

FIVE MINUTES INTO THE FUTURE

VOLUME 13

SHAPE MEMORY MATERIAL



**HORIZON SCANNING
REAL TECH
FOR YOUR GAMES**

WARNING

Disclaimer: A little knowledge is a dangerous thing

Each issue of 5 Minutes into the Future (5MF) looks at one real world developing technology and tries to make it something fun to add to your games. But I am not a scientist. Or a technologist. I am almost definitely dumbing things down to a level I understand, or unwittingly misinterpreting the science and theories involved in the technologies presented.

I am also making stuff up about crazy impossible impacts of the technology, to make it interesting for your games.

So, please! Don't treat anything in here as truth!

If you have a better understanding than me, by all means get in touch on our Discord server (see the sidebar or footer) and explain it to me, I'd love to learn more.

If you want a better understanding than I can provide, go check out the links I give for the source material – I would always encourage everyone to broaden their own learning.

Oh, and there is no implied challenge or slight to any person or organisation about the technologies I cover or the game systems I give added rules for. I love the systems, and I am amazed and awed by the tech – if I wasn't, I wouldn't write about it. If you believe there's a permission I need, or a credit I've missed, please get in touch.

Otherwise, enjoy issues of 5MF for what they are, some (hopefully) fun stuff to include in your game that are more interesting because they have roots in the real-world.

Wanna chat?

Get over to our Discord server <https://discord.gg/bE5zCgH>

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Other attribution & licences are at the back of the issue.

Volume 1.3:

Shape-Memory Material (SMM)

Contents

Disclaimer: A little knowledge is a dangerous thing	2	Wearables	22
Contents	3	Environment	23
What is Five Minutes into the Future?	4	Manufacturing SMM	23
What is the technology?	5	Process the keratin	23
Why is it important?	5	Choose/create a template	23
What is the background to the technology?	5	Spinning and printing	24
How does the technology work?	5	Activation	24
What is next for the technology?	6	Deconstructing another's SMM	24
Where can I find out more?	6	Fate Core	25
Implications for your game	6	Creating SMM objects	25
Bleeding edge tech	7	Aspects	26
Modern paranormal	7	Stunt: fail faster, succeed sooner	26
Magic ability to control SMM	9	Powered by the Apocalypse	27
Heist	10	Move: Weaver	27
High tech	12	Move: Weird Weaver	28
Ultramodern warfare	12	5e Modern D20	29
Medical cyberpunk	14	Creating SMM objects	29
The Origamist	15	Common effects for SMM	29
Accepted Tech	17	HexDNA	30
Planetary colonisation	18	Creating SMM objects	30
Apocalyptic	19	Minor complications	30
Rules and game info	21	Major complications	30
Keratin	21	Minor boosts	30
Sources of keratin	21	Major boosts	30
Weapons	22	Edge: Designer	30
		Attribution and licences	31

What is Five Minutes into the Future?

Five Minutes into the Future (5MF) are a series of zines scanning the horizon for cutting edge technologies being developed in the real-world right now.

Each 5MF issue will present one technology that is in development as of the date of the zine's release.

You'll get a break down of what the technology does, or what the creators hope it will do, at least. I try to stick close to reality here and discuss what makes this interesting and important without getting too bogged down in the science.

Then I get into the realms of speculative fiction and present some possible implications of including the nu-tech in your game's setting, covering three different levels of integration:

- bleeding edge tech,
- high tech, and
- accepted tech.

For each level of integration you'll have some story hooks for using it in your games in a selection of genres including:

- modern,
- heist,
- espionage,
- technoir,
- near future,
- superhero,
- cyberpunk,
- modern/techno horror,
- hard sci-fi, and
- (post)-apocalyptic.

All of which is system neutral and easy to mix and match.

Finally, you'll get some rules crunch for using the technology, or character options, in your games. You will see rules for:

- Fate Core,
- Powered by the Apocalypse,
- 5e modern D20 systems, and
- HexDNA.

If you'd like me to feature another specific game system, please get in touch on the Discord (link below). Can't promise to oblige, but I'm happy to try!

NB: Rules presented will generally be for the core rule systems, for licence reasons. For Powered by the Apocalypse games I'll list which specific game.

What is the technology?

This issue's technology is

Shape-Memory Material (SMM).

Why is it important?

Shape-memory materials are textiles that change shape, or return to a set shape, no matter how altered. The particular shape-memory material we are discussing was created by Harvard in 2020 and uses fibres made from keratin, the protein that makes up hair, fur, and wool. In this case it actually comes from recycled wool textiles. SMM is relatively cheap to produce, bio-compatible, uses recycled ingredients and could be useful for a whole host of things including self-adjusting clothes and organ tissue.

What is the background to the technology?

Shape-memory materials have a history dating back to the 1930's with the discovery of shape-memory alloys (mixed metals) like gold-cadmium. Despite this there were few practical uses until the US Navy began using them in the 1960's. From that point shape-memory alloy use grew significantly in many industries.

In the 1990's shape-memory polymers (plastics) were discovered which extended the number of uses, reduced the costs of production and the likelihood of stress fatigue which many alloys suffer with repeated changes.

Both shape-memory alloys and polymers use heat, or other energetic transfers (like electricity), to activate their changes.

Harvard's research article of August 2020 marks a new phase in shape-memory materials and demonstrates the first shape-memory textile material which responds to just simple hydration.

How does the technology work?

The key to the new SMM is keratin, a protein found in human and animal hair and nails. But for the particular tests described recycled and waste wool from the textile industry was used.

Once the keratin fibres have been extracted they are subjected to stresses to align them. As they combine, the fibres have different molecular states as either a helix or a sheet and it is the transition from one state to the other under hydration that causes the SMM to revert back to its 'remembered' shape. A more common example is how hair straightened with heat will return to a wavy form when the hair gets wet.

Fibre spinning and 3D printing are used to turn the keratin fibres into a textile, and this process allows for the creation of extremely complex shapes that can have characteristics imbued at the micron level.

