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Designing for the Public Sector with Generative AI

With a few rules of design, government leaders can harness new generative AI tools to help design the innovations of the future

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In September, 2022, Jason Allen won a $300 first-prize at the Colorado State Fair's fine arts competition.[1]

But Jason isn't an artist. He's a video game designer. And he didn't use an art program to create his entry. He used Artificial Intelligence.

Through the use of MidJourney and AI Gigapixel, Jason produced something that was judged superior to works that human artists spent painstaking hours creating. This sparked controversy about whether AI-generated art should be allowed in art competitions, but also shed light on AI's ability to perform a variety of creative tasks.

The explosion of **Generative AI** tools like ChatGPT, MidJourney, Codex, and Dall-E is demonstrating that AI can be successful in creative endeavors ranging from image creation to product design to document authorship.

But this does not mean that human designers are obsolete. AI offers the potential to exponentially scale the volume and diversity of innovative concepts. However AI cannot yet understand the needs of users or the context of problems, so it needs humans to set parameters for that search or make decisions on which solutions best navigate an organization's trade-offs. AI catalyzes human innovation rather than replaces it. So as AI matures, public-sector leaders should consider the following:

What if the next wave of government innovation is powered by Artificial Intelligence?

While that question may seem far in the future, today's leaders should think deeply about how humans and AI will work together. Government admittedly faces different challenges than a software company developing a new game or an aerospace company designing new airplane flaps. But Generative AI is already showing that it can create a raft of potential solutions that can test assumptions and uncover new paths to public innovation.

AI-powered innovation is coming. So, the question is **will government be ready? Will the public?**

What is Generative Design?

In its simplest form, Generative Design is idea generation with Artificial Intelligence. Generative Design uses machine learning and algorithms to rapidly create new and original content.

Typically this is done using a generative adversarial network (GAN) which pits two neural networks against one another, one generating content, the other judging it until the generated content gets good enough to fool the other neural network.

This means that GANs work differently than familiar forms of AI that you may interact with on a daily basis. Think of most AI algorithms as a funnel: they take in lots of disparate data and distill that down to one answer. They can take your whole movie watching history and use that to predict the next film you will want to watch, for example. But GANs and other Generative AI tools flip that funnel around: they take in one specific piece of information and use that to generate potentially lots of different outputs. For example, they can take in the prompt "draw me a chair" and use that to produce a sketch-like picture of a chair. So where typical AI algorithms seek to give you the one, correct answer, Generative AI can give you lots of answers that may be right.

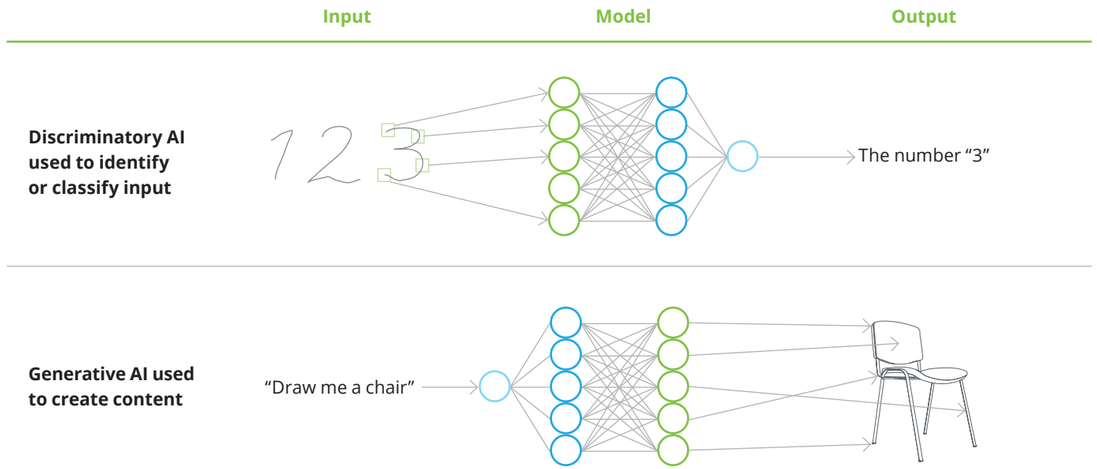

Figure 1. In some sense, Generative AI models work in reverse of more familiar AI models that recognize handwriting or predict trends

