DROP ON DRUM VISION SYSTEM

PRODUCT DESIGN SPECIFICATIONS REPORT - WINTER 2007

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Project Background

Color printers have become common in homes and businesses across the globe due to advancement in technologies that allow for lower up-front and per-page costs for the consumer. Lower costs, however, do not mean lower quality. The opposite is in fact true, especially when considering the solid-ink technology of the Xerox Corporation. Solid-ink technology produces brilliant, vibrant prints on a wide range of media while being easy on the environment with 95% less waste than a typical color laser printer.

The printing occurs on what is actually a simple, robust, and reliable printing mechanism. One major benefit of the technology and why crisp images are produced is because the spreading of liquid ink-jets or the scattering of laser is eliminated form the process. A simple description of how the process occurs is the following[1]:

1. Assuming the printer is stocked with the ink and a signal is received by the printer for the image, a long-life maintenance roller quickly applies a microscopic layer of silicon oil to the heated drum for ink release, Figure 1.

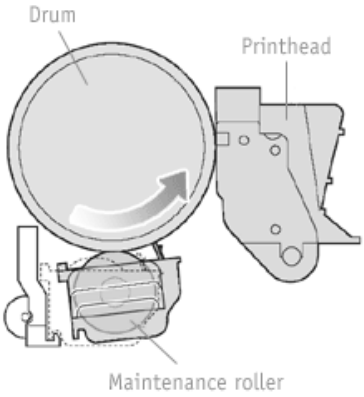
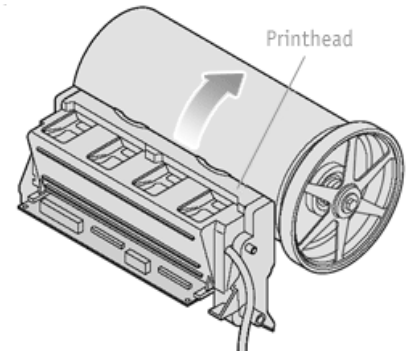


Figure 1



2. The print head then applies all of the colors to a rotating drum at the same time, Figure 2. This step enables higher speeds and eliminates the misregistration that can occur when colors are applied separately.

[1] Images and summarized process steps are taken from <http://www.office.xerox.com>

Figure 2

3. Image transfer occurs when the sheet of paper is fed between the drum and a transfix roller, Figure 3.

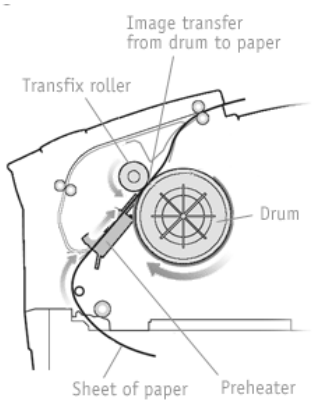


Figure 3

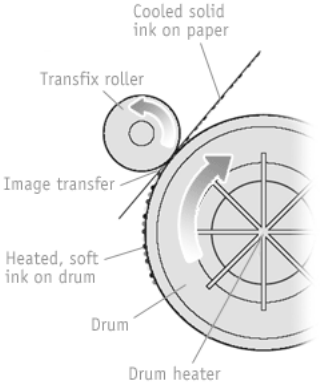


Figure 4

4. The ink is then bonded to the paper because the ink penetrates the fibers then cools and solidifies immediately, Figure 4. This results in a strong, permanent bond of the ink onto the paper.

To maintain the highest quality Xerox continually studies, evaluates, and explores options to its current printers. In order for these further improvements to be made more information needs to be gathered about the characteristics of the individual drops of ink. A way to gather this information is to obtain digital images of the individual drops of ink while they are still on the drum surface and compare them to the same location on the piece of paper after the printing process. Due to the complexity of removing the drum from the printer, it is advantageous to produce a system that is capable of capturing images of the drops on the drum while the drum is still in the printer. Then after the ink transfer, capture images of the ink on the paper at identical locations.

Current systems used for imaging fail to meet the requirements of Xerox. One current system is clumsy to use, contains excessive vibration when in use, and the optical system fails to meet the desired image quality, figure 5.

Another system is clumsy to use because it is not fixed and repeatability of image location is hard to achieve, figure 6. There is no imaging system specific to the paper for comparing the drum images to paper images.

