

Team 501 Concept Generation

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Concept Generation

Introduction

Concept generation is one of the most important steps of product development. It is where the group members meet to create ideas to solve the problem they are presented with. Concept generation has three main steps: preparation, concept generation meeting, and medium/high-fidelity concept selection. Extensive preparation was done to optimize the concept generation meeting. Preparation included finding different concept generation methods with their descriptions and an agenda of the order to use them.

Concept Generation Tools

The concept generation methods utilized were Pre-Concept Generation, Ideation, Anti-Problem, Forced Analogy, Crap Shoot, Biomimicry, and a Morphological Chart. Pre-Concept Generation begins at the same time as the project. Group members briefly recorded a concept any time before the concept generation meeting. This method gives group members the opportunity to add a concept at the time they think of it. The agenda for the concept generation meeting was then made.

The agenda began with a rundown of each of the methods that were going to be used and the order in which they should be performed. The first method on the agenda was Ideation. This method is a session of no judgement contribution. Any group member can add any concept regardless of its feasibility or effectiveness. Ideation was first on the agenda because it let the group members describe concepts while they had a fresh mind.

The next method used was Anti-Problem. This method has the group members ask the opposite problem from their current problem. This helps highlight flaws with current concepts

that the group members came up with during Ideation. This method was used second because it helps change the perspective by finding concepts that don't solve the problem.

The next four methods are more abstract to generate more creative ideas. The first abstract concept used was Forced Analogy. This method asks the group members to come up with a random word. The group members start relating this word to other words to eventually give insight to a new concept that could be used to solve the problem. The next method was Crap Shoot. This method lets the users think of concepts that are completely infeasible, but the new concept could bring the group member's attention to concepts that haven't been thought of. The last abstract method used was Biomimicry. This method relates concepts seen in biology to solve related problems. While these methods create many concepts that are not feasible, many novel and great ideas can come out of using them.

The last method on the agenda for the concept generation meeting was using a Morphological Chart. A morphological chart can create thousands of concepts by putting the functions (from Functional Decomposition) in the left column and solutions for each in the columns to the right. Once this is completed, a solution for each function is chosen to create one concept. This process of choosing solutions can be done thousands of times to create new concepts. Only four of the generated concepts from this method were included in the table of one hundred concepts. This was done to hit one hundred ideas, and to not flood the table with hundreds of excess ideas. The table of concepts can be seen at the end of the concept generation section.

Narrowed Down Concepts

Once the concepts have been generated, they must be filtered down to a smaller group of concepts which are achievable goals for the project. The concepts that are filtered down will be split into two groups, medium-fidelity and high-fidelity concepts. The concepts which are considered high-fidelity are shown in green in the generated concept table. Medium-fidelity concepts are shown in yellow. These concepts were chosen because the group believe they are the best solutions that can be feasibly done. High-fidelity concepts are considered the best solutions to the problem at hand, and medium-fidelity concepts are considered slightly less feasible than the high-fidelity. They are the favorites of the design team and associated parties.

Medium-Fidelity Concepts

The concept table contains all the concepts generated and highlights the five medium-fidelity concepts in yellow. The first medium-fidelity concept, number 10, was developed before concept generation began. This concept is a mounting system for the building plate which can rotate any direction in space and will allow the operator to quickly rotate the part to ease the removal of powder. It would also have a vibration feature, which would vibrate the part in whatever configuration the part is being held at. A sketch of this concept is shown in Figure 1. This concept was chosen instead of the other concepts because this technology is already in use in CNC machines which operate in 5 dimensions and would increase the effectiveness of current methods employed by the customer by allowing more maneuverability of the build plate.

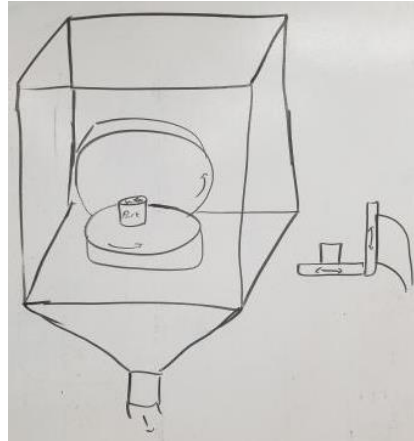


Figure 1. Medium-Fidelity Concept 10: CNC orientation.

The second medium-fidelity concept, number 12, is called “the spinning sifter.” The spinning sifter attaches to the build plate and spins it at a high rate, using centrifugal force to remove the powder from the part. The part is surrounded by a filter which will prevent contaminated powder or parts from leaving the sifting section. Reclaimed powder would be the only material that fits through the filter. A sketch of this concept is shown in Figure 2. This concept was chosen instead of other concepts because the technology needed to develop it would be relatively simple as well as the fact the same filtering method is used in other industries.

