

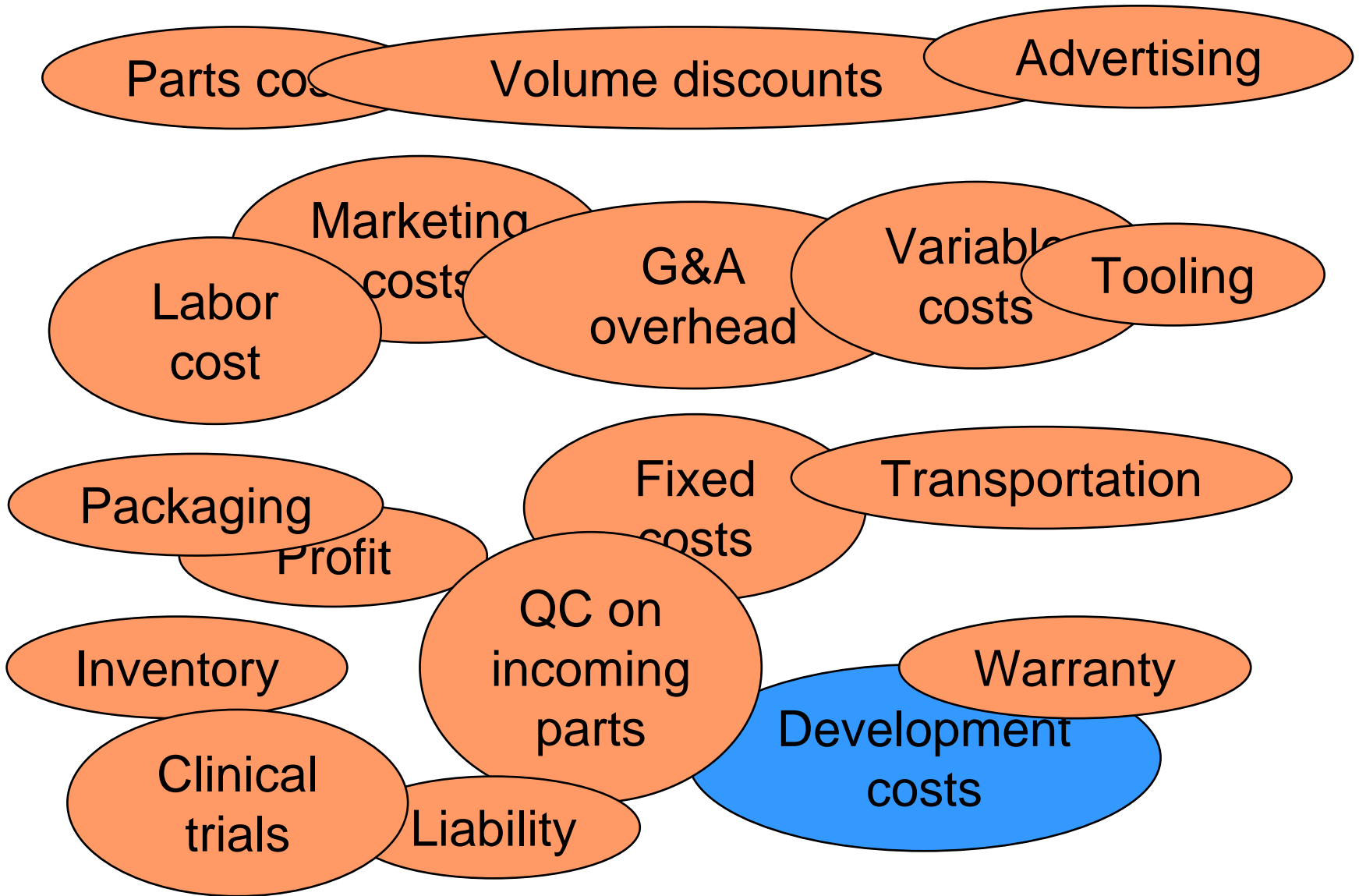
PROJECT/PRODUCT ECONOMICS

- 1. How much will it cost?**
- 2. Will we make \$?**

Ref: Ulrich & Eppinger text: Chap. 11, (Design for Manufacturing), Chap. 15 (Product Development Economics)

Commonly heard in engineering circles

“Gee, the price at Home Depot is \$50 but I can build one for 10 bucks. I should go into business. I’ll make a ton of money!”



