Ceramic Composite Printing

Team 19
Restated Project Definition
Scope/Project Plan

Team Members

Ernest Etienne - ME

Cody Evans - IE

Sonya Peterson - ME

Basak Simal - ME

Daphne Solis - IE

Sam Yang - ME

Advisors
Dr. Wei Guo, FSU
Dr. Yong Huang, UF

Project Sponsor
Dr. Cheryl Xu

Instructors
Dr. James Dobbs
Dr. Nikhil Gupta
Dr. Okenwa Okoli
Dr. Chiang Shih

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Table of Contents

Project Scope

The project scope is to develop a novel application of commercially available 3D printing technology. A liquid polymer precursor, will be mixed with Carbon Nanotubes (CNT) to form a chemical slurry, serving as the printing material of the repurposed 3D printer. This slurry will be cured after a single layer of printing with the use of ultraviolet spectrum LEDs. CNTs within the slurry will be aligned to some extent, using the methods of magnetic field alignment or electrophoresis. This product will be providing a prototype-level product that will act as progress towards strengthening the transformation method of the polymer from its liquid state to its solid state. The printer will be performing this transformation in the lab.

Background

Team 19's project is sponsored by Dr. Cheryl Xu. The sponsor has requested that at the end of the spring semester a 3D printer will be able to deposit a liquid slurry reinforced with CNTs, and that this slurry will be cured and the CNTs aligned once deposited on the print stage. The material that the printer will use to create solid parts is a liquid polymer precursor that after being cured by UV light solidifies into a translucent material with similar properties to epoxies and other thermosetting resins. After the material is cured, it can be subjected to pyrolysis whereby the polymer structure is converted to a ceramic material composed mainly of silicon carbide (SiC). It is to this precursor that the CNTs will be added, in order to achieve the performance desired by the customer. Adding CNTs to the polymer should significantly alter its mechanical properties such as strength, electrical conductivity, and thermal conductivity. Team 19 will be retrofitting a Fused Deposition Modeling (FDM) format 3D printer. Extensive modifications will be made to the printer: the FDM extrusion head will be replaced with a syringe pump, and the curing process will be accomplished by the aforementioned LEDs an array. These components will be controlled by the printer motherboard in tandem with a slaved Arduino microcontroller board.