Figure 5: Current DODVS in use at PSU

Figure 6: Current DODVS in use at Xerox

Because of these shortcomings there is a need by Xerox for newly designed imaging systems for the printer drum and paper so their research can continue to improve their solid-ink printers.

Purpose of the Product Design Specification (PDS) Document

The purpose of the PDS document is to provide a comprehensible definition of design criteria, metrics, targets, priorities and customer needs. A list of typical criteria considered for this PDS is provided in Appendix A. The PDS document will also be referred back to throughout the project to ensure targets are on track and conflicts with customer requirements are avoided.

Mission Statement

The design team will design and manufacture a new Drop on Drum Visual System (DODVS) and Bench Top Microscope (BTM) that meet the requirements of Xerox for their research. The items that will be delivered include completed assemblies, detail drawings, bill of materials, and a detailed report of the design process and analysis. Upon completion of the assemblies testing will be performed to compare the new imaging systems to the available current systems in use. The design is intended for research and development by Xerox and the final quality of the imaging systems will be determined by the users of the current systems.

Project Plan

In order to meet the June 2007 delivery date, the tasks and the associated dates that have been established in a Project Gantt chart, figure 7, will be followed with updates and modifications as needed. Important milestones include but are not limited to:

- The ME492 class requirements of the PDS report and presentation, external and internal search presentation end of term progress report and presentation.
- The design process of the DODVS and BTM milestones are:
    - A thorough vibration analysis performed using hand calculations along with an ANSYS or similar analysis of design concepts.
    - Design review with Industry Sponsor for approval of design
    - Prototyping
    - Testing
    - Any necessary rework
    - Final delivery