The SMM produced is malleable when soaked in water or other liquid solutions and will retain any shape given, even when dried out.

But the next time it is hydrated it will spring back to its original fixed form.

The process is important because it is relatively cheap to produce and use.

It also uses simple, renewable and often recycled materials, and has numerous applications.

What is next for the technology?

With the process in place it is hoped that the SMM textile can begin to utilise waste keratin and be adopted into numerous industries.

Applications in fashion and textiles might include clothing which is:

- self-sizing and fitting,
- self-folding,
- self-ironing, and
- self-regulating and venting.

It may also include personal protective equipment that deploys buoyancy when immersed or which becomes rigid or expands.

Medical applications might include:

- self-adjusting, airing wound dressings,
- bio-wearables like medicine administering patches,
- organ tissues that are self-erected inside the patient using micro-surgery, and
- other feats of bioengineering.

Where can I find out more?

Check out the links below for more information:

[Nature Journal](#)

[IFL Science](#)

[Harvard Website](#)

Implications for your game

It's clear that in the real-world this shape-memory material textile will have lots of innovative impact on the way we live. It should make it easier and more reliable to repair ourselves, extend and improve our quality of life, and encourage the fashion industry to move away from wasteful production practices and cheap, disposable garments, of course this may be resisted but

is something for which there will be increasing public pressure as it is an essential step to help tackle the climate crisis.

But what could SMM mean for your game? We'll look at how SMM could radically impact your near-future settings, characters and stories.

Bleeding edge tech

Bleeding edge technology is the newest tech, clearly more advanced than anything else available and can give a significant advantage to those who control it.

When the SMM first enters the market it will be a novel phenomenon, displayed in high-fashion shows and used for trendy gimmicks, like:

- shawls and jackets that extend into hoods in the rain,
- boots that change from ankle to knee high,
- dresses decorated with buds that bloom into flowers,
- origami snakes that slide around a skirt or shirt,
- adaptive clothing that changes from work to party wear,
- bespoke tailoring that cannot be creased,
- sportswear with adaptive air flow to cool, warm and dry, and
- running and cycling clothes that constantly adapt to air slipstreams to maximise speed providing an edge in professional sports, which of course runs the risk of being banned or controlled as 'technological doping' as other improvements in sporting wear have [sometimes been](#).

Private medical facilities will begin to use the SMM in experimental treatments and surgeries for the rich or in charity edge cases where other surgical options are unsuitable, or to assist in treating the most serious of

burn victims. Bioengineering options such as prosthetics are also made more useful by the use of SMM.

Modern paranormal

Another world exists. Scratch the surface of the world we live in and you will find that we share our nights with strange creatures and unexplainable forces. And the worst of them are the vampires. Oh, sure they look like us, but really all they want is our blood. That's why I hunt 'em. And I'm not the only one.

The folx at HQ told me about this new thing, 'shape-memory material'. I was kinda skeptical at first but I have to admit I am impressed with what they've come up with. These days I don't go anywhere without several SMM products.

My standard kit includes an SMM scarf, because vampires ALWAYS go for the neck. The central layer has super elasticity so no matter what, those fangs will not penetrate. Of course that doesn't stop them from literally crushing your neck with the bite instead, so when the SMM is activated one layer inflates with a special gas while the layer underneath is reshaped into thousands of tiny needles. The fangs, or the needles, cause the inflated layer to burst outwards showering the vamp with whatever was inside.

We have several different loads for that, from silver-nitrate and garlic, to local anesthetic (I've literally seen vampires shred their faces to bloody chunks on the needles as they couldn't feel anything because of the anesthetic). But my personal favourite load is a special 'holy water' pepper spray, because watching a vampire roll on the floor crying blood is always good for a laugh.

Other SMM favourites include;

- a handkerchief that unfolds into a vampire snaring net,
- a stylish jacket that becomes rigid like a stab vest,

- a flexible belt that is also a whip that becomes a solid restraining pole, and
- various SMM stakes, shivs, shanks, saws and garrotes disguised as anything from a purse, to shoe laces, to a handy packet of disposable tissues.

Actually, the folx at HQ are currently working on a tie that is also a mono-filament edged dagger, which transforms using holy water, leaving it dripping wet. Talk about a nasty surprise for a vamp!

But it seems like we're not the only ones utilising SMM these days. Intel snared us this fragment of email from a lackey to their vampiric master...

...Iso collected the items from Emmanuel. She said you would particularly enjoy the shape-memory material items:

- the shirt that folds away blood stains,
- the coat which can become a rigid, light-proof coffin, and
- the rucksack with SMM syringe and tubing that undulates to draw blood into a concealed bladder.

Emmanuel reminded me that in the event of another late payment, sh...

Finally, there's more weirdness in this world than I will ever understand. Last week, one of our hunters who specialises in hunting witches reported that she encountered some sort of techno-witch utilising SMM as a foci for his spells. Witches often use the idea of 'sympathetic magic', that if one thing is similar to another, they are connected.

It seems this witch uses SMM to create delicate little models in the likeness of those he curses, then uses the shape changing function of the SMM to tear them apart, or twist them into hideous creatures. Doors, safes and even titanium vaults unfold like origami when he uses SMM models and allow

the techno-witch access before folding back into place like nothing was wrong.

When my colleague finally confronted him, the witch turned her own SMM items against her and it was like his long SMM coat was almost sentient - twisting and turning to protect him, before folding into a giant bat and whisking the witch away into the night air. That little stunt has definitely put this techno-witch on our top 10 most wanted list.

Magic ability to control SMM

The interplay of technology and magic in a setting offers up some interesting and unique character and story concepts.

Here, we offer some ideas on how SMM can be used by characters with a magical aptitude as a complement to, or replacement for traditional magical methods and accouterments.

Scientists are already finding a multitude of ways to program and trigger SMM's, using water and other liquids as highlighted above, but also other methods such as electrical currents and heat can be used. But how do wizards and mages interact with it?