This potential to generate a large volume of high-quality solutions makes Generative AI an effective pair for a human designer. Because it is only bound by its training data and programmed constraints, Generative AI can produce truly “outside the box” solutions to complex problems. For example, NASA has used Generative AI on hard-to-design parts for spacecraft. These parts need to be strong and incredibly light, but also meet other unique properties like not obstructing sensors or leaving room for astronauts to assemble them. Even with all these constraints, Generative AI has proven that it can design parts up to ten times stronger than those from human designers.[2]

But that does not mean that human designers are not needed. Choosing those initial constraints for the model and setting the parameters for choosing a final design all involve value judgments – something that only humans can do. For example, you could even give the Generative AI a little inspiration by feeding it information on pre-existing structures or accelerate the process by training another program to recognize certain designs you or your organization tend to like or dislike, and set that program up as the “discriminator,” effectively automating the iteration process. In such a setup, the Generative Design program can churn through thousands of potential building designs in the same time it would take a human to model just one.

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The magic of Generative AI isn’t in the silicon, it’s in this process. They way humans and AI work together to unearth new, valuable solutions to hard problems. That process is known as Generative Design (See Figure 2)..

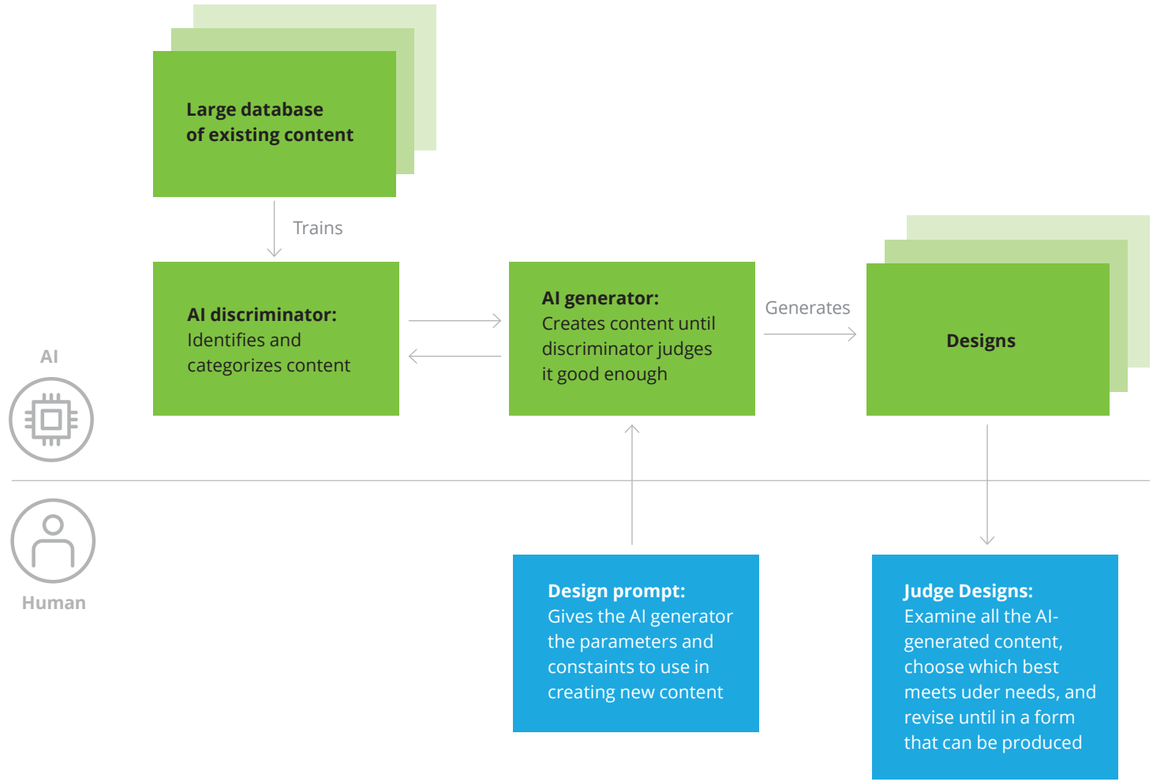


Figure 2. The Generative Design process pairs Generative AI with human expertise

Using Generative Design, a human designer can set up the process, input parameters, intervene partway through to tweak constraints, and ultimately, select the best design or designs (orange boxes in the graphic above). The designer could then alter the designs personally or input them back into the process to be refined. Significantly, this can be done at scale and while minimizing resource intensity. The computer generates a variety of solutions and tests them against constraints; successful variations are amplified until multiple correct - and often unconventional - answers are produced that satisfy all constraints (blue boxes in the graphic above). In many ways, Generative Design is the ultimate whitespace innovation tool; enabling designers to exhaust entire solution spaces in a fraction of the time, freeing up the human to think strategically about where to play next. For example, when researchers applied the same kind of reinforcement learning used in Generative AI to AI playing board games, it was able to uncover new strategies that had never before been seen in the thousand-year histories of games like chess and go.[3]

It is therefore unlikely that Generative AI will automate away entire jobs or industries. Rather, the Generative Design process highlights the future of human-machine teaming, as these capabilities automate certain tasks and free humans to provide oversight and solution evaluation.