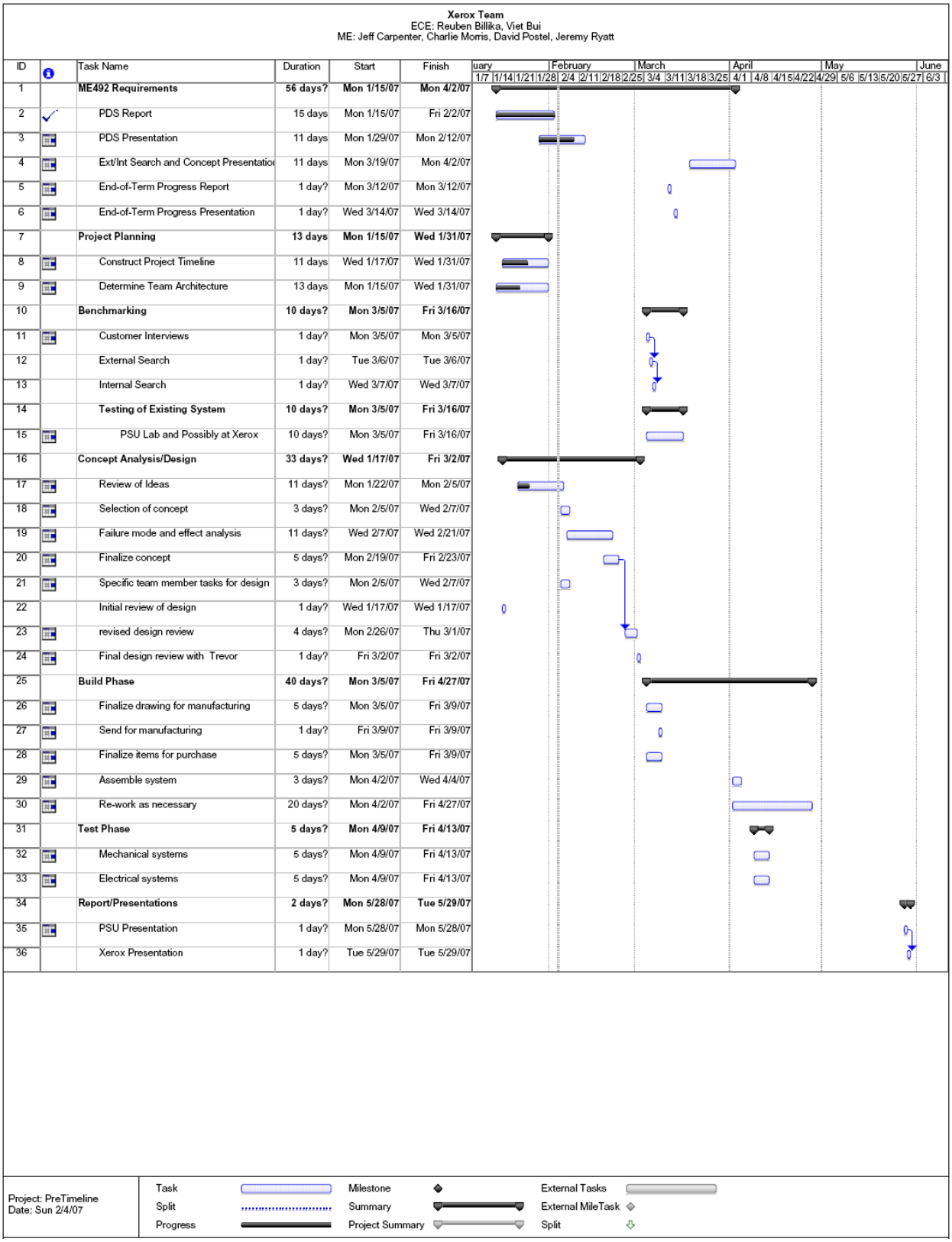


Figure 7: Gantt Chart

Customer Identification

The primary external customer for the DODVS and BTM is the Solid-Ink Printer design and research team at the Xerox facilities in Wilsonville, Oregon. The DODVS and BTM will also be used for research at Portland State University so the operators of the devices will be considered secondary external customers.

The goal of this project must also satisfy the University and this course in particular; therefore, we have established ME492/493 as our primary internal customer and our faculty advisor, Dr. Mark Weislogel, as our secondary internal customer.

The prototype, machine shop at Xerox is also considered a customer because through an agreement with our industry sponsor they will machine many of our required components. Because of this the drawings produced and material call-outs must meet their requirements.

Customer Interview and Feedback Summary

The initial interview with our customer was held during the fall 2006 term. We met with our industry contact, Trevor Snyder, to discuss the functionality and operational flaws of the existing DODVS and BTM. A second meeting was held on January 12, 2007 at the Xerox facilities, while at Xerox we were given a tour of the engineering department, manufacturing areas and research departments. We were also shown other systems similar to the DODVS that were functionally different put provided an example for how the DODVS should be design and constructed. We also viewed the prototype shop where many of our components will be made and we were provided a list of basic materials that are readily available in the shop.

Product Design Specification

~ PERFORMANCE ~						
Requirements	**Primary Customer**	**Metrics & Targets**	**Metric**	**Target**	**Target Basis**	**Verification**
Image Quality	Xerox	Viewing area	inches	1/600 in^2	Customer Defined	Prototyping
Vibration resistance	Xerox	Time of oscillation	seconds	0-1 second	Customer Defined	Prototyping
Table speed (BTM)	Xerox	Table traverse speed	in/min	> 1/3 in/min	Group Decision	Prototyping
Position Locating	Xerox/Operator	Position of printer vs DODVS	inches	0-1/64 in	Customer Defined	Prototyping
Adjustability	Xerox	Adjusting Z-location of camera	inches	1/64 in	Group/Customer	Prototyping
Reliability	Xerox/ Operator	Time until part failure	Years	5 yrs	Customer Defined	Prototyping

~ SAFETY ~						
Requirements	**Primary Customer**	**Metrics & Targets**	**Metric**	**Target**	**Target Basis**	**Verification**
Finger Guard	Xerox Legal Department	Guard fingers from moving platform	N/A	Shroud	Group Decision	Prototyping

~ ENVIRONMENT and ERGONOMICS~						
Requirements	**Primary Customer**	**Metrics & Targets**	**Metric**	**Target**	**Target Basis**	**Verification**
Withstand operation in a Lab environment	Xerox	Needs to withstand constant adjustment	Years	5 Years	Customer Defined	Time will tell
Sit side-by-side on a table	Xerox/Operator	Minimal distance between units	feet	< 1 foot	Customer Defined	Set-up
Aesthetics	Operator	Clean, Streamlined look and feel	N/A	N/A	Group Decision	Post interview
Portability	Xerox/Operator	Weight	Pounds	< 75 lbs/piece	Group Decision	Prototyping