It may be that the SMM in question is actually physically inert, but is magically active, and therefore can only be manipulated by someone with the relevant magical knowledge and skills. Or perhaps the SMM works in a traditional way, but the use of magic allows enhanced or improved applications of the material, far beyond what is possible with mere science. Maybe an individual has to spend time imprinting on the material to become correctly attuned before they can manipulate or use it to its full extent, or even at all.

Offensively, magically charged SMM (MSMM) can be formed into bolts or arrows and hurled at opponents as magical projectiles, or used to create tough bladed weapons that also pack a magical punch. To protect a

mage, MSMM can be used to create layers of armour to protect from conventional and magical weapons alike, or can be added as a thin layer to existing armour to create similar effects. The mage might even be able to impart some of these benefits on non-magical allies.

MSMM offers up a number of other more nuanced uses for the magic user that prefers an indirect or stealthy approach. An MSMM structure might emit a noise or sound when it changes shape, by compressing air for example, allowing it to be used as a remote distraction tool. Or it could change from an innocent looking piece of fabric into a spell foci of some kind that helps a magic user to cast a spell. MSMM Wards? Wands? How about an SMM spell-book that forms three-dimensional representations of runes, ritual circles, demons faces etc.

There exists a wealth of inspiration in fantasy genres for magic, and with a little thought and planning, there are myriad ways that these can be replicated or supplemented using SMM in a magical modern or future setting.

Heist

International Institute of Insurance
Investigators (4I) forum thread: #7953

Topic: *Anyone encountered SMM?*

----(7 days ago)----

Heidi'n'Seikh: Hey fellow 4I's, we recently investigated a theft where the perp used SMM. Anyone else encountered that?

TheBare: Is that a sex thing?

Heidi'n'Seikh: SMM = Shape-Memory Material, a textile that changes shape when you add water.

TheBare: Is that a sex thing? 🤔

Heidi'n'Seikh: Don't you have some traffic to play in?

Anderson Investigations 101:

@Heidi'n'Seikh, I encountered SMM about 3 months ago. A man used an SMM mask just a couple of microns thick to change his facial features and skin tone to impersonate 2 different senior bank staff, with the SMM changing between one and the other. Walked out with €3m in bearer bonds. Took us nearly 6 weeks to work out how he did it.

TheBare: Whoa! How comes I didn't hear anything about that?

Anderson Investigations 101: The bank spent more on suppressing the story than they lost in the heist. They didn't want the whiff of incompetence to cause a run.

----(6 days ago)----

TheBare: So... Are ya gonna tell us which bank?

Anderson Investigations 101: No.

Cuppa-Jo (they/them): Hi, we had an extortion threat at an auction house last month. Whoever it was threatened to destroy their entire inventory if they didn't pay-up. The auction house moved everything to a secure warehouse and called their bluff... Turns out there was an SMM layer on the reverse of one of the paintings in the inventory with a tiny water bladder squeezed into the frame. As the bladder leaked the layer transformed and lowered, releasing a pyrophoric chemical (one that combusts in oxygen) and the whole warehouse burnt down.

Heidi'n'Seikh: There has to be a connection, right? There can't be more than a couple dozen places set up to do SMM worldwide. Even less that are criminal. Especially not complex criminal stuff like this. Is it all coming from one place?

Cuppa-Jo (they/them): What like one person doing all these jobs?

Heidi'n'Seikh: Or one group. Or one fixer supplying them?

Anderson Investigations 101: Conjecture.

TheBare: Overruled! You can't handle the truth!

Heidi'n'Seikh: 😏

----(4 days ago)----

Cuppa-Jo (they/them): You never said what happened in your theft @Heidi'n'Seikh.

Heidi'n'Seikh: A woman used an SMM bag switch to steal an executive's laptop at a restaurant. It had bid details for a multi-million dollar deal which was later undercut. We are assuming corporate espionage.

Heidi'n'Seikh: She also cut the power to the CCTV server with an SMM wrap that snipped the power cable just before she walked in. Witness accounts of her differ so she may have also had one of those SMM masks @Anderson Investigations 101 spoke of too. The only real lead we have is that one of the waiters spotted a snake tattoo curling around her right forearm under her jacket. He's a tattoo fetishist, so it stuck with him. We've run it through all the usual databases but nothing turned up.

Cuppa-Jo (they/them): Not much then.

Heidi'n'Seikh: No. 😏

----(Today - New Messages)----

TheBare: #I know something you don't know!#

TheBare: @Heidi'n'Seikh... #I know something you don't know!#

Heidi'n'Seikh: Seriously? What are you, five years old?

TheBare: Fine. I won't break your case...

Heidi'n'Seikh: Alright. I'll play. Hey, @TheBare! Tell me what you know.

TheBare: Well, you didn't say please, but I'll let it go. So, I was listening on my police scanner yesterday when I hear chatter about a guy who has been arrested on one of those

gambling river-boats trying to make off with an arm full of lolly.

Heidi'n'Seikh: <ignoring the illegal hardware> I don't get it.

TheBare: Just wait. That piqued my interest, but what really made me listen was when they said that he was trying to jump into the water, but before he got there, he knocked over a waitress carrying a pitcher of beer and got covered in it. His coat suddenly pops itself into a CANOE, while he's still wearing it, and it damn near breaks him in half! Had to be taken to the hospital with two cracked vertebrae.

Heidi'n'Seikh: Haha! An SMM canoe coat!

TheBare: Exactly. So I visit the casino, get them to take me on for the case and liaise with the investigating officers. Today, he agrees to take a deal and tells them that he got the canoe-coat from a woman...

TheBare: A woman with a snake tattoo wrapped around her right forearm. Named Emmanuel.

Heidi'n'Seikh: OMFG!! 😏

TheBare: I'm sending you copies of his statement, the e-fit he helped compile and all the deets in a PM.

Heidi'n'Seikh: That is amazing! Thank you! I take back all the bad things I said about you! I'll be there first thing. I'm leaving for the airport now!

TheBare: Ah, it was nothing.

TheBare: Wait... What bad things did you say about me?

TheBare: @Heidi'n'Seikh what bad things?