A novel, aftermarket product for automobiles

- **Five year lifetime**
- **Saves you 7.5% on gas mileage**
- **DIY market**

At what price should Target sell this product?

Fixing a price

- Estimate value to end users (subtract any switching costs)
- Also look at equivalent products for pricing

What is the “supply chain” for the auto accessory product

(All the organizations which touch it.)

- Raw material provider
- Factory
- Distributor
- Customer

\$0.20

\$0.25

\$0.55

\$1.00

Product cost

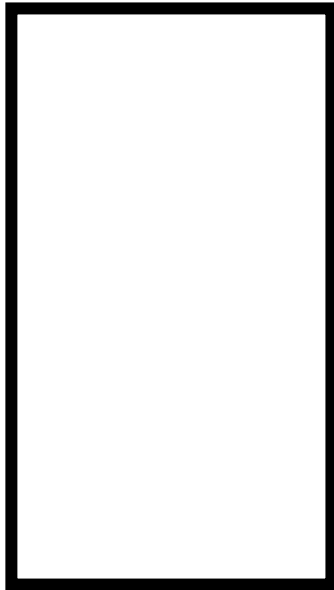
Price \neq Cost !

MANUFACTURING COST

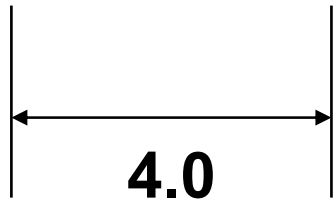


- **Cost estimation is an art**
 - **Several layers of detail, use what's appropriate**
 - **Manufacturing process matters....a lot!**
 - **Volume matters.....a lot!**
 - **Design details matter...a lot**
 - **Everything starts with a good BOM**
 - **Cost of prototype \neq cost of product!**
-
- **See Ulrich and Eppinger DfM Chapter for details**

