

Project Tycho



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Modern Problems

(Issues)



Effective life-saving treatments don't always reach the ill. Distribution catastrophes could reduce lives saved, whether it's Congolese tuberculosis or Martian pneumonia; producing, storing and transporting expensive heat-sensitive drugs during emergencies is a logistical humanitarian nightmare.

“The cure is where the disease is not and the disease is where the cure is not”

— John Green

Chem plant problem:

- ❧ Environmental pollution
- ❧ Generational health hazards
- ❧ Land exploitation



Modern Problems

(Industrial examples)



E4c, Reactors



E4b, Large pressurised vessel



E4d, Sydney solvent warehouse



E4g, University students



E4a, Industrial production facility



E4e, Typical chemical lab



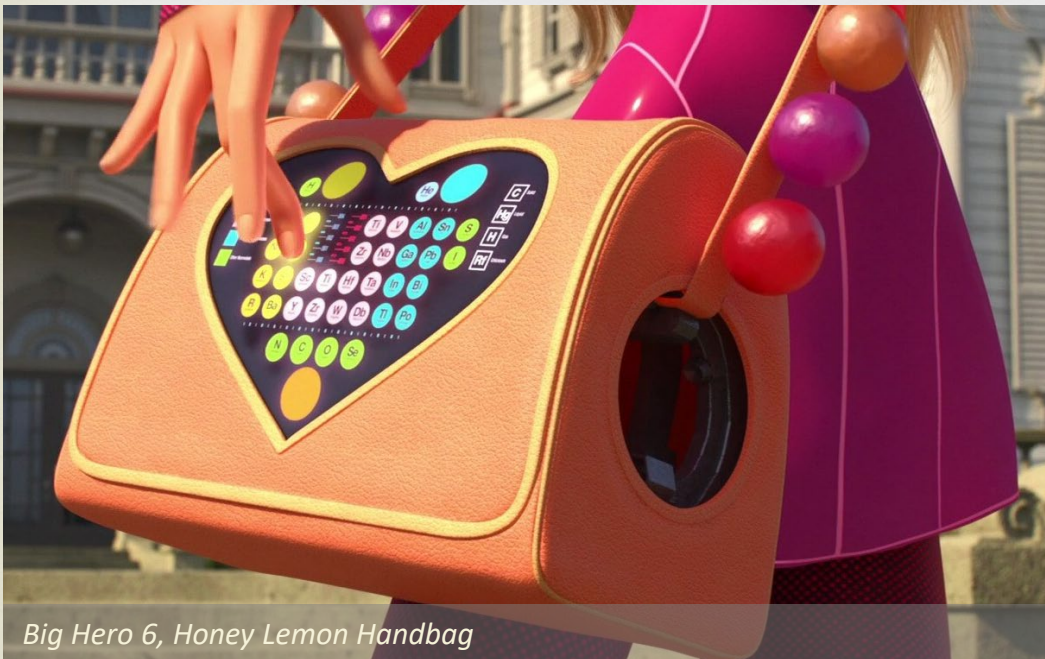
E4f, Dr. Alexander Shulgin in his lab

Modern Solutions

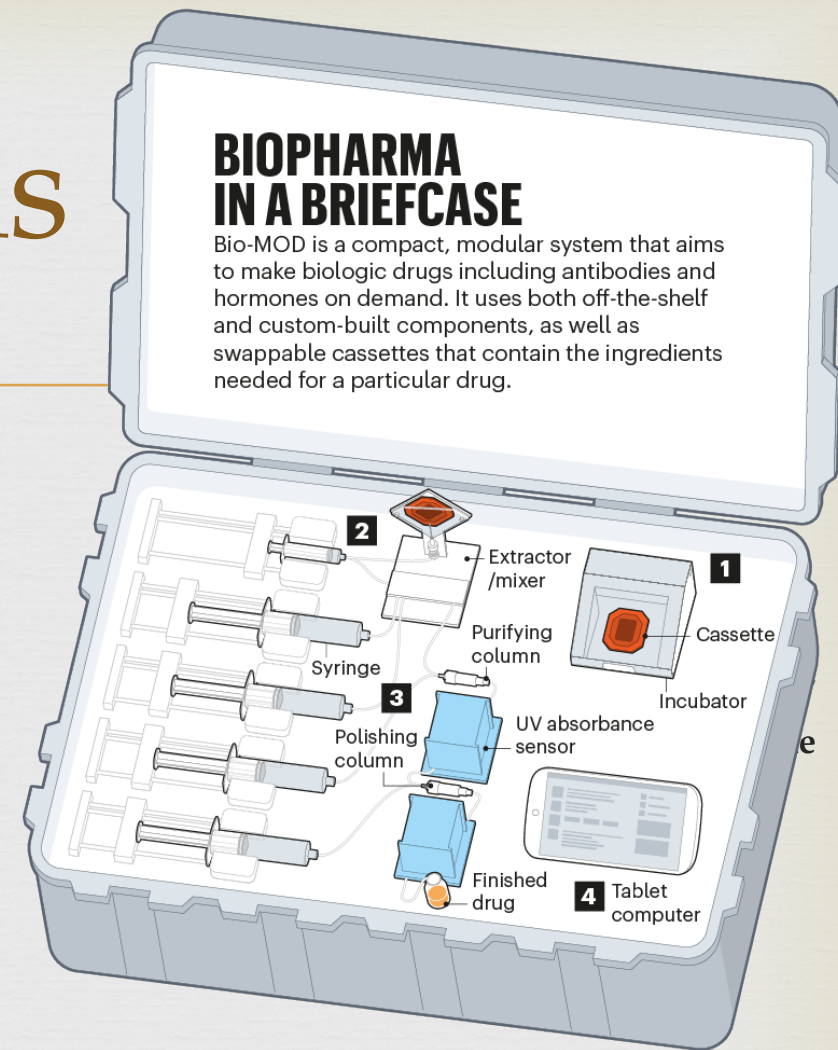
(Realistic examples)



Cronin, Kitson, Rao and other pioneers daydream of portable powerhouse blackboxes. Briefcase factories pumping out on-demand antiretrovirals in remote environments (Adamo 2016; Kitson 2016; Arnold 2019) These revolutionary techniques require democratization, inexpensive standardization and long-sought AI integration. This presentation explores potential pathways to this future.



Big Hero 6, Honey Lemon Handbag