High tech

High tech is slightly more available than bleeding edge tech, and all well-moneyed groups have access to the technology but it isn't yet common enough that it turns up on the street.

As the SMM technology begins to proliferate, moneyed groups will begin to experiment with using it in a variety of industries.

For example:

- safety technologies such as airbags and parachutes, or
- survival/disaster recovery gear like pop-up enclosures.

Or for use deploying mechanical solutions in environments where traditional shape changing alloy and polymer can't be deployed because heat and electricity are not safe, like;

- in spacecraft,
- in bomb disposal tools and robotics, or
- in lifting debris following earthquakes.

As experimentation with SMM continues we may also see different trigger mechanisms, such as heat, cold, electricity, or vibration frequency also begin to replace or supplement hydration in those situations where it is safe to do so.

Ultramodern warfare

Welcome to today's presentation and demonstration of our newest product. General, I would like to thank you and your staff for making space in your busy schedule to see what we have developed to ensure continued dominance of the battlefield for decades to come. Trust me, you won't regret it.

For the elite modern soldier, SMM is an invaluable part of the warrior's arsenal. The material's flexibility and ability to adapt to multiple situations means that a soldier can carry many more weapons and tools than usual, and to account for myriad different scenarios.

First up, we have protection. The standard armour jacket is coated with an ultra-thin layer of super-elastic SMM, and the ceramic inserts are exchanged for SMM ones which will misshape to take the force out of the

impact but can be 'reset' to its original shape within a few seconds once the SMM is activated. All of this has no material impact on the weight of the armour but once treated in this manner, it offers superior protection against bullets, puncture damage from bladed weapons, and significantly increases the usable life of armour and keeps soldiers safer for longer.

(Video clip of test dummies, then soldiers, testing the SMM enhanced armour with live rounds).

For close up wet work, SMM blades of all shapes and sizes can be created. The razor sharp mono-filament edges can also be made to move or oscillate at an extremely high rate, creating a vibrating blade that is capable of cutting through any natural or man-made material.

(Video clip of SMM cutting tools versus ballistic gel, animal carcasses and then live goats).

SMM ammunition in the soldier's firearm offers the flexibility of multiple load-outs in a single magazine. By selecting the pattern the SMM round takes troops can perform key roles in a flexible format within standard fire teams.

- Standard munitions are still the default for maximum distance and all round purpose,
- Armour piercing rounds for light vehicles are achieved by hardening the tip and increasing the density of the round which stop it from flattening on impact with SMM so that it can punch through armour more easily.
- Dum-dum rounds use SMM to have a softer tip, increase flattening and 'flower' open on impact causing maximum injury value at the expense of armour penetration.
- Flechette rounds use SMM to split into hundreds of needles after exiting the

barrel of the weapon, shredding soft targets.

- And, finally SMM has allowed us to create fragmentation rounds which cause the bullet to become hard but brittle which shatters and spreads hot metal shards over a considerable area, like micro grenades.

All of these things are possible without having to swap weapons or magazines.

(Extended video clip of all types of ammunition used against static paper targets, moving targets and ballistic gel, and then live goats).

Whether on offence or defence, in combat zones or the urban jungle, the SMM equipped soldier is ready to handle any operation.

Any questions?

...No, Captain. I can assure you we have nothing against goats.

Now if you would all like to follow me out to the firing range, we have some live demonstrations of the product in action. Any volunteers to test the armour?

Medical cyberpunk

In the chrome neon noir cities of the near future, SMM use is becoming more widespread, SMM armed black-ops teams and Corporate soldiers compete to have the latest innovations. But what about when they get hurt? Well, assuming you have the cash to pay for it . . .

Whilst SMM has basic applications in emergency or battlefield triage, its use in hospitals is much more sophisticated. SMM dressings filled with pain relief and antibiotics can change shape to deliver their doses in response to changes in body temperature or chemistry.

SMM is also routinely used in micro-surgery for stenting, repairing damaged arteries, and internal wound stapling, with 'flat-packed' SMM inserted and guided to site before being

activated and changing shape. Creating and grafting complicated sections of muscle and organs in the same way is also becoming more routine with 3D printed tissue supported with prepared keratin taken from the patient's own hair to avoid rejection and infection issues. These are then transformed and anchored in place using the SMM's properties with a minimum of fuss.

A still experimental but growing area of medical SMM use is in injecting micron-scale SMM structures directly at the point where they are needed, where they activate and join-together in-situ. No longer do you need to cut someone open and rely on donor organs to replace faulty ones. The most common uses for these sorts of injections are to stem bleeding and destroy dangerous blood clots but more complex uses are being pioneered where micro and nano-scale assemblies, combined with stem-cell treatments, can be created in the most high risk locations, such as the brain, drastically reducing rates of complication and mortality, and almost entirely eliminating recovery times.

And if you can't afford to pay for surgery or a replacement organ, then one of the corporations will probably lend you the money. But you had better not fall behind on your repayments. All it takes is the correct electrical pulse or nearby coded low frequency radio signal to tell the SMM to revert back to its pre-assembled shape. And you can only imagine the mess that occurs when an SMM heart graft or brain enhancement reverts to its original shape 'in situ'.

Even if not the main part of the plot, having a player always looking over their shoulder for the 'Repo Man' can add an interesting dynamic or counterpoint to the main story. Or maybe the corporation in question will allow you to keep the graft and clear a few of your payments. In exchange for you completing a little job on their behalf of course.

The Origamist

They call her the Origamist, but she tells me she is just a folder. Zoi Kappaseydt is the city's premier origami artist and I have been given a rare invite to interview her and watch her at work. I say 'work', but actually for about an hour she kneels motionless on the wet flagstones in her small studio courtyard as the rain hammers down onto her, and the large white paper square placed in front of her on the ground. The rain causes the climbing roses on the trellises ringing the courtyard to shake and dance releasing a pleasant scent into the otherwise dull, wet city air. The water rolls down Zoi's face and drips from her nose. I wonder if I should say something. It certainly isn't the most entertaining way to spend my afternoon. Surely the paper in front of her, about the size of a beach towel, will just be a sodden mess by now.