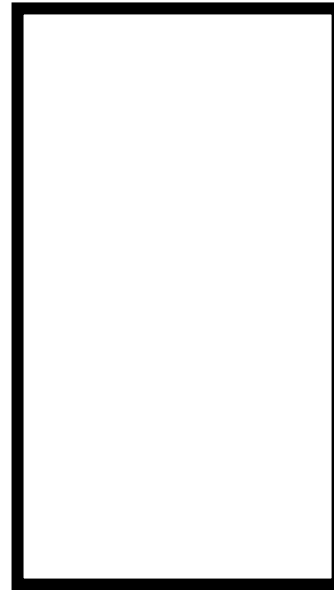
Design detail #1



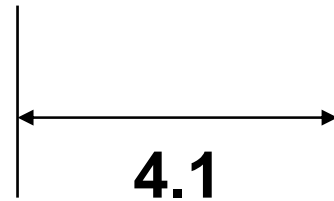
A



4.0



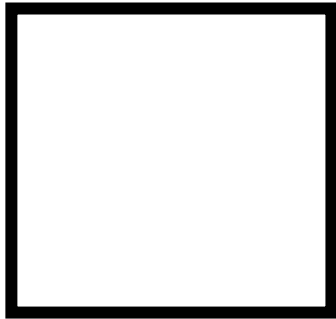
B



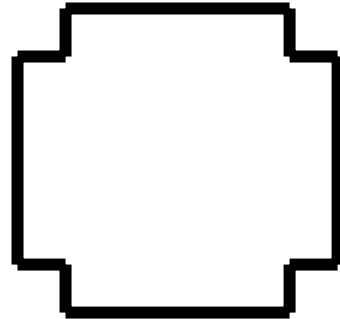
4.1

Design detail #2

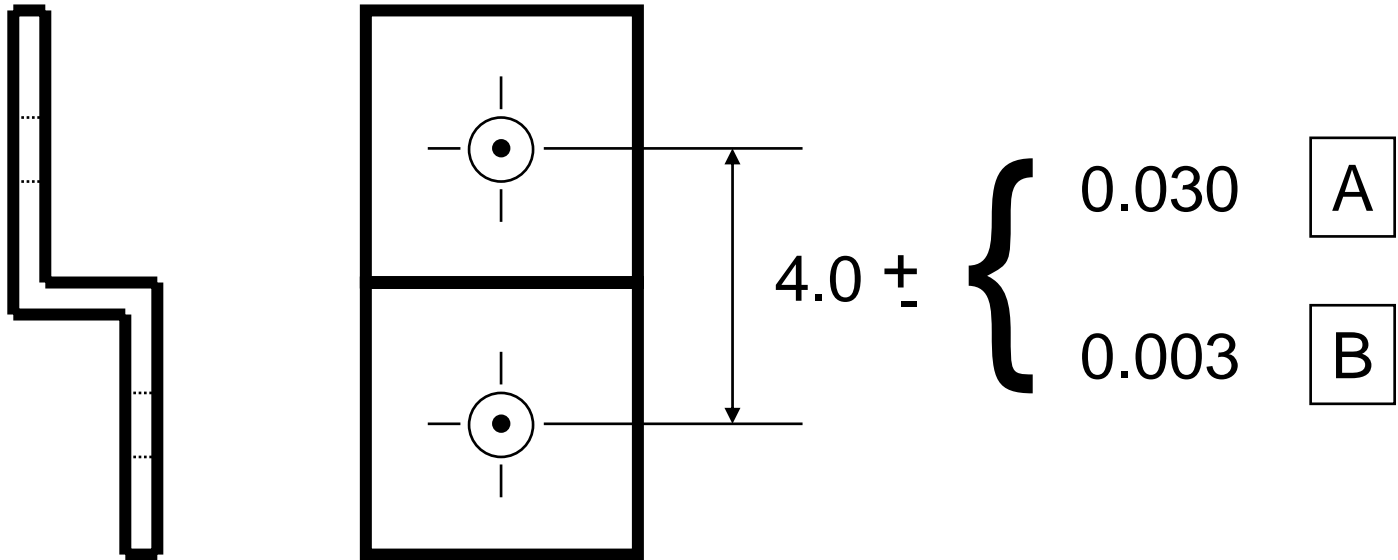
A



B



Design detail #3



Product costs

- **More than parts plus labor**
- **Must account for all costs required to produce product**
- **Product cost models differ for different companies**

$$\boxed{\text{DIRECT}} + \boxed{\text{INDIRECT}} + \boxed{\text{PROFIT}} = \boxed{\text{COST}}$$

- Labor
- Material
- Components
- Tooling

- Design
- Marketing
- Sales
- Accounting
- Purchasing
- Management
- Warranty
- Liability
- Administration

- Match investment

- Supervisors
- Mfg eng
- Factory

- Purchasing
- Inspection

- Mgmt
- Mrktng
- Engng
- Design

$$(\{[(\text{Hours} * \$/\text{hr}) * \text{LbrMul}] + [\text{Materials} * \text{MatMul}]\} * \text{Ovhd}) * \text{Profit} = \text{Factory price}$$

0.55 \$10 2.00 \$9.09 1.10 1.43 1.10

(\$5.50)

[\$11.00]

[\$10.00]

{

\$21.00}

(

\$30.00)

= \$33.00

Distributor

Matl\$ * Ovhd * Profit

\$33.00 * 1.21 * 1.05 = \$42.00

Retail

Matl\$ * Ovhd * Profit

\$42.00 * 1.19 * 1.10 = \$55.00

Real cost of buying the product

Project economics

- **Development cost** **\$5 mill**
- **Ramp-up cost** **\$2 mill**
- **Marketing/support cost** **\$1 mill**
- **Unit mfg cost** **\$400**
- **Unit price (factory)** **\$800**
- **Sales volume (per year)** **20,000**

Development costs

- Information gathering
- Market research, patents, ...
- Lab testing, CAD/simulation/...
- Prototype construction and test

