Drypress Part Cost Estimation Spreadsheet
Guide To Use

Concept

This model is based upon a detailed analysis of the methods and costs of producing ceramic components for automobile engines, prepared over many years by teams from the MIT Materials Systems Laboratory, under sponsorship of major automobile companies and materials processors in North America and Europe. It has proved to be a highly realistic cost model, and has been used as a basis for numerous practical decisions.

The model basically chains together the elements of the manufacturing process (see below) with a realistic assessment of the capital and operating costs of each stage. These data have been validated through numerous discussions and analyses in the industry. They can also be changed to reflect local circumstances and new developments.

For the purposes of the case, most of the model has been masked (i.e., made inaccessible to the user). This has been done to focus discussion on the key educational aspects of the case. The model should be taken as a general example of the kind of cost model of a technological process that good managers of technology should have available. Some versions of the model made available for this case should be accessible to any strategic analyst. The technology has been hidden: nevertheless, given some basic assumptions and decision variables, the model will generate realistic cost estimates.

Model

The spreadsheet file DRYPRESS.WK1 is based upon a detailed model of one of the most well-established ceramics processes, dry pressing. The process is composed of several operations, listed below:

Materials Preparation	As the name suggests, the materials employed in the production in the production of ceramic components require some pretreatment before they are actually used to make a part. These preparation steps usually include mixing the powder with a binder material of some kind, so that the ceramic material will retain its shape after it is formed. (Consider, for example, making bricks. If you were simply to press clay powder into the shape of bricks, they would fall apart as soon as they were formed. By mixing water with the clay, it retains its shape after forming.)
Spray Drying	When making some parts, this step is also required to control the amount of binder in the ceramic. For the purposes of this case, this step is not used.

Isopressing The actual forming of the ceramic into the part shape is called isopressing. Essentially, this is a press forming operation where ceramic powder is placed in a cavity and pressure is applied, yielding a so-called "green" part. While the part can hold its shape, it is very weak and delicate, hence the name.

Green Machining When high precision is required, the green part is machined to establish correct dimensions. In particular, since the green part will shrink as it dries (the next step), green machining is done to "tailor" the way in which this shrinkage takes place.

Drying While the binder holds the ceramic powder together after isopressing takes place, removal of the binder has to be done carefully to avoid damaging the part. Once the green machining step is completed, a greater delicacy of the part is acceptable, so drying is undertaken to remove as much binder as possible. If too much binder remains in the green part when it is fired (which takes place at high temperatures), the vapor pressure of the binder might be high enough to generate significant flaws in the part.

Firing During firing, the green part is subjected to elevated temperatures to sinter the ceramic powder, forming a strong part.

Finishing Because the part shrinks during firing, some final machining is required to achieve the necessary dimensional tolerances. Unfortunately, the ceramic part at this point is difficult to machine, so this can be a very expensive step in the manufacturing process.

Inspection Finally, the parts must be inspected. There are a wide range of non-destructive tests that can be employed to verify the performance of the manufactured parts. Unfortunately, parts which fail to pass inspection must be discarded; the ceramic material cannot be economically recovered from a fired ceramic part.

All of this complexity has been captured and modeled in the spreadsheet DRYPRESS.WK1. However, to spare the users of this model, the model has been tailored to treat the case of drypressed ceramic engine components. The complete set of inputs has been masked, as have the inner workings of the model. Instead, the user is presented with a simplified set of required inputs, and a detailed cost report. Pressing the {HOME} key on your keyboard will take you to the upper left hand corner of the spreadsheet, where you will find the inputs. These inputs are presented in Figure 1.

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|	Drypressing Cost Model			
|				
|	Modified for Use in Engineering Systems Analysis Case Study			
|	By FRField, 1991			
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NOTE:	The parameters upon which we want you to focus your efforts			
	are presented below. You will find that there are a large number			
	of parameters in this model, but most of them are outside of			
	scope of this case study.			
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INPUTS				
	Total Plant Capacity	5,000,000	parts/year	
	Annual Part Production	5,000,000	parts/year	
	Operating Days/Year	230	days	
	Part Material	0	(0-Al2O3;1-Si3N4)	
	Current Material Price	$8.00	$/lb	
	Material Price Override	$0.00	$/lb (0-no o.ride)	
	Part Weight	0.018	lbs	
	Number of Shifts	2		
	Part MTBF (relative to steel)	0.80	(1 = steel)	
	Years To Recover Investment	10	years	
	Opportunity Cost of Capital	12.0%	/year	
	Dedicated/Non-Dedicated Production	0	(0-ded;1-not ded)	
	Cost of Labor	$22.00	$/hr incl benefits	
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Figure 1: Input areas for DRYPRESS Spreadsheet are the shaded areas in the figure

The meaning of each of the items in the figure is summarized below:

Total Plant Capacity

(INPUT) This value dictates the amount of capital equipment, physical plant, etc. that will be purchased to set up the facility. Expressed in total number of parts produced per year, this value represents a physical upper limit to the number of parts that can be produced annually. An increase in Plant Capacity must be accompanied by an increase in capital expenditures. Essentially, this term defines the size of the plant being modeled.