~ MAINTENANCE and PARTS ~						
Requirements	**Primary Customer**	**Metrics & Targets**	**Metric**	**Target**	**Target Basis**	**Verification**
Part Replacement	Xerox/ Operator	Off-the-shelf parts	N/A	Readily available	Group Decision	Market research
Fasteners	Operator	Assembled using standard parts	Inches	Standard Tools	Group Decision	Prototyping
Manufactured Parts	Xerox Prototype Shop	Standard Materials	N/A	In stock material	Group Decision	Stock List, Appendix B

~ INSTALLATION ~						
Requirements	**Primary Customer**	**Metrics & Targets**	**Metric**	**Target**	**Target Basis**	**Verification**
Withstand occasional relocation	Xerox/Operator	Can be disassambled and assembled by one person	Minutes	45 minutes	Customer Defined	Experiment
Electricy source	Operator	Outlet	VAC	120 VAC	Group Decision	Prototyping
Level of table	Xerox/Operator	Level	degrees	±0.25°	Group Decision	Prototyping

~ COST ~						
Requirements	**Primary Customer**	**Metrics & Targets**	**Metric**	**Target**	**Target Basis**	**Verification**
Low production cost	Xerox	Cost	Dollars	< $5,000.00	Customer Defined	BOM/Invoices

House of Quality

								Competition	
	Importance	**Pertainee**	**Mass**	**Geometry**	**Vibration Resistance**	**Magnification**	**Cost**	George Fox	Image Xpert
Performance	10	Xerox							
Image Quality	4	Xerox	5	3	5	5	5	3	5
Vibration resistance	3.5	Xerox	5	5	5	NA	2	1	5
Table speed (BTM)	0.5	Xerox	2	3	2	NA	4	NA	NA
Position Locating	1	Xerox	2	3	2	NA	3	2	1
Adjustability	1	Xerox	NA	4	1	NA	3	2	2
Safety	3	Xerox/Operator	4	3	NA	NA	NA	4	4
Environment	2	Operator	NA	NA	NA	NA	NA	5	5
Maintenance	4	Operator	NA	NA	NA	NA	NA	3	4
Installation	4	Operator	5	5	NA	NA	NA	4	3
Cost	7	Xerox	NA	NA	4	5	5	1	1

Competition								
							DODVS	BTM
Image Xpert			75 lbs	NA	Good	7.0 X	$5,000.00	$3,875.00
George Fox Univ			25 lbs	NA	Poor	5.25 X	$7,500.00	
Team Xerox			< 75 lbs /unit	NA	Good	10 X	$5,000.00	
Verification Method			Weigh	NA	Test	Test	BOM/Invoices	

Conclusions

This document has provided a summary of design requirements provided by Xerox for a Drop on Drum Vision System and Bench Top Microscope to aid in their studies of ink transfer in solid-ink printers. The PDS will be referred to during the entire process of the design because it will assist in keeping on target with the goals of Xerox.

Meeting all the design goals for the DODVS and BTM will not only be challenging but highly rewarding. Although the end result of the project will not be for consumer consumption or be used in competition it will provide a tool that will be utilized by students and researchers alike for advanced studies to better understand the physics of the ink transfer process in Xerox's solid-ink printers.

Appendix A – PDS Criteria List

Criteria	Applicable	Not Applicable
Performance	X	
Environment	X	
Life in service	X/ Performance	
Quantity		X
Cost of production per part (material and labor)	X	
Size, Shape and Weight	X/ Environment and Ergonomics	
Maintenance	X	
Installation	X	
Ergonomics	X	
Safety	X	
Materials	X/ Maintenance and Parts	
Manufacturing facilities	X/ Maintenance and Parts	
Shipping		X
Packaging		X
Aesthetics	X/ Environment and Ergonomics	
Quality and Reliability	X/ Performance	
Applicable codes and standards		X
Testing	X/ Performance	
Company constraints and procedures		X
Documentation		X
Legal (Related patents)		X
Competition products	X/ House of Quality	
Timelines	X/ Project Plan	
Disposal		X