The environmental conditions are building for an 'explosion' of Generative Design applications across a wide range of industries. In the last three years, venture capital firms have invested over $1.7 billion in Generative Design solutions with drug discovery and AI software coding receiving the most funding. Some experts suggest that by 2025, more than 30% of new drugs and materials could be discovered and developed through Generative Design techniques.[4] Generative Design is already being used to dub feature films into foreign languages, and one filmmaker is even using it to write and film an entire feature length movie.[5]

Generating designs with Generative AI

How the public sector can use Generative Design

Generative Design is used in commercial industries to improve manufacturing efficiency, discover new drugs, create new consumer products, and protect privacy by creating synthetic data.

(For more on current uses of Generative Design, see page 14 “Generative Design goes to work.")

Government is different and that’s good!

Despite Generative Design’s wide-ranging applications, its use in the public sector is limited today. Part of the challenge is the type of problems that government tackles. While designing a new drug or airplane part can be a complex process, most people tend to agree what a “good” product looks like. However, for the public sector’s most complex problems, there can be deep disagreements over what “good” looks like. Even for issues where desired outcomes are clear, like public health, education, or national defense, debates can occur about the right ways to achieve those outcomes.

But far from being a drawback, this is actually another reason for government to try Generative Design. Its ability to create several potential solutions, unconstrained by human cultural baggage, **can help test assumptions and uncover shared common ground** as human decision-makers sift through the trade-offs posed by various AI-generated options.

For this and many other reasons, forward-thinking government leaders should begin considering how Generative Design could transform their operations, increase innovation, and deliver real value to the public.

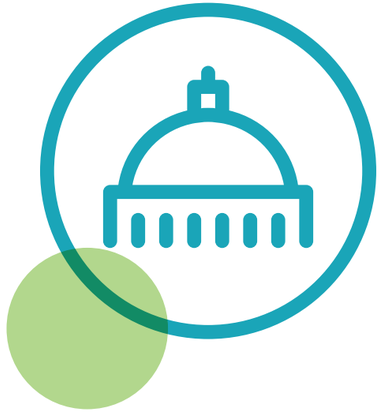
Potential applications of Generative Design in the public sector could include:

Facility design

Generative Design offers a new path to designing public buildings. Autodesk, which offers a Generative Design platform today, designed its Toronto office using the company's own AI software, which optimized for employee-sourced criteria such as "daylight," "productivity," and "buzz."[5] Using Generative Design for architecture enables organizations to discover unexpected novel designs and navigate trade-offs.[7] Imagine using Generative Design to rapidly produce hundreds or even thousands of variations for military bases, ports of entry, or medical facilities to optimize operations or reduce costs. This is particularly critical when considering hybrid work models, in which virtual work will become more prevalent and the introduction of new technologies that promote virtual service delivery will impact facility footprint and layout.

Urban planning

Generative Design can also be used to create novel layouts for entire neighborhoods and cities. Digital twins have been used for years to understand how a new building or train line might impact a city. And now, Generative Design can work with those digital twins not just to test ideas, but to create them as well. Generative Design can prototype different solutions to downtown congestion, electric grip overloading, air quality or any number of other issues facing urban communities.