**Prototype cost \neq
Product cost !**

Prototype Costs

- **Bill of Materials**
- **Quantity = 1 pricing**
- **Split out subassemblies**
- **Direct costs, indirect costs**
- **Catalog parts vs fabricated parts**
- **Design/technician labor cost**
- **Overhead costs**

ChopSim Case Study





BILL OF MATERIALS -- CHOPSIM GEN4

Ref	What	Vendor	Vendor PN	Cost	Notes
INTEGRATED CIRCUITS					
U1	Op amp, quad, TLV2374ID, 14 pin, SOIC-14	mouser	595-TLV2374ID	\$ 1.55	
U2,U3	Voltage regulator, +5V, fixed, 1A, TO-263 D2PAK, STM L7805ABD2T-TR	mouser	511-L7805ABD2T-TR	\$ 0.47	
U4	Microcontroller PIC16F690, 20 pin, SOIC-20	mouser	579-PIC16F690-I/SO	\$ 3.14	
U5	8-channel driver, ULN2003AD, SOIC-16, Texas Instruments	mouser	595-ULN2003AD	\$ 0.64	
U6	2x16 serial LCD with backlight	parallax	27977	\$ 29.95	
SEMICONDUCTORS					
D1	Diode, constant current, 2 mA, KSI CIL1302	dytran	6123	\$ 5.00	
D2,D3	Diode, dual 4148, SOT-23, Fairchild MMBD4148SE	mouser	512-MMBD4148SE	\$ 0.06	
D4	Diode, Schottky, SOT-23, Fairchild BAT54	mouser	512-BAT54	\$ 0.05	
D5,D6,D7,D8	LED, super-brite, white, T1-3/4, 3700mcd, 3.5Vf@20mA	jameco	142894PS	\$ 3.89	
PASSIVE COMPONENTS					
R3,R18	Resistor, 100 ohms, 1%, 1/4W, 1206, Vishay CRCW1206100RFKEA	mouser	71-CRCW1206-100-E3	\$ 0.07	
R15,R16,R17	Resistor, 324 ohms, 1%, 1/4W, 1206, Vishay CRCW1206324RFKEA	mouser	71-CRCW1206-324-E3	\$ 0.07	
R2,R4,R14,R19,R20,R21	Resistor, 10K ohms, 1%, 1/4W, 1206, Vishay CRCW120610K0FKEA	mouser	71-CRCW1206-10K-E3	\$ 0.07	
R1,R5,R6,R7,R8,R9,R10,R11,R12,R13	Resistor, 100K ohms, 1%, 1/4W, 1206, Vishay CRCW1206100KFKEA	mouser	71-CRCW1206-100K-E3	\$ 0.07	
C2,C5,C8,C11,C12	Capacitor, ceramic chip, 1206 smd, 50V, 0.1uF, X7R, 10%, Kemet C1206C104K5RACTU	mouser	80-C1206C104K5R	\$ 0.07	
C6,C9	Capacitor, ceramic chip, 1210 smd, 50V, 0.33uF, X7R, 10%, Kemet C1210C334K5RACTU	mouser	80-C1210C334K5R	\$ 0.55	
C1,C4,C7,C10	Capacitor, aluminum electrolytic, surface mount 5x5.8mm, 50V, 10uF, Cornell Dubilier AFK106M50C12T-F	mouser	5985-AFK50V10-F	\$ 0.44	
C3	Capacitor, ceramic chip, 1206 smd, 50V, 0.01uF, X7R, 5%, Kemet C1206C103J5RACTU	mouser	80-C1206C103J5R	\$ 0.15	
OTHER COMPONENTS					
P1	Power supply, regulated, 12V, 1.5A, F 2.1mm cntr pos connector, Meanwell ES18U12-P1J-R	jameco	312865	\$ 14.99	
P2	DC-DC converter, 12V in, +/-12V out, 42 mA, DIP pkg, C&D Technologies NMA1212DC	mouser	580-NMA1212DC	\$ 9.21	
S1	Incremental encoder, mechanical, 15 pulses, with switch, Piher C111-CT-V1Y22-LFACF	mouser	531-C111CTV	\$ 4.00	
SP1	Buzzer, piezo, 5V, 85dB, .36" high x .46" dia.	jameco	76065	\$ 2.99	
	Sensor, accelerometer, 2500 G range, 2 mv/g, 10-32 top connector, 1/4-28 mounting stud	dytran	3200B6	\$ 399.00	