Goals & Objectives for Spring 2015

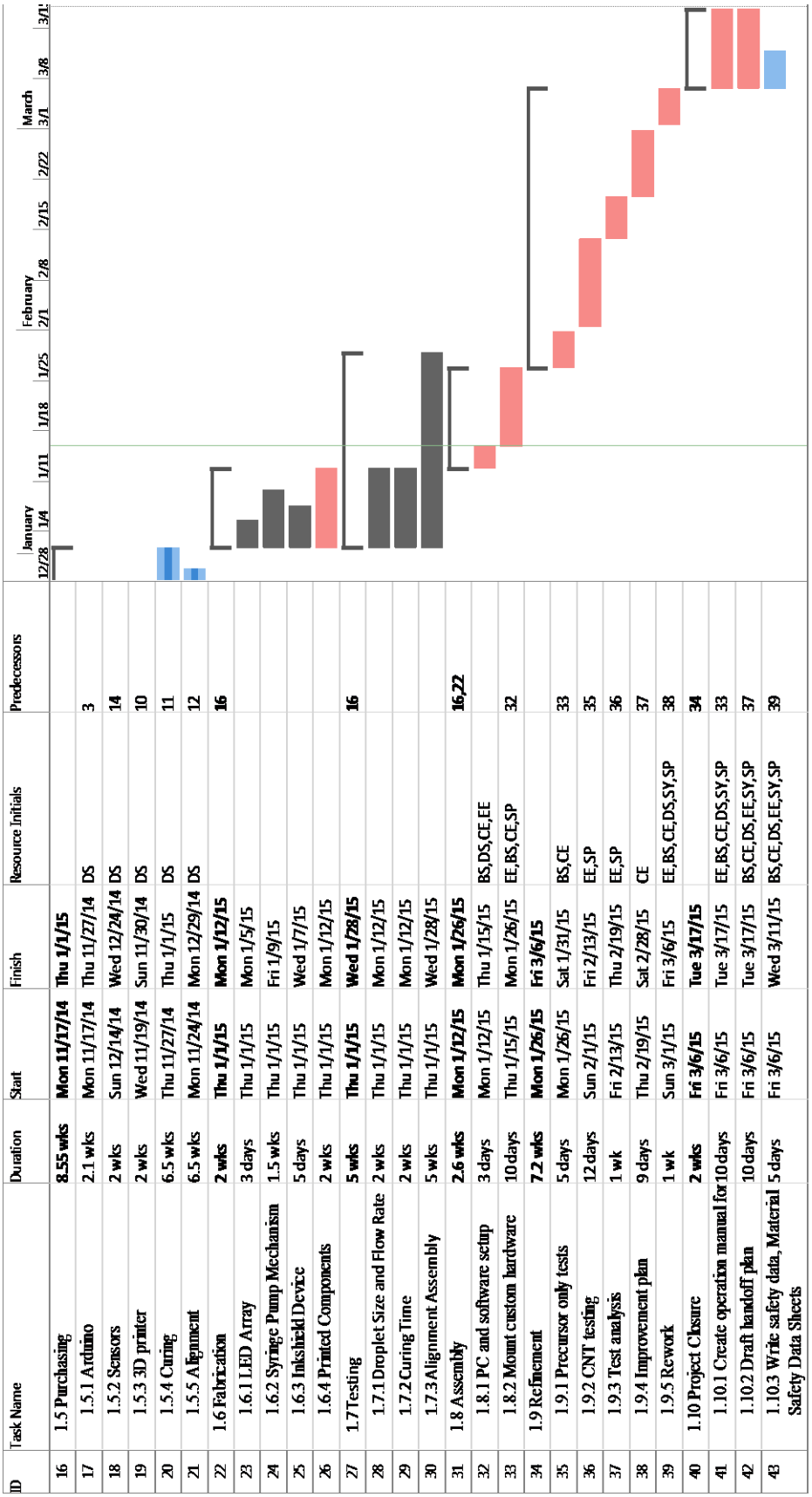
The following is a list of milestones that must be accomplished by the end of this spring semester. These milestones were determined through careful examination of our sponsor's requests along with advice and information from team advisors and instructors.

- Print a multi-layer solid part with the specified precursor
- Incorporate a polymer curing method into the printer
- Apply an aligning force to CNTs in solution
- Deliver proper organization and documentation of project expenses and components
- Setup a printer control system using a desktop PC to provide software control and video monitoring
- Draft an operations manual for the printer system to include a maintenance guide and schedule
- Provide guidance and training for sponsor-designated users

Project Update

The team has obtained parts and put them together to best retrofit the 3D printer project. Experimentation is ongoing to determine the optimal configuration of the extrusion system. Test variables such as distance of the needle from the printing platform, flow rate, and precursor viscosity will be explored. Additionally, by experimenting with different UV light power and distance, ideal UV curing conditions can be identified. The parameters we will test for CNT alignment will be frequency, field strength, light flux, and the percentage of CNT polymer in the matrix. The physical apparatus to test these parameters will be built, then the optimal numbers from all the parameters will be found through a series of tests. Lastly, some team members are working to incorporate control over ancillary printer systems through the printer microcontroller interface, allowing the team to exploit existing hardware and providing a means of software control over these new subsystems.