Policy creation

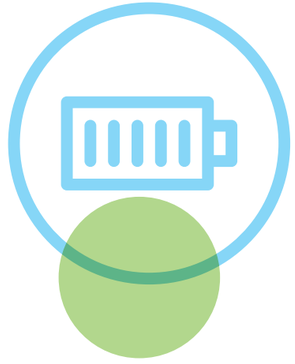
Public policies and rules are another area where, until now, technology has been able to test rules, but not help create them. Previously policymakers had to rely on their own expertise and instinct to craft new policies. But now, Generative AI can ingest huge volumes of data about a problem, examine past policies and their results, and then create new policy ideas to help achieve the collective goal. Even fundamentally human challenges like reducing speeding or improving **tax compliance could be modeled with agent-based discriminators.** Then Generative AI models could create many potential interventions that the discriminator says would be effective, enabling human decision makers to choose the right ones for their communities.[8]

Customer experience

Similar to the policy and regulation development application, Generative Design could be used to create more engaging websites and applications. Government functions ranging from tax collection to passport administration to benefits administration all rely on citizens using their forms and websites correctly. Creating a better user-experience for these services isn't just government policy, it can also **save agencies money and even improve citizens' trust** in government. Generative Design could essentially serve like virtual A-B testers. But instead of using only a few testers, Generative Design could simulate millions of users of diverse backgrounds, abilities and preferences to zero in on the fastest forms and the easiest to use website, all improving customer experience for a variety of citizens.

Learning and development

Better training may be the key to better government in an environment where digital skills and workforce are changing rapidly.[9] But traditionally training has been hampered by a trade-off: a general lesson could reach more people while a individuated lesson could reach fewer people but be more effective. Generative Design can break that trade-off. It can quickly create individualized training customized to the learning needs of each student. For example, Army soldiers and Air Force pilots are already being trained in synthetic training environments where soldiers use a mix of real and virtual equipment to accomplish missions in virtual reality.[10] Although these training scenarios are currently manually programmed, Generative Design could help create custom scenarios, tailored to the learning needs of each squad or even each individual. Stanford University is even supporting research into how Generative Design could help school children learn through more customized lessons.[11]



Reducing carbon emissions

Generative Design can also help reduce carbon emissions by fostering breakthroughs in material and energy science. The National Science Foundation is funding research into the use of GANs to explore novel metal organic frameworks (MOF) and solid-state electrolyte materials. New materials suggested by the GANs could help build higher-performing batteries that could speed the adoption of electrification in sectors such as long-haul trucking that require lighter, longer lasting batteries.

Generating designs with Generative AI

Generative Design goes to work

Generative Design is more than just a curiosity. The process is already helping companies in many different industries become more innovative and more efficient.

In the food industry, Consumer Packaged Goods (CPG) companies ranging from PepsiCo to Unilever to Danone, are using AI to shape their innovation pipelines. Suppliers like Cargill and Givaudan also are using AI to identify ingredients and flavors they can sell to manufacturers.[12] And in semiconductor chip design, Generative Design has been shown to successfully optimize component placement, reducing product-development life cycle time from weeks with human experts to hours with Generative Design.[13]

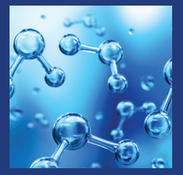
Other uses include:

Image and art creation

Synthetic image generation can produce photorealistic images of people who don't exist, or the digital impersonation of a real-life person, for instance, via deepfake. But GANs can do more than that when it comes to image generation: they can be used to generate animated or rendered content for videos, video games, and computer programs, a task that previously took human creators days or even weeks to accomplish. Similarly, GANs can translate images from one setting to another, for instance, converting satellite images into a "Google Maps" layout, or creating an animated version of an authentic human face.[14]

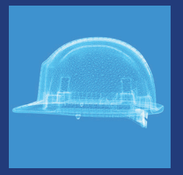
Engineering and manufacturing

Generative Design has been used to create innovative, high-performing aerospace parts. As part of their Concept Cabin project, Airbus set out to redesign parts of the A320 with the ultimate goal of halving greenhouse gas emissions by 2050. The team used Generative Design to create more than 10,000 designs of cabin partitions, drawing inspiration from the structures created by slime molds. At first, the team settled on a design they couldn't manufacture—but that was no problem. Such "ideals-first design" aims to create a "Platonic form" of a part that can serves as a model for the next-best manufacturable part. In this case, the final biomimicry-inspired partition came with a few key augmentations, but was still 45% lighter than conventional models, resulting in huge cost and carbon savings.[15]