HARDWARE					
J1	BNC panel jack, isolated, Amphenol 112431	jameco	296067	\$ 2.99	
J4	Connector, plug, audio, 3 pos, female, cable mount, Switchcraft A3F	mouser	502-A3F	\$ 5.13	
J5	Connector, plug, audio, 3 pos, male, panel mount, Switchcraft D3M	mouser	502-D3M	\$ 4.51	
J3,J7,J9,J11,J13,J15	Header, .100 centers, right angle, friction lock, 2-pin, Molex 22-05-3021	mouser	538-22-05-3021	\$ 0.36	
J18	Header, .100 centers, right angle, friction lock, 3-pin, Molex 22-05-3031	mouser	538-22-05-3031	\$ 0.44	
J2,J6	Housing, .100 centers, crimp terminal, locking ramp, 2-pin, Molex 22-01-3027	mouser	538-22-01-3027	\$ 0.22	
	Crimp connectors for .100 series, 22-30g, tin, Molex 08-50-0114	mouser	538-08-50-0114	\$ 0.11	
J10,J12,J14,J16	LED cable assembly, for T1-3/4 (5mm), 2-pin header, twist fit, VCC CNX440-E02-4-1-08	mouser	593-CNX440E24108	\$ 2.98	
	LED lens for cable assembly, clear, 8mm hole, VCC CMC441-CTP	mouser	593-CMC441CTP	\$ 0.81	
J18	LCD extension cable, 10 in.	parallax	805-00011	\$ 1.95	
	Socket strip, SIP, breakaway, 20 position, Tyco : 1-1571994-0 (for ICSP connector, not used)	mouser	571-1-1571994-0	\$ 2.28	
	Spacer, 6-32 thread, .250" L (for board mount)	jameco	77534	\$ 0.25	
	Pan head machine screw, 6-32 x .250 (for board mount)	jameco	106543	\$ 0.02	
	Nut, 6-32 (for board mount)	jameco	42420	\$ 0.02	
	Spacer, M/F, M2.5x.45 thread, 9mm L (for LCD mount)	mouser	728-FM1256-2545-A	\$ 0.48	
	Pan head machine screw, M2.5x.45, 5mm L (for LCD mount)	digikee??	H738-ND	\$ 0.06	
	Nut, M2.5x.45 (for LCD mount)	digikee??	H761-ND	\$ 0.04	
	Knob, black, 1/4 in. (6.4 mm) shaft, .5 in. dia, .62 in. high, Eagle 450-6009	mouser	450-6009	\$ 1.82	
	Enclosure, die-cast aluminum, 7.6 X 4.4 x 2.2 in., black, Hammond 1590R1BK	mouser	546-1590R1-BK	\$ 26.94	
	Printed circuit board	expresspcb			
	SMT component storage box, www.engineeringlab.com/engineers.html	engg lab	SE-128	\$ 44.95	
	BNC female-female, isolated, bulkhead feed-thru (at machine)	jameco	148232	\$ 2.49	
	BNC cable, RG59/U, 12 ft	jameco	102373	\$ 5.99	
	Sensor cable, 10-32 coax to BNC, teflon jacket, white, 5 ft	dytran	6011A05	\$ 34.75	
	Sensor mounting block, aluminum bar, 6061-T6, 0.5" x 3" x 3"	online metals	---	\$ 4.39	
	Feed-thru mounting bracket, aluminum angle, 6061-T6, 1.5" x 1.5" x 1/8", 2" length	online metals		\$ 1.66	
	Camera tripod				
	Hammer, dead blow, sledge, 8 lb	snapon.com	BC110B	\$ 167.10	

Prototype BOM

As a team, create a BOM table for the prototype you will have at the Design Show. Part, source, cost. Include fabricated and purchased components. Make guesstimates where appropriate. Create in Excel, upload to Google site.