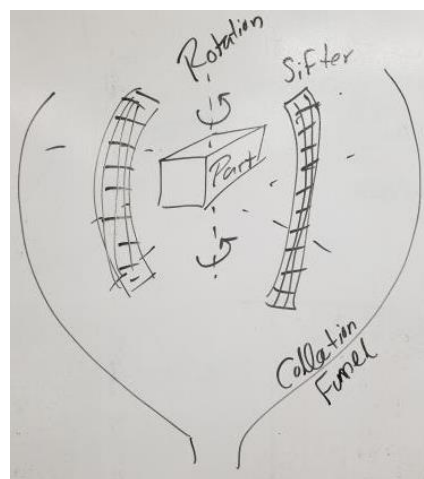


Figure 2. Medium-Fidelity Concept 12: The Spinning Sifter.

The third medium-fidelity concept, number 14, is called “vibration through all stages.” This concept is exactly what its title states, vibrating the part throughout all collection stages of the recovery process. The general theory behind this concept is that by vibrating the part during all three stages of the recovery process the powder will stay loose during reclamation and thus improve the amount of powder collected from the current method. An image of what this concept would accomplish is shown in Figure 3. This concept was chosen over the others because it incorporates the current process used well.

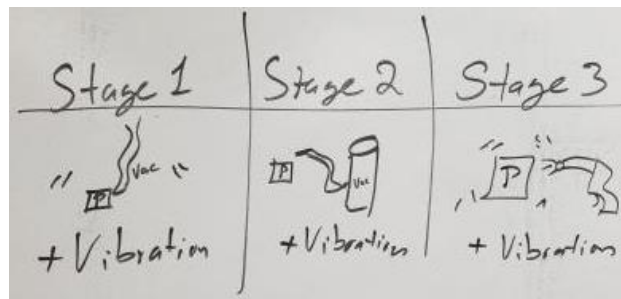


Figure 3. Medium-Fidelity Concept 14: Vibration Through All Stages.

The fourth medium-fidelity concept, number 6, is called “multi-directional vibration.” This concept is the opposite of the CNC style concept mentioned above, since it focuses more on the vibration directionality than the parts orientation. The vibration direction would be uniquely controlled to vibrate in multiple dimensions to maximize the powder knocked loose. This concept can be seen in Figure 4. This concept was chosen over others because it should remove a large amount of powder without large motion of the part itself.

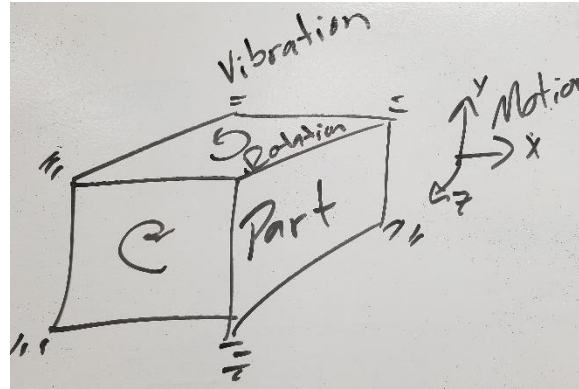


Figure 4. Medium-Fidelity Concept 6: Multi-Directional Vibration

The fifth and final medium-fidelity concept, number 23, is an electrostatic brush. This concept involves using a brush with fine bristles. The brush would be very small and capable of fitting within most crevices that are printed. The brush would be electrostatically charged so that the fine metal powder would be attracted to it, the brush would be removed from the part and then grounded so the powder would fall from it into a collection area. A sketch of this concept is shown below in Figure 5. This concept was chosen over the others because the use of an electrostatic brush would be able to remove powder from difficult to reach places with minimal effort from the operator.

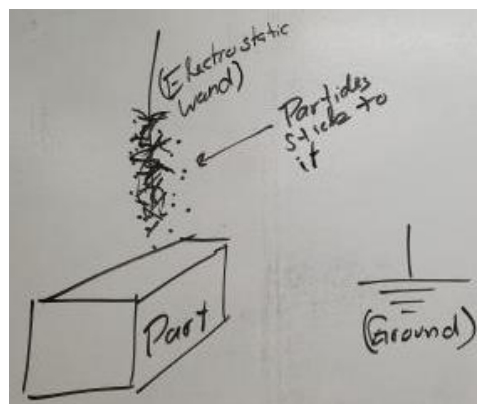


Figure 5. Medium-Fidelity Concept 26: Electrostatic Brush

High-Fidelity Concepts

The concept table contains all the concepts generated and highlights the three high-fidelity concepts in green. The first high-fidelity concept, number 31, is a tiny tube that blows compressed air. This concept was developed by realizing the hardest powder to remove was trapped in tight corners of the part's geometry. A common part printed is a cylinder with a lattice inside. This concept was conceived with this complicated, tight, geometry in mind. This concept is shown in Figure 6. This concept was chosen over the others because using such a small tube would allow the system to work well with any geometry that has hard to reach places. This concept was chosen over the medium-fidelity concepts because it directly attacks the problem of entering the tight geometries that were printed, and physically using air to blow the particles loose.