Suddenly, she moves, and it is like watching a spring uncoil or a ballerina twirl. The white sheet is whipped up into the air and flipped around. In a blur of turns, folds and moves the sheet becomes smaller and begins to take a shape, though I cannot discern what it is. I do see though that the sheet is not paper at all but a sort of thin stiff material, like felt, but not quite. Later she tells me that this is her new medium, a type of shape-memory textile to which she has added her own flourishes through micron level 3D printing. She says that while she kneels she is visualising every move, every fold she will make, waiting for the material to reach optimum saturation from the rain before beginning.

Within ten minutes it is all over. Zoi walks to the awning I'm standing under out of the rain, cradling the white shape she has created like a baby. There's a beatific energy about her, serene but powerful. The shape appears to be a geometric spiky ball or star. It's actually a kusudama, a sort of traditional origami decoration, so my research tells me.

It is pretty, but I was expecting a bit more from the Origamist.

Zoi puts the kusudama in front of an industrial fan dryer, the sort of thing you would use to dry out an area after your pipes burst. She just smiles when I ask if that is the end of the demonstration and walks to a cupboard. Inside are dozens of kusudama, maybe fifty stars all together, all different sizes from tiny to quite large. All of them are clearly made of the same textile. Quickly, she begins to hang them outside in the rain. On the trellis, on the wooden supports of the awning, or scattered across the rain-slicked flagstone.

One by one, they begin to twitch and jerk, writhing almost like they were copying the moves made by their folder just a short time ago. Zoi runs to pick up the kusudama she made just now, clearly the largest of all, it seems dry now but she takes it straight back out into the rain and lays it, almost reverently, in the centre of the courtyard before stepping back.

The twitching stars are almost vibrating now, and then as one they begin to transform in front of my eyes. The kusudama unfurl themselves into butterflies. Butterflies that flap their wings in the rain, as if the water causes the continual movement. I stand dumbfounded, watching their folded beauty. Their technical brilliance. Their... purity of spirit?

It's only after several moments that I notice the largest star, the one I watched being folded hasn't changed. But the Origamist grips my arm tightly, intently staring, as it too begins to twitch before unfurling into the largest and most ornate butterfly of them all. It beats its wings slowly and... takes off. It flutters, hesitantly, upwards for what feels like a minute or more. Through the rain, above the studio roof we see it fluttering before the wind whips it away and we lose sight of it. Forever.

Zoi releases my arm and she looks exhausted, but tranquil. I'm not sure what I have just seen. I feel like I want to smile and cry at the same time. She takes me inside and we drink green tea poured from a rust stained metal teapot. I try to stumble through the list of questions I have, but my heart isn't in it. The only question I want to ask is the only one she won't answer. How?

As I leave, she gives me one of the smaller butterflies to take with me. It's still sitting on my windowsill and every now and then it will flap its wings, almost mournfully. I still don't know what it was I saw that day. All I know is that the Origamist has left a shape-memory fold in my soul that will last forever.

Accepted Tech

An accepted technology is one which has now been fully absorbed into everyday life and is now unremarkable for the people in that society, being adapted and modified to fit a variety of needs.

SMM is everywhere. It's in your smartphone. It's in your computers and tablets. It's in the clothes you wear. It's in the walls of your home. In some cases, it is the walls of your home. Shape-memory materials are now so common that most people will own at least one item that is made from, or contains some element of SMM. Some houses are fully furnished with shape-memory-materials, with items being shaped and reshaped to meet the current needs of the occupant/resident to save space and minimise consumer impact.

On the global stage, SMM has accelerated the shift of power to the Asia-Pacific region that was already occurring. China and India with the largest populations are able to capture huge quantities of human hair for keratin processing. India already had the world's largest human-hair for wigs production and this industry very soon switched to servicing the SMM boom. Selling your hair is often a great way to make

money and, as with wigs, the highest prices go to those with the longest, untreated, unbleached hair. The sale of particularly high quality hair can lift an entire family out of poverty, meaning the use of dyes, perms or products are often a status symbol of the rich, or an indication of rebellion for some youth cultures.

China and India are only rivaled in global keratin production efficiency by New Zealand and its sheep population which has pivoted, using genetic manipulation, to fill several niche roles including medical industry SMM.

Planetary colonisation

As humanity reaches out to the stars looking to settle new worlds, the logistics of establishing even a single new colony pose an enormous challenge. The amount of raw materials, tools, products and technology required to make even a small colony self-sustaining is vast. Colony ships are the largest things that humans have built, and yet every square metre of space in their cargo holds is a precious commodity.

Are there enough perishables and foodstuffs on board to keep the colony going until it becomes self-sufficient? Are there seeds and plants in sufficient quantity and variety to ensure that something can be found that will grow on the new world? Are there enough spare parts and supplies for the myriad machines and technology that the colony needs to ensure essential equipment can be rebuilt? Every decision has an opportunity cost - take more of something means you have less space for something else.

The use of shape-memory material solves many of these problems. Instead of carrying habitats, tools or raw materials, these are instead replaced with vast quantities of SMM. Computer banks store tens of thousands of patterns that can be used to program the SMM. Now, on arrival at their destination, the colonists can use SMM to make anything.

Need somewhere to live? Fully customisable habitats and common areas can be built and ready to use in minutes. Need a spare part to fix a more complex machine? SMM can replicate thousands of parts, large and small to keep all of the colony's machines running. Winter approaching and you only have shorts and t-shirts? Your existing SMM clothing can be reconfigured for any need come rain or shine. With SMM, building better worlds becomes almost trivial. But as the colony grows, the amount of material available per person decreases, and at some point, demand could outstrip supply. So what will you do to get your hands on some?