Appendix B – Standard Materials Available at Xerox Prototype Shop

ID	Category	Material	Type	Ga.	Dec.	Description	Auto	Avail
132	SLS w/Glass	SLS w/Glass	Resin Glass Filled			Selective Laser Sintering -- 20% glass for greater temp modulus	assign	☑
131	SLS	SLS	Resin			Selective Laser Sintering -- Nylon Part -- Grainy Surface finish	assign	☑
61	SLA	Plastic	Resin			Stereolithographic generated part	assign	☑
168	Sheet Metal	(Specify in Job Desc)	(supplied)			Supply your own material to the shop	checkin	☑
10	Sheet Metal	Aluminum	5052		.025		checkin	☑
1	Sheet Metal	Aluminum	5052		.040		checkin	☑
13	Sheet Metal	Aluminum	5052		.050		checkin	☑
12	Sheet Metal	Aluminum	5052		.063		checkin	☑
15	Sheet Metal	Aluminum	5052		.080		checkin	☑
17	Sheet Metal	Aluminum	5052		.090		checkin	☑
16	Sheet Metal	Aluminum	5052		.100		checkin	☑
14	Sheet Metal	Aluminum	5052		.125		checkin	☑
21	Sheet Metal	Circuit Board	CB		.062	Use for dummy circuit boards	checkin	☑
22	Sheet Metal	Plastic	Acrylic (sm)			Specify color and thickness in Job Desc.	checkin	☑
2	Sheet Metal	Polycarbonate	Polycarb (sm)			Bendable, does not break as easy, use for shieldings	checkin	☑
57	Sheet Metal	Stainless Steel	304			Specify thickness and hardness in Job Desc.	checkin	☑
28	Sheet Metal	Stainless Steel	304 Annealed	11	.125		checkin	☑
18	Sheet Metal	Stainless Steel	304 Annealed	12	.105		checkin	☑
42	Sheet Metal	Stainless Steel	304 Annealed	14	.074		checkin	☑
19	Sheet Metal	Stainless Steel	304 Annealed	16	.060		checkin	☑
25	Sheet Metal	Stainless Steel	304 Annealed	18	.048		checkin	☑
26	Sheet Metal	Stainless Steel	304 Annealed	20	.036		checkin	☑
27	Sheet Metal	Stainless Steel	304 Annealed	22	.030		checkin	☑
58	Sheet Metal	Stainless Steel	305			*NO LONGER AVAILABLE. DO NOT USE!	checkin	☑
65	Sheet Metal	Steel	Cold Rolled	10	.135	Rusts faster than EG, least expensive	checkin	☑
5	Sheet Metal	Steel	Cold Rolled	11	.120	Rusts faster than EG, least expensive	checkin	☑
34	Sheet Metal	Steel	Cold Rolled	12	.105	Rusts faster than EG, least expensive	checkin	☑
38	Sheet Metal	Steel	Cold Rolled	13	.090	Rusts faster than EG, least expensive	checkin	☑
66	Sheet Metal	Steel	Cold Rolled	14	.075	Rusts faster than EG, least expensive	checkin	☑
20	Sheet Metal	Steel	Cold Rolled	16	.060	Rusts faster than EG, least expensive	checkin	☑
35	Sheet Metal	Steel	Cold Rolled	18	.048	Rusts faster than EG, least expensive	checkin	☑
36	Sheet Metal	Steel	Cold Rolled	20	.036	Rusts faster than EG, least expensive	checkin	☑
37	Sheet Metal	Steel	Cold Rolled	22	.030	Rusts faster than EG, least expensive	checkin	☑
39	Sheet Metal	Steel	Cold Rolled	24	.024	Rusts faster than EG, least expensive	checkin	☑
40	Sheet Metal	Steel	Cold Rolled	26	.018	Rusts faster than EG, least expensive	checkin	☑
30	Sheet Metal	Steel	EG	12	.104	Electro galvanized, G-90 coating, chemical treat, no oil	checkin	☑
24	Sheet Metal	Steel	EG	14	.075	Electro galvanized, G-90 coating, chemical treat, no oil	checkin	☑