Drug discovery

Generative Design is also being applied to breakthroughs on the very small scale. For instance, in pharmaceuticals, it costs slightly more than $2.5 billion to develop a new drug, and only about 14% of drugs make it past clinical trials. In total, the average R&D cycle time for a new drug is a little greater than 12 years, a large portion of which is spent trying to identify suitable molecules to test. However, as recently as last year, the Japanese pharmaceutical firm Sumitomo Dainippon Pharma partnered with Oxford-based AI start-up Exscientia to create a novel drug for treating OCD in just 12 *months*. The team used a series of generative algorithms to parse through millions of permutations of chemical compounds, until they identified 350 for the scientists to trial. Used in this way, Generative Design can not only increase the breadth of innovation, but also its speed.[16]



Advanced material creation

The creation of advanced materials is yet another sphere of exploration for Generative Design. Researchers from Lawrence Livermore National Laboratory (LLNL) are using Generative Design to create material shock absorbers that improve energy dissipation.[17] In particular, they are trying to make better protective helmets by modeling myriad foam structures using generative software. Also in materials science, there is emerging research into the use of Generative Design to create new structures for storing energy. In a recent grant funded by the National Science Foundation, researchers are using GANs to explore novel metal organic frameworks (MOF) and solid-state electrolyte materials to build higher-performing batteries, which could have a dramatic impact on the adoption of electrification in sectors such as long-haul trucking that require lighter, longer lasting batteries.[18]

Synthetic data generation

GANs can be used to create synthetic data, on which other GANs can be trained. Research firm Gartner estimates that "by 2024, use of synthetic data created with Generative Design will halve the volume of real data needed for machine learning." Such synthetic data can be used to enhance the efficacy of digital security systems by creating new training data for other ML models without violating the privacy in ways real-world data might.[19, 20]

Getting started with Generative Design

Generative Design is a new process and can be a challenge to many organizations. To set themselves up for success, potential adopters of Generative Design need to keep in mind a few key considerations:

Put the user at the center

Generative AI tools can produce a number of impressive concepts. But since AI only knows the constraints it has been given, it is important that the human part of Generative Design bring the user's needs to the fore. The best innovations are not just new—they are feasible, desirable, and viable. But what is desirable or what is viable with users depends on the needs and beliefs of actual human users. Therefore, designers working in Generative Design should reflect the perspectives of end-users in the prompts given to the AI and the decision criteria the designers use to select a final design.

Tap into the ecosystem for needed capabilities

As a process blending human and machine, Generative Design calls for not just design skills but also technology skills as well. For the latter, talent proficient in GANs and other forms of machine learning is required. This talent needs to be able to supervise the operation of GANs from training through use to help ensure that they function as intended.

Luckily, not all of these skills need to be resident within government. Key partnerships with academia, technology providers, and non-profits can help government agencies develop the skills and tools they need to use Generative Design effectively and ethically.

Implement strong governance

Since Generative Design can produce content indistinguishable from human-produced creations, great care needs to be taken in its use, especially on public issues. There are several areas of public service where there needs to be trust that interaction is truly human—think mental healthcare, political decision making, and so on. Additionally, if the training data used to develop the model underlying a Generative AI system has bias, that bias can be reflected in the system's outputs. Therefore, significant care needs to be taken to embed ethical controls into every step of model development and use. Principles such as NIST's **standards on trustworthy and responsible AI** or Deloitte's **Trustworthy AI framework** can help leaders "bake in" ethics to their Generative Design processes.