Apocalyptic

When we settled a new world, we thought we had left the old ways behind. We were wrong. Soon, the Company controlled every aspect of our lives and the one thing that gave it most control of us was over the supply of SMM. Without SMM there were no new shelters or communities, no tools for agriculture, no reliable water filtration systems, even the air scrubbers relied on SMM. Its utility ensured our reliance on it, and its control was the surest way they had to keep us oppressed. The genetically engineered sheep that produce the best sort of keratin never leave Earth, keratin from any other source just doesn't produce the best SMM.

So, when the colonists rebelled and accidentally caused a shipment of several hundred tonnes of SMM that they were trying to steal to be lost, the Company responded with the enforced shaving of all hair in the colony, so they could extract the keratin to make more SMM. We heard that they even started ripping out the nails of any of the rebels they found to get more keratin. Don't know if it was true, but that was the spark that turned a rebellion into a civil war and split the rebels into two groups, the Shearers and the Shorn, who fought each other almost as much as the Company.

The two sides of the rebellion got hold of some of the SMM manufacturing and imprinting technology, set up their own communities and prepared for war. Neither the rebels nor the Company had much access to firearms but they all soon got creative with the SMM, creating catapults and harpoon-guns and other projectiles.

Worst of all were the SMM bombs, the Company used them first, but the Shorn weren't far behind. SMM bombs explode in a quiet puff but fill the air with microfibrils of SMM that trigger in damp human airways, lungs, eyes, throats and stomachs and begin shredding you from the inside.

You die slowly, a burden to your companions, bleeding from every orifice. Even if you are lucky enough to survive, chances are you'll develop something nasty like COPD or cancer at a pretty alarming rate over the next few months. If that were not bad enough, the stuff from an SMM bomb hangs around for years in dusty little clouds, ready to activate when someone walks into it. We think there may even be a variant that causes other SMM made from human keratin to break down, stopping it from working, maybe even turning it into more SMM bomb particles.

Slowly but surely the Shearers and the Shorn turned the tables on the Company, despite suffering horrible losses.

Last week, the last and largest community controlled by the Company exploded. We don't know why. Reckon about 5,000 people died in the explosion.

Since then we've had a trickle of survivors start arriving. Some of them are pretty ill, looks like they might have inhaled a lot of SMM bomb fibres. A couple of the most ill keep raving about how the Company was trying to make the SMM sentient. I'd call that just delirious rambling, but they both called it the same thing, Project: Maelstrom. Who knows if that's what caused the explosion?

Still, looks like the civil war is over, for now at least, there may still be infighting between the Shearers and the Shorn over who gets to decide what happens next. But we have more important things to worry about; like survival, and maybe, rebuilding. The Company definitely controlled more resources than either the Shearers or the Shorn, now that's all gone and we have more people to deal with than ever. And what if some of them still support the Company and are willing to sabotage what we got left? After such bitter fighting it's hard to trust anyone anymore.

We figure it'll be at least 5 years before any off-worlders arrive, whether that'll be Company reinforcements or a different group of settlers. But who arrives and when probably doesn't matter, as we don't have enough SMM to meet our needs for longer than a year, and that's if it doesn't start decaying, or worse as most of it isn't the good kind.

I know we brought the worst parts of humanity with us to this new world, I just hope we brought the best parts as well, or we won't survive. Welcome to our new world; Apocalypse.

Rules and game info

So far everything has been system agnostic advice.

Here's where you get some tools to help embed this tech into your game.

Below are rules for Fate Core, Powered by the Apocalypse, a 5e D20 modern system, and for the first time, the HexDNA system. (And if you would like us to consider giving information for other systems, please contact us on the Discord).

But first, here are some generic rules that can apply to most games.

Keratin

To keep things simple, raw SMM is tracked as the amount of keratin used.

The basic rules are:

- 1 person's hair contains 1 basic project's worth of keratin, we call that a Spool.
- Each change in size increases the number of Spools needed by 1.
- Each 'special feature' doubles the amount of Spools needed.
- Add the sizes first, then double for each feature added.

For example: e-Zorro wants to create an SMM dueling sword which deploys from a bandanna/handkerchief. The GM asks the player how it will work, who describes that when she squirts a small bladder stitched into one corner of the bandanna it rolls itself tightly into a sword, both the tip and length of which are mono-molecular cutting edges. The GM decides this will require 4 Spools - a basic sized project with 2 special features; disguised and mono-molecular edge (1 Spool, doubled to 2, then doubled to 4).

Here's a sample list of items and the number of keratin Spools produced/required.

Sources of keratin

- Head of human hair - whole (produces 1 Spool).
- Set of human nails - whole, not trimmings (produces 1 Spool).
- Woolly jumper (produces 1 Spool).
- Very long hair (produces 2 Spools).
- Average sheep fleece (produces 10 Spools).
- Small haired creature, e.g. dog, cat, goat (produces 5 Spools).
- Larger haired creature, e.g. llama (produces 15 Spools).

Weapons

- Simple weapon (uses 1 Spool).
- Pole arm simple weapon (uses 2 Spools).

- Simple weapon disguised as something else (uses 2 Spools).
- Simple weapon with a mono-molecular cutting edge disguised as something else (uses 4 Spools).
- Simple weapon with a vibrating, mono-molecular cutting edge disguised as something else (uses 8 Spools).
- SMM catapult (uses 2 Spools).
- SMM staff catapult (uses 4 Spools).
- SMM folding sling crossbow (uses 8 Spools).
- Harpoon gun with 5 SMM harpoons (uses 14 Spools).
- 30 SMM versatile bullet ammunition (uses 12 Spools).
- SMM bomb, small 5ft radius (uses 18 Spools).
- SMM bomb, medium 10ft radius (uses 36 Spools).
- SMM bomb, large 15ft radius (uses 72 Spools).
- SMM bomb, large with a special feature (uses 144 Spools).

Wearables

- Dozen self-airing wound dressings (uses 2 Spools).
- Dozen chemical administering self-airing dressings, e.g. blood clotting agents (uses 4 Spools).
- Dozen 2 chemical administering self-airing dressings, e.g. antibiotics and local anesthetic (uses 8 Spools).
- SMM artificial muscle/joints for prosthetics or robotics (uses 2 Spools).
- Micro or nano scale SMM structures used for surgery, stenting, or the repair/replacement of organ tissue (uses 6 Spools).
- Face mask disguise - single use (uses 1 Spool).
- Face mask disguise, switches between 2 different appearances - single use (4 Spools).