Gantt Chart



ID	Task Name	Duration	Start	Finish	Resource Initials	Predecessors
16	**1.5 Purchasing**	**8.55 wks**	**Mon 11/17/14**	**Thu 1/1/15**		
17	1.5.1 Arduino	2.1 wks	Mon 11/17/14	Thu 11/27/14	DS	3
18	1.5.2 Sensors	2 wks	Sun 12/14/14	Wed 12/24/14	DS	14
19	1.5.3 3D printer	2 wks	Wed 11/19/14	Sun 11/30/14	DS	10
20	1.5.4 Curing	6.5 wks	Thu 11/27/14	Thu 1/1/15	DS	11
21	1.5.5 Alignment	6.5 wks	Mon 11/24/14	Mon 12/29/14	DS	12
22	**1.6 Fabrication**	**2 wks**	**Thu 1/1/15**	**Mon 1/12/15**		**16**
23	1.6.1 LED Array	3 days	Thu 1/1/15	Mon 1/5/15		
24	1.6.2 Syringe Pump Mechanism	1.5 wks	Thu 1/1/15	Fri 1/9/15		
25	1.6.3 Inkshield Device	5 days	Thu 1/1/15	Wed 1/7/15		
26	1.6.4 Printed Components	2 wks	Thu 1/1/15	Mon 1/12/15		
27	**1.7 Testing**	**5 wks**	**Thu 1/1/15**	**Wed 1/28/15**		**16**
28	1.7.1 Droplet Size and Flow Rate	2 wks	Thu 1/1/15	Mon 1/12/15		
29	1.7.2 Curing Time	2 wks	Thu 1/1/15	Mon 1/12/15		
30	1.7.3 Alignment Assembly	5 wks	Thu 1/1/15	Wed 1/28/15		
31	**1.8 Assembly**	**2.6 wks**	**Mon 1/12/15**	**Mon 1/26/15**		**16,22**
32	1.8.1 PC and software setup	3 days	Mon 1/12/15	Thu 1/15/15	BS,DS,CE,EE	
33	1.8.2 Mount custom hardware	10 days	Thu 1/15/15	Mon 1/26/15	EE,BS,CE,SP	32
34	**1.9 Refinement**	**7.2 wks**	**Mon 1/26/15**	**Fri 3/6/15**		
35	1.9.1 Precursor only tests	5 days	Mon 1/26/15	Sat 1/31/15	BS,CE	33
36	1.9.2 CNT testing	12 days	Sun 2/1/15	Fri 2/13/15	EE,SP	35
37	1.9.3 Test analysis	1 wk	Fri 2/13/15	Thu 2/19/15	EE,SP	36
38	1.9.4 Improvement plan	9 days	Thu 2/19/15	Sat 2/28/15	CE	37
39	1.9.5 Rework	1 wk	Sun 3/1/15	Fri 3/6/15	EE,BS,CE,DS,SY,SP	38
40	**1.10 Project Closure**	**2 wks**	**Fri 3/6/15**	**Tue 3/17/15**		**34**
41	1.10.1 Create operation manual for 10 days		Fri 3/6/15	Tue 3/17/15	EE,BS,CE,DS,SY,SP	33
42	1.10.2 Draft handoff plan	10 days	Fri 3/6/15	Tue 3/17/15	BS,CE,DS,EE,SY,SP	37
43	1.10.3 Write safety data, Material Safety Data Sheets	5 days	Fri 3/6/15	Wed 3/11/15	BS,CE,DS,EE,SY,SP	39

Revisiting of the Code of Conduct 1/14/2015

Below are the members of Team 19 and their titles. Team dynamics are to remain the same where members agreed to work as a team while accepting constructive criticism. They will remain professional and request help from each other as they see fit throughout the project. Decision making will be conducted by the majority of the team members and what the sponsor agrees to as well as considering what the advisors suggests.

Materials Specialist – Ernest Etienne

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Team Leader & Lead IE- Cody Evans

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Multidisciplinary Liason – Sonya Peterson

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Lead ME – Basak Simal

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Financial Coordinator - Daphne Solis

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Lead Researcher – Sam Yang

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Advisor – Cheryl Xu

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