- 1** A cassette containing DNA, cell extract and other necessary biomolecules is incubated in a temperature-controlled shaker to produce therapeutic proteins.
- 2** The cassette is then moved to another location, where its contents are extracted and mixed with solutions that will help separate the drug.
- 3** Syringes inject buffering solutions to stabilize and wash the drug as it passes through purifying and polishing columns.
- 4** A tablet computer controls the system's pumps and sensors to monitor the purity of the finished drug.

*"Any sufficiently advanced technology
is indistinguishable from magic"*
— Arthur C. Clarke

Future Solutions



Although Rao (Arnold 2019) describes rural, impoverished and primarily medical applications — Cronin and company are steadfast visionaries. Space exploration demands self-sufficient fabrication technology. Perhaps glass regolith reactors and chip-labs that reveal whether Martian nuclear detonations or spherical minerals indicate organic life — whilst feeding Earthlings that discover it — can emerge from today's work!



Star Trek: The New Generation, Replicator



Subnautica, Fabricator

Early Work



Seminal 2010s publications demonstrated crude 3DP plastic reactionware (Symes 2012); after several material improvements, the Cronin group released theoretical automation protocols, but the high technical ceiling and private interests limited wider adoption (Seifrid 2021; Hou 2021). Today, new open-source promises flow from LLM-CAD integration.