- Face mask disguise, switches between 5 different appearances - single use (32 Spools).
- Face mask disguise, switches between 5 different appearances - multiple uses (64 Spools).
- Garment of clothing (uses 1 Spool).
- Garment of smart clothing with 1 special feature, e.g. temperature regulating (uses 2 Spools).
- Garment of smart clothing with 2 special features, e.g. self-sizing and athletic performance enhancing (uses 4 Spools).
- Garment of smart clothing with 3 special features, e.g. self-ironing, self-folding, moving decorative feature (uses 8 Spools).
- Garment of smart clothing with 3 special features, e.g. scarf with protection, needles and exploding layer (uses 8 Spools).
- Full light armour (uses 6 Spools).
- Full medium armour (uses 12 Spools).
- Full heavy armour (uses 24 Spools).
- Full heavy armour with another special feature (uses 48 Spools).

Environment

- Small pop-up emergency shelter for 2 people (uses 8 Spools).
- Large pop-up field hospital tent for 30 beds (uses 60 Spools).
- Small pop-up environment sealed habitat, 5 small living areas (uses 200 Spools).
- Section of pop-up, environment sealed connecting corridor (uses 40 Spools).
- Large pop-up, environment sealed habitat (uses 800 Spools).
- A couple of small spare parts (uses 3 Spools).
- Oxygen scrubber filter for 1 week (uses 4 Spools).
- Water filtration unit for 1 week (uses 6 Spools).

Spools used will only be relevant to your game if SMM is a limited commodity and not easy or cheap to obtain. Don't add complexity if you don't need to. But if you do use it remember some of these items will require non-SMM components or chemicals to function which may be scarce as well.

The amount of Spools used can also be a general indication of purchase costs or the difficulty of production in your setting, even if keratin is plentiful.

Manufacturing SMM

Turning raw sources of keratin into completed SMM items can be broken down into a few steps. You may wish to handle this with none, one or more rolls but don't be afraid to hand-wave it if it isn't fun or important to your story.

Here are the steps with a few things to consider.

Process the keratin

- How much raw keratin is there, how long does it take to process?
- Use science or biology for rolls if needed.
- What are the consequences if a roll goes wrong?

Choose/create a template

- Does using an existing template require a roll at all?
- How hard is it to create new templates? Can anyone do it? Is it a specialist knowledge? How long does it take? Does it have to be tested?
- Can unique items be created without making a template first? Is this quicker? Does it require specialist knowledge? Will it begin to break down or malfunction over time?
- Use computer skill rolls.
- What are the consequences of a failed roll?

Spinning and printing

- Is this handled automatically with a template?
- Is there skill involved with unique items?
- Use engineering and technology rolls.
- Does the difficulty of any roll increase with the number of special features being created?
- What are the consequences of a failed roll?

Activation

- If SMM is stored in a sheet awaiting imprinting or activation, how easy is it to shape? Are skills like origami and sewing needed?
- What triggers the change – if it's just good old fashioned water you could find yourself in trouble when it rains?
- If the SMM is disguised or otherwise changes appearance when activated how is it triggered? Is there a delay after activation before it can be used?
- Are there deception/disguise rolls required for the item not to be noticed before activation? Does the item require skilled use?
- How long does the SMM item last? Is it single use? Lasts for a scene? Lasts for a week? Lasts indefinitely? Breaks down after uses equal to the level of success of a creation roll? Breaks down on a failed use roll? What happens when it does break down?

Deconstructing another's SMM

There are many ways of causing an SMM to alter its shape - contact with certain fluids, airborne particles, electrical currents or radio signals from across the spectrum are just some of the ways this can be achieved. Therefore, it is potentially possible to change, damage or deconstruct an SMM product that has been built by someone else if you know the method they use to encode their SMM. Determining this would potentially require some kind of scanning

equipment, espionage, or a lab and access to the material, and the level of success needed would be in opposition to the level of skill of the person that created the item in the first place.

Fate Core

Creating SMM objects

- Unless your setting has more relevant skills built into it then most SMM creation rolls will be covered by Craft.
- Processing keratin can be assumed to be part of any other creation roll. If you want to process it separately, are having to use unusual sources, or limited technologies, then make a Craft roll of appropriate difficulty.
- Items which have a template can be created with only a mediocre (+0) Craft roll. It takes 1 minute per Spool used.
- Creating a template for an item takes 1 day per Spool used and a mediocre (+0) Computer roll, with one additional step difficulty for each special feature.
- Making an item without a template is completed in 1 hour per Spool used. Roll a mediocre (+0) Craft roll with every Spool used increasing the difficulty by 1 step.
- Typically SMM items will work by Creating an Advantage, with a successful roll on the creation, the player can define an Aspect that is introduced at the time the SMM is used, with every shift allowing an additional use.

For example:

- Saima is creating a large, pop-up, environmentally sealed habitat from a template, she must make a Mediocre (+0) Craft roll and wait 13 hours (800 Spools x 1 minute) to create the flat-packed habitat.
- Benneth is designing a template for a canoe coat - its use is disguised, it transforms and it's a canoe - 3 special

features and 18 Spools will take him 18 days to program and he must succeed at a (+3) Good Computer roll. But, once the template is complete the coat can be created in just 18 minutes.

- Jaime is creating a 2 change disguise mask and doesn't have time to make a template. The mask requires 4 Spools and so takes 4 hours to complete, plus a Great (+4) Craft roll. Jaime is a talented SMM artist so when they make the roll they achieve a Fantastic (+6) result, giving 2 shifts, allowing Jaime's player to tag the Advantage Aspect created by the mask a total of 3 times.