Annual Part Production

(INPUT) This value dictates the total number of parts that are actually produced in the current year. This value can be less than or equal to the

Total Plant Capacity; it can never be greater. Inputting a value greater than Total Plant Capacity will result in an error.

Operating Days/Year

(INPUT) As this states, this is the number of days per year that your plant will operate. Typical figures from around the world are: US - 240 days/yr; Netherlands - 180 days/yr; Korea - 320 days/yr.

Part Material

(INPUT) You are restricted to two possible materials. A '0' in this cell means that you want to use alumina; a '1' (or any value other than '0') means that you want to use silicon nitride.

Current Material Price

(RESULT) This is NOT an input cell; it merely reports the current price of the material chosen in the above cell.

Material Price Override

(INPUT) If this value is anything other than 0, it will be used as the current material price, and will override the values built into the spreadsheet.

Part Weight

(INPUT) Obviously, you must supply the weight of the part you are making in this cell, in pounds.

Number of Shifts

(INPUT) This value is the number of 8 hour shifts that the facility will operate during the day. You should set this value once and not change it again. 2 shift operations are an upper limit; a great deal of maintenance work is required to keep the machines operating (remember, you are basically processing dirt!).

Part MTBF (relative to steel)

(INPUT) This is a characteristic of the part that you can set here. Basically, the model assumes that you will "inspect in" part reliability; as the target MTBF increases, the number of parts per 100 which fail to pass inspection will increase according to the equation: $N/100 = 3 + 200 (MTBF - 0.8)0.7$

Years To Recover Investment	(INPUT) This is an accounting assumption. The model amortizes capital costs over this time period, and distributes these costs annually onto the number of parts produced. This cost is justified on the basis of the opportunity cost of capital, suggesting that if this capital cost is not recovered, then you should have invested the money you spent elsewhere.
Opportunity Cost of Capital	(INPUT) This is the interest rate used in the above-described amortization calculation.
Dedicated/ Non-Dedicated	(INPUT) If a '0' is in this cell, all capital costs are distributed over the annual part production; if a '1' (or any value other than '0') is put in this cell, only the fraction of the total capital costs actually required to manufacture the annual part production is charged to the part cost. In general, this cell should always contain a '0', unless you are prepared to make a strong demonstration of what else the plant will be producing to bear the rest of these capital costs.
Cost of Labor	(INPUT) This is the total cost of labor, including overhead and benefits.

Once you have input these values, the model will calculate the costs of producing the part using the scenario outlined in your inputs. Paging down from the input area (achieved by pressing the {PgDn} key, the cost model outputs appear. These outputs are shown in Figures 2 and 3.

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MODEL OUTPUTS				
CAPITAL				
	Materials Preparation	$50,364		
	Spray Drying	$0		
	Isopressing	$123,500		
	Green Machining	$283,152		
	Drying	$52,780		
	Firing	$342,820		
	Finishing	$625,564		
	Inspection	$82,174		
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	Total Cost of Facilities	$1,560,355		
YIELDS	Materials Preparation	99.0%		
	Spray Drying	100.0%		
	Isopressing	98.0%		
	Green Machining	89.0%		
	Drying	100.0%		
	Firing	100.0%		
	Finishing	99.0%		
	Inspection	97.0%		
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	Total Yield	82.9%		

Figure 2: Outputs from Drypress Cost Model - Plant Capital Costs and Process Yields

The first half of these outputs (presented in Figure 2) gives two sets of supplemental information. The first of these is a summary of the capital costs of setting up each of the processing steps, and the sum of these capital costs. The second table gives the effective yield of each processing step, and the total effective yield of the manufacturing process.

COSTS BY OPERATION	$/piece	% of total
Material	$0.1748	39.7%
Spray Drying	$0.0000	0.0%
Isopress	$0.0296	6.7%
Green Mach	$0.0342	7.7%
Drying	$0.0028	0.6%
Firing	$0.0342	7.8%
Finishing	$0.1440	32.7%
Inspection	$0.0212	4.8%
Total Cost	$0.4408	100.0%

COSTS BY FACTORS		
Materials	$0.2282	51.8%
Energy	$0.0062	1.4%
Labor	$0.1229	27.9%
Capital	$0.0571	12.9%
Other	$0.0264	6.0%
Total Cost	$0.4408	100.0%

Figure 3: Outputs from Drypress Cost Model - Cost Breakdowns

The second set of outputs (Figure 3) are two different breakdowns of manufactured part cost; the first table presents the cost of each process step, the second breaks down cost by factors of production (i.e., materials, labor, energy, etc.).