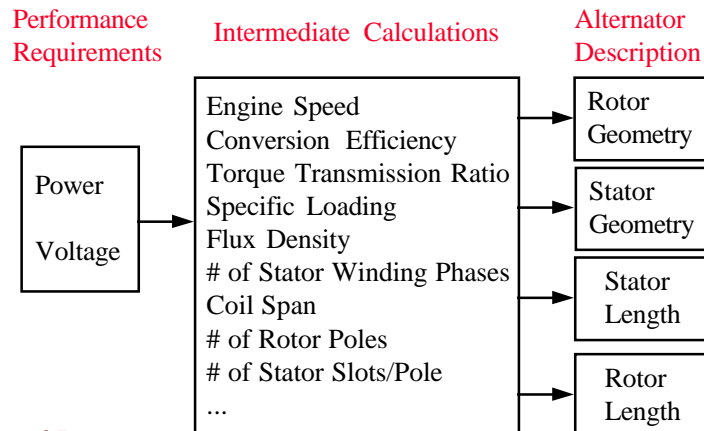
Battery Size & Cost Calculations

Battery Requirements	Dimensions (mm)	Weight (kg)	Cost (\$)
12v, 78AH, 750CCA	280 x 165 x 152	22.84	\$28

12v, 60AH, 300CCA	127 x 165 x 152	14.80	\$17
36v, 15AH, 220CCA	262 x 165 x 152	20.56	\$22



Schematic of the Alternator Model



Proposed Future Work

- Expansion of Generation/Storage System Analysis
 - Analysis of an entirely 42 volt system
 - Modification of electronics modeling
 - » DC/DC converter model
 - » Electronics of dual voltage alternators
- Systems Approach/Trade-off Analysis
 - Analysis of economics of key vehicle loads
 - Analysis of potential cost savings or increases at 42 volts
 - Identification of potential value added of new loads