Aspects

While it would be impossible to make a definitive list of Aspects that can be used, here are a few possible examples:

- Not really unarmed
- Surprise!
- Who is that?
- Where does he get those toys?
- Amaze the crowds
- Emotionally moved
- Escape plan
- Protected
- Stop the bleeding
- Medicated

If a character is adept at using SMM it may form one of their own permanent Aspects, such as:

- Shokunin (master crafts person),
- Shapes the world, or
- Always an SMM gadget

Stunt: fail faster, succeed sooner

The character follows a modern design philosophy celebrating failure as the quickest route to success. They can halve the length of time it takes to attempt any Craft or Computer roll they have previously failed at.

Additionally they automatically gain the Aspect: Focussed until they succeed.

Powered by the Apocalypse: (Apocalypse World)

Move: Weaver

This Move is available to anyone with access to SMM creation technology, or a supply of prepared 'blank' SMM sheets.

Describe the item you want to create and work with the MC to establish the number of Spools needed. With enough sources of keratin, take 1 hour per Spool and Roll +Cool.

On a roll of:

10+: You create the item you described including up to 3 special features. If your description included more than 3 then for each extra feature pick a cost from the list below.

7-9: You create the item you described including up to 1 special feature. If your description included more than 1 then for each extra feature pick a cost from the list below.

Costs:

- Double the Spool cost of production.
- Additional production costs require 2D6 Jingle.
- Additional production costs require 2D6 Barter.
- Double the length of production time.
- The SMM machine develops a glitch, the next time it is successfully used there will be an additional cost.
- The SMM machine breaks at the end of production and requires several days to repair.
- The SMM machine breaks at the end of production and requires unusual parts.

- The SMM machine broke halfway through production but you patched it, however the next time it incurs a cost it will break down in addition to any other cost.
- The item you created has a complicated, unusual activation process, describe it.
- The item you created has a glitch and only activates on a D6 roll that is even.
- The item you created will activate using only pure distilled water.
- The item you created can only be used for 1 scene before breaking down.

Notes:

- Add +2 if there is a complete and working template for the item being made.
- Items created with this move retain any costs given to them no matter who uses them.

Move: Weird Weaver

This Move can be used by any PC who has developed an odd relationship with SMM items.

This Move functions as the normal Weaver Move with the following changes.

- The roll is made +Weird.
- In addition to the outcomes listed under Weaver:

On a 10+: Pick 2 from the Weird effects listed below, you can use them for free a total of 3 times.

On a 7-9: Pick 1 from the Weird effects listed below, you can use it for free 1 time.

(If you have no more free uses then it costs you 1 Harm to use the effect(s) you picked).

Weird effects:

- Cause the user of the object to experience a very strong emotional reaction - specify which emotion when taking this effect.
- Cause the user of the object 'bad' luck.

- Cause the user of the object 'good' luck.
- Cause all observers of the object to experience a (limited) emotion - specify which emotion when taking this effect.
- Know where the object is.
- Cause the object to be lost, or if lost, found.

5e Modern D20

Creating SMM objects

- Processing keratin is DC 10 Intelligence (Engineering) check. DC 15 if there are unusual sources or circumstances. It takes 1 minute per Spool being processed.
- Items which have a template can be created with a DC 10 Intelligence (Engineering) check. It takes 1 minute per Spool used.
- Creating a template for an item takes 1 day per Spool used and a DC 10 Intelligence (Computer use) check, add +2 to the DC for each special feature.
- Making an item without a template is completed in 1 hour per Spool used. Make a DC 10 Intelligence (Engineering) check, with +2 DC for every Spool used.

Common effects for SMM

Whilst every SMM item will have its own uses and effects, here are some common ones.

- Disguised objects generally require a DC 18 Wisdom (Perception) check to see through, and that's if someone knows about SMM. If they don't know about SMM they shouldn't really get a roll, although you can allow a DC 25 check if they are really suspicious.
- Items which transform require a Move action to change, but can provide a +5 Initiative for the first round of combat if the activation is the trigger for combat and the other side were not expecting it.
- If an item assists a roll it generally provides a +2 skill bonus.

- Mono-molecular special features allow structures generally too flimsy for combat to function as a normal weapon.
- High frequency vibration gives a weapon the armour piercing quality.

HexDNA

(Broken Shield)

Creating SMM objects

Generally in HexDNA the process for creating SMM items will default to making a single 4+ Weaver (Hardtech) skill check, with the Drama Die providing sufficient complications and boosts to provide interest and move the story forward.

However, if the story requires more granularity:

- Make a 3+ Weaver (Hardtech) skill test to process keratin. It takes 1 minute per Spool being processed.
- Items which have a template can be created with a 3+ Weaver (Hardtech) skill test. It takes 1 minute per Spool used.
- Creating a template for an item takes 1 day per Spool used and a 4+ Weaver (Hacking) skill test. For especially complex templates increase the difficulty to 5+.
- Making an item without a template is completed in 1 hour per Spool used. Make a 5+ Weaver (Hardtech).

Here are some SMM specific sample complications and boosts to use with the Drama Die.

Minor complications

- The noise of the process attracts unwanted attention.
- The process creates noxious fumes that cause anyone in the room to hallucinate.
- The process has left an identifying signature on the item that will make it

easy to match to this machine, which will become important later.

Major complications

- The 3D printer catches fire, the project is ruined and the fire is spreading quickly.
- An industrial accident ruins the item and causes a Physical Injury to someone.
- The computer controlling the process is hacked and every template is wiped or stolen.

Minor boosts

- The project is completed in half the time anticipated.
- During the process you identify a hacking attempt and block it, but who is it, and why?
- During the process you glimpse someone you thought was dead - is it really them?

Major boosts

- During the process someone stumbles onto you, but it turns out they can be very helpful to your situation - gain a new ally.
- The process glitches but creates an unintended extra special function in the item for free.
- From waste from the project you are able to construct a second smaller project within the same time - what is the second item?

Edge: Designer

You are skilled in designing and creating gadgets, including those made with SMM. You gain +4 dice for any Weaver (Hardtech) or Weaver (Hacking) skill test relating to the design and creation of a new gadget.

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