ID	Category	Material	Type	Ga.	Dec.	Description	Auto	Avail
23	Sheet Metal	Steel	EG	16	.060	Electro galvanized, G-90 coating, chemical treat, no oil	checkin	☑
31	Sheet Metal	Steel	EG	18	.047	Electro galvanized, G-90 coating, chemical treat, no oil	checkin	☑
32	Sheet Metal	Steel	EG	20	.036	Electro galvanized, G-90 coating, chemical treat, no oil	checkin	☑
33	Sheet Metal	Steel	EG	22	.030	Electro galvanized, G-90 coating, chemical treat, no oil	checkin	☑
41	Sheet Metal	Steel	EG	25	.020	Electro galvanized, G-90 coating, chemical treat, no oil	checkin	☑
389	Rapid Prototype	No Cust Preference	Resin			Choose this for mock-ups and fit check parts	assign	☑
147	Rapid Mold	REN 2000 Epoxy	Resin			Complex Rapid Tool built from SLA master	assign	☑
288	Mold	Aluminum	Tool			Aluminum soft tool -- quicker build time -- 500-1000 parts	assign	☑
62	Mold	Steel	Tool			Steel mold for plastic parts	assign	☑
167	Machined	(Specify in Job Desc)	(supplied)			Supply your own material to the shop		☑
43	Machined	Aluminum	6061			Good all around use, welds and anodizes well		☑
4	Machined	Aluminum	7075			Strongest, most expensive, very machinable, not weldable		☑
53	Machined	Aluminum	Cast Tooling Plate			Very stable, flat, cannot anodize, machines poorly		☑
127	Machined	Aluminum	Machinist Choice			Any old aluminum will do		☑
56	Machined	CRS	1018			Free machining steel bar & plate, low cost		☑
3	Machined	CRS	12L14crs			Free machining round stock		☑
45	Machined	Phenolic	Linen Board			Good heat resistance, stable, not recommended unless conditions warrant		☑
9	Machined	Plastic	ABS			Glueable, easy to machine, natural color recommended		☑
51	Machined	Plastic	Acrylic			Brittle, cannot shear; but machines and glues well		☑
7	Machined	Plastic	Delrin-(Acetal)			Easy fab, good wear surface, cannot glue, specify black or white		☑
130	Machined	Plastic	Machinist Choice			Any old plastic will do		☑
44	Machined	Plastic	Nylon			Hard to deburr, tough and resilient, absorbs water, not glue well		☑
46	Machined	Plastic	Polycarbonate			Tough, glues well, not as machinable as ABS or Deldrin		☑
52	Machined	Plastic	Teflon			Light, good for bearing surfaces, easy to deform, high heat resistance		☑
47	Machined	Plastic	Ultem			High heat resistance, glueable, very expensive		☑
48	Machined	Stainless Steel	303			PREFERRED for machining, non-magnetic		☑
6	Machined	Stainless Steel	304			Difficult to machine, not recommended for part designs		☑
49	Machined	Stainless Steel	316			Higher chemical resistance, use 303 when possible		☑
50	Machined	Stainless Steel	416			Magnetic, heat treatable to 39rc, machines well		☑
128	Machined	Stainless Steel	Machinist Choice			Any old Stainless will do		☑
55	Machined	Steel	Low Carbon Steel			Flat ground stock, used for fine surfaces, free machining, stress relief		☑
54	Machined	Steel	O-1			Oil hardening tool steel, hardness range: 63-65 rc		☑
348	FDM PPSF	PPSF	Polyphenelene Sulphi			High Heat material -- use with thick section parts without much intricate detail	assign	☑
268	FDM Polycarb	Polycarbonate	Polycarbonate			Expect longer leadtimes -- process is slightly less accurate than ABS	assign	☑
88	FDM	Printed ABS	ABS			Good for quick funtional prototypes 70% the strength of molded ABS	assign	☑
63	Existing Mold	Plastic	Specify plastic			Use for molding additional parts from existing mold	assign	☑
289	Cast Urethane Par	(Specify in Job Desc)	Specify plastic			Use for special applications such as rubber	assign	☑
311	Cast Urethane Par	AFP-3008	Resin			Solid Concepts material -- higher heat applications	assign	☑
308	Cast Urethane Par	AFP-3100	Resin			Solid Concepts material - PC/ABS-like properties	assign	☑
251	Cast Urethane Par	PDG-80D	Resin			Standard Material without Glass	assign	☑
254	Cast Urethane Par	PDG-80D-GF20	20% Glass-filled			Higher Heat Deflection Values but more brittle	assign	☑
449	Cast Urethane Par	U0080DBR w/20% Glass	Resin Glass Filled			Solid Concepts material -- Very stiff and stable	assign	☑