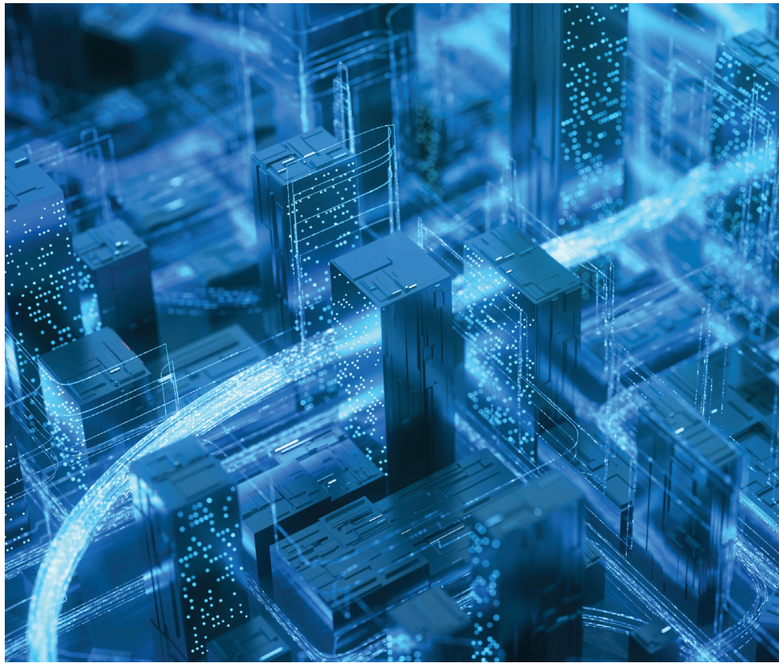
Generating designs with Generative AI

Generative Design is a powerful tool, but even such a powerful tool can bump into limitations of what is possible in the real world.

Don't forget real-world constraints

Although Generative Design can create some truly remarkable designs, not all of those designs are realistically manufacturable. 3D printing has made it possible to create some of the previously impossible Generative Designs for physical objects, but limitations in the size, cost, and strength of 3D printed parts can limit some applications.

Similarly, for non-physical designs like urban plans or public policies, the constraints of human incentives can be strong barriers. Generative Design will optimize against whatever constraints are provided. While that means values such as sustainability can be built into their designs, it does not mean that adoption of the designs created is a foregone conclusion. To improve adoption, designers need to pay attention to users' incentives in the Generative Design process. Designers can then either tailor design prompts to appeal to those incentives—by weighting designs that are cheaper to produce if cost is a key incentive for example—or working with government leaders to adjust those incentives when necessary—such as creating tax incentives to reduce carbon emissions if more sustainable products are desired.



Generating the future

Imagine a future in which requirements gathering happens at a massive scale, drawing on data from digital call centers and internet of things devices.

These requirements are fed into a Generative Design tool which can produce between one and thousands of possible solutions depending on preferences in a mere matter of minutes. Those solutions are fed into a digital twin, which simulates their impact on government service delivery, and gives human designers a "top" 10 list for further evaluation. **This could—and should—be a major part of the future of government innovation.**

As Generative Design technologies continue to become cheaper, and the processing power of personal devices continues to increase, it is not unrealistic to envision a world in which a Generative Design tool is found in everyone's pocket (i.e., smartphone). In such a world, the following could happen: You walk past a vacant lot. You snap a picture of it, draw a quick sketch on top of it and whisper a few words to your phone. Your phone produces a potential design for the space. You provide feedback, shake your phone, and a new design appears. You go through this process a few more times before you submit it to your local government's concept intake page. And then you continue walking down the street.

The future of government innovation will be no different. Ideation will not be a point-in-time activity, but rather an ongoing process in which thousands of promising concepts are generated and evaluated by AI in minutes. This vision offers an opportunity to fundamentally transform how government interacts with citizens and stakeholders. But for it to become a reality, forward-looking government leaders must begin laying the foundation today.

Reach out for a conversation.

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Endnotes

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3 Wired: In Two Moves, AlphaGo and Lee Sedol Redefined the Future
4 Generative AI Use Cases for Industries and Enterprises (gartner.com)
5 TechEU: Generative AI is bringing the biggest disruption to film making in 100 years and The Byte: Someone's making an entire movie using video generated by AI
6 Autodesk University: Hands-on with Project Rediscover: Generatively Designing the Autodesk Toronto Office
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19 Allerin: The growing role of AI in the pharmaceutical industry
20 NSF Award Search: SBIR Phase I: AI Enabled Cameras for Fire Detection

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