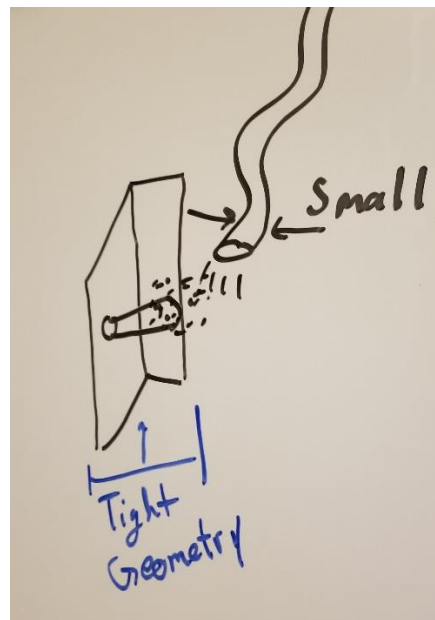


Figure 6. High-Fidelity Concept 31: Tiny Tube

The second high-fidelity concept, number 20, is called “high to low frequency vibration while enclosed.” This concept would involve vibrating the part during a collection portion of the

recovery process at different frequencies. The part would begin vibrating at a low frequency and then increase to a much higher frequency before being brought back down to a low frequency. While the part is vibrating, most likely while upside down, a funnel will be used to catch the powder and guide it into a container to keep it uncontaminated. This system would be in some form of an enclosure so that powder cannot escape into the lab atmosphere. The purpose behind this is that the variation in vibration will cause powder which normally wouldn't come out to do so. A sketch of this concept is shown in Figure 7. This concept was chosen over the others because it would allow collection of normally difficult to remove powder with a very feasible solution.

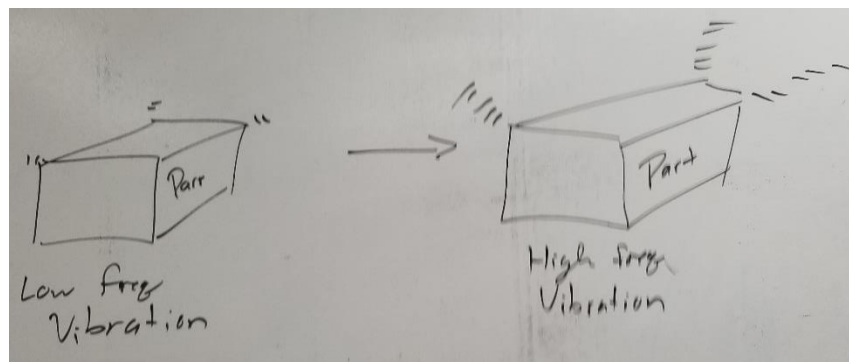


Figure 7. High-Fidelity Concept 20: Low to High Frequency Vibration

The third and final high-fidelity concept, number 8, is titled “the kitchen magnet.” This concept was generated by thinking of the large kitchen sinks with the hanging faucet. This is a very convenient way to allow a user to use a tool in a work area, such as the faucet at a sink. This concept incorporates an electromagnet that hangs down from above the part. The part would be held down as the user guides the electromagnet around to collect powder. Once a large amount of powder is stuck to the electromagnet, the current would be turned off to drop the powder and recover it. A sketch of this concept is shown in Figure 8. This concept was chosen over others

because it uniquely generates a large removal force (magnetic field) to the powder. This concept also would be very easy for an operator to use.