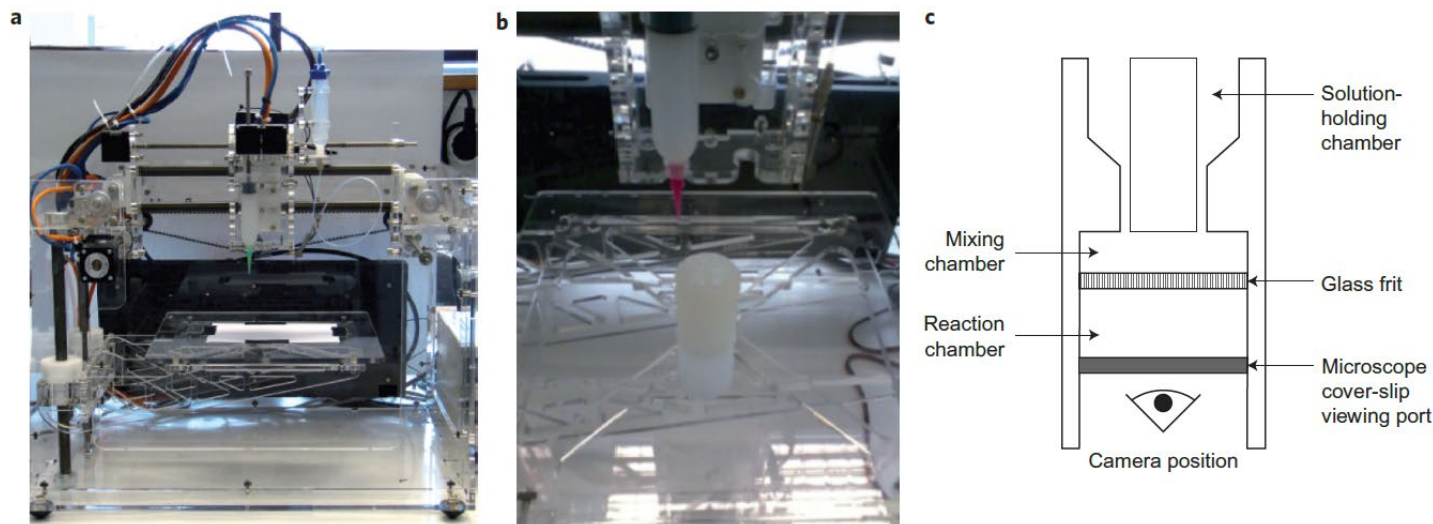


Figure 1 | The Fab@Home Version 0.24 RC6 freeform fabricator. **a**, The fabricator viewed from the front, with a single syringe of acetoxysilicone polymer loaded in the printing head. The white area below the printing head is a square of ordinary paper onto which the reactionware was printed. **b**, The fabricator printing one of the devices used in this work. **c**, Schematic of the as-printed multipurpose reactionware used in the synthesis of compounds 1-3, which shows the key features of the design.

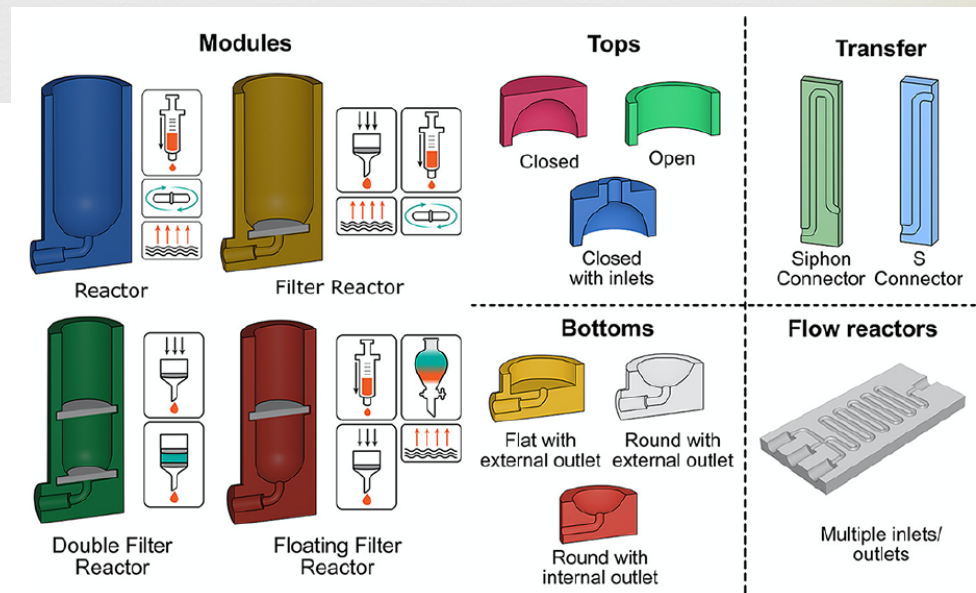


Figure 1. ChemSCAD software produces custom 3D printed reactors based on a number of templates while taking synthetic operations and reaction parameters into account. Reprinted from ref 5. Copyright 2020 The Authors. Published by American Chemical Society.

Reactor Design Software

(OpenSCAD and ChemSCAD)



Although any modern design software can create similar models, OpenSCAD's programmable syntax can be directly manipulated by agentic LLMs to tune precise adjustments that would otherwise be hand sculpted. (Daareyni 2025; Kumar 2025; Xie 2025).