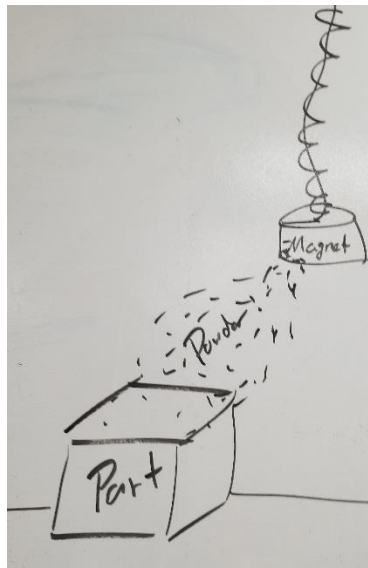


Figure 8. High-Fidelity Concept 8: The Hanging Magnet

All Concepts Generated

Concept Generation		
Method	Number	Concepts
Pre-Concept Generation	1	Attach the plate to a magnetic device that holds it at two ends, and the device spins the plate around, shaking loose particles
	2	Create a reinforced wooden beam we can slam the plate/part against
	3	A stronger vacuum
	4	A transportation system that takes the part from stage 1 to 3 immediately
	5	Replace the water in the wet-vac with a non-corrosive solution
	6	Multi-directional, high speed vibration to knock loose any lingering particles during stage 3
	7	Mobile enclosed box with gloves that morphs to the 3d printer exit chamber to keep powder encased. Have vibration and or air power to clean and collect powder
	8	An electromagnet that is movable like a hanging kitchen faucet
	9	rollable magnet/electromagnet similar to a lint roller
	10	A plate holder like that within 5 axis cnc machines that allows user to easily flip it over and rotate in any direction to maximize access to the part, as well as "vibration" mode
	11	Substitute the wet-vac with a device that can both collect the powder and filter it out of the collect air in order to safely exhaust
	12	A spinning sifter
Ideation	13	hydraulics to shake the part during third stage
	14	vibration through all stages
	15	using abrasive material to rub areas (napkin?)

16	octopus style tube that blows different parts
17	hit like pinata
18	suspend in air and smack it with object
19	figure out resonance frequency to optimize powder removal
20	go through high to low frequencies of vibration while enclosed
21	heating part to expand crevices
22	vibrating tool to vibrate certain parts, not the whole thing
23	using electrostatics brush to attract powder
24	dissolve powder and retrieve through chemical reaction
25	melt powder into solid
26	fill stage one container with liquid
27	flush out part with cnc coolant
28	melt powder using temperature techniques
29	device to shake part that's in a tornado
30	something to shake in stage one container
31	thin flexible tube that can go into lattice structure and blow air
32	carwash spinny thing
33	electrostatically charged pipe cleaner put into lattice
34	insert tube into part to force air in and suck it out
35	catheter type that pulses air flow
36	catheter that pushes particles out with liquid

	37	gloves that electrostatically charged
	38	magnetic gloves
	39	put gooey stuff into the part
	40	duster that is inserted and removed
	41	rock tumbler device
	42	metal bb's with vibration
	43	have particles a little bit larger than powder to get them out
	44	nozzle that blows and sucks
	45	vacuum press table that is used for thermal plastics
	46	having part follow a coupler curve
	47	Multi-axis part in a tornado box
	48	centripetal force to get internal powder loose
	49	Bristle/brush with air power that has "drill bit channels" for the powder to move up and out
	50	have a fiber brush similar to broom
	51	transport from stage 1 to 3 so it excludes stage 2
Anti-problem	52	massive machine
	53	expensive machine that costs too much to run
	54	magnetizing part to stick powder to it
	55	fusing the powder to the part through temperature
	56	cause damage to part trying to get part out
	57	dunking part in water

	58	run part through dish washer
	59	put part in car wash
	60	corrosive liquid in wetvac
	61	disposable build plate
	62	allow powder to be acquired through stage 2
	63	put the whole part in an acid bath
	64	put the part in a giant furnace
	65	drop the part from a rooftop
	66	eat the part
	67	prevent user from visual contact with part
	68	vibrate powder with loud subwoofer system
	69	blow powder steel powder onto the product submerge 3d printer and let fishes eat them
Forced Analogy	70	peanuts - use liquid that will evaporate
	71	feather - chizzle powder away
	72	flag - whip the part with a giant napkin
	73	yoyo - jerk to staying alive
	74	ice - freeze powder
	75	tape - use sticky stuff to get the powder off
	76	shoe - floss the powder out
	77	razor - cut the outer layer off of part
	78	blister - outer layer expands and pops

Crap Shoot	79	stampede of animals over the part
	80	nanobots enter and remove particle one by one
	81	take part into space and use zero gravity
	82	get a big jet turbine and melt everything
	83	use zero gravity in a plane
	84	use quantum entanglement
	85	put part on a roller coaster
	86	subject it to many G's
	87	put part into a microwave
	88	flamethrower to the part
	89	time travel.
	90	create a microorganism that loves to eat steel powder
Biomimicry	91	cats tongue cleans very well
	92	ant eater tongue
	93	chinchilla and dust baths
	94	whale bristles filter water out and keeps krill
	95	woodpecker that pecks in certain places to get stuff out
	96	boars do dust baths
Morphological Chart	97	Vibration converter held by build plate screws. User uses PAPR
	98	Blower with vacuum held by human wearing PAPR
	99	vacuum that goes into funnel. Part is held by a clamp and wet vacuumed

	100	electrostatic that releases into a funnel. Part is held by human that wears PAPR
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