Fractal OpenSCAD example

```
1 // Recursive calls of modules can generate complex geometry, especially
2 // fractal style objects.
3 // The example uses a recursive module to generate a random tree as
4 // described in http://natureofcode.com/book/chapter-8-fractals/
5
6 // number of levels for the recursion
7 levels = 10; // [1:1:14]
8 // length of the first segment
9 len = 100; // [10:10:200]
10 // thickness of the first segment
11 thickness = 5; // [1:1:20]
12
13 // the identity matrix
14 identity = [ [ 1, 0, 0, 0 ], [ 0, 1, 0, 0 ], [ 0, 0, 1, 0 ], [ 0, 0, 0, 1 ] ];
15
16 // random generator, to generate always the same output for the example,
17 // this uses a seed for rand() and stores the array of random values in
18 // the random variable. To generate different output, remove the seed or
19 // replace the function rand() to just call rand(s, e, 1)[0].
20 rcnt = 1000;
21 random = rand(0, 1, rcnt, 18);
22 function rnd(s, e, r) = random[r % rcnt] * (e - s) + s;
23
24 // generate 4x4 translation matrix
25 function mt(x, y) = [ [ 1, 0, 0, x ], [ 0, 1, 0, y ], [ 0, 0, 1, 0 ], [ 0, 0, 0, 1 ] ];
26
27 // generate 4x4 rotation matrix around Z axis
28 function mr(a) = [ [ cos(a), -sin(a), 0, 0 ], [ sin(a), cos(a), 0, 0 ], [ 0, 0, 1, 0 ], [ 0, 0, 0, 1 ] ];
29
30 module tree(length, thickness, count, m = identity, r = 1) {
31   color([0, 1 - (0.8 / levels * count), 0])
32   multmatrix(m)
33   square([thickness, length]);
34
35   if (count > 0) {
36     tree(rnd(0.6, 0.8, r) * length, 0.8 * thickness, count - 1, m * mt(0, length) * mr(rnd(20, 35, r + 1)), 8 * r);
37     tree(rnd(0.6, 0.8, r + 1) * length, 0.8 * thickness, count - 1, m * mt(0, length) * mr(-rnd(20, 35, r + 3)), 8 * r + 4);
38   }
39 }
40
41 tree(len, thickness, levels);
42
43 echo(version=version());
```

Viewport: translate = [2.76 81.56 103.90], rotate = [52.20 0.00 6.80], distance = 495.70, fov = 22.50 (814x680)

Reactor Designs

(Kitson)



(Kitson 2016; 2018)'s OpenSCAD .stl files are still available online. Agentic LLM-augmented CADs could use ROMA to pull from diverse libraries of valid reactionware workflows whilst cross referencing publications to inform human operators or suggest improvements.



Automated Reactor Design

(OpenSCAD, ChemSCAD, GAD, etc.)



Multimodal LLM integration enables:

- ❧ Natural language exchanges
- ❧ Data annotation
- ❧ Self-evaluation
- ❧ Human-reviewer quality control

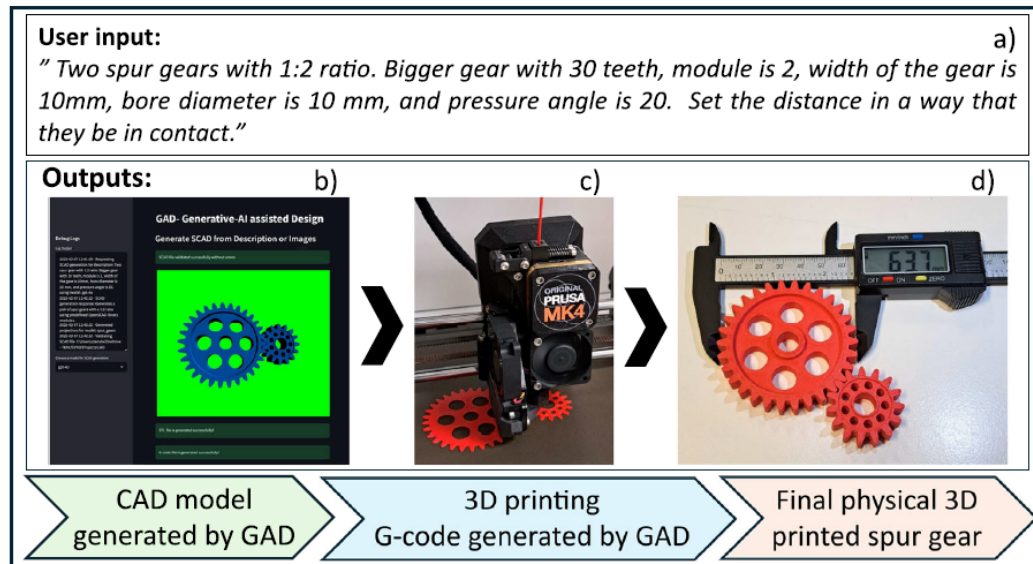


Fig. 4 Design to manufacturing process handled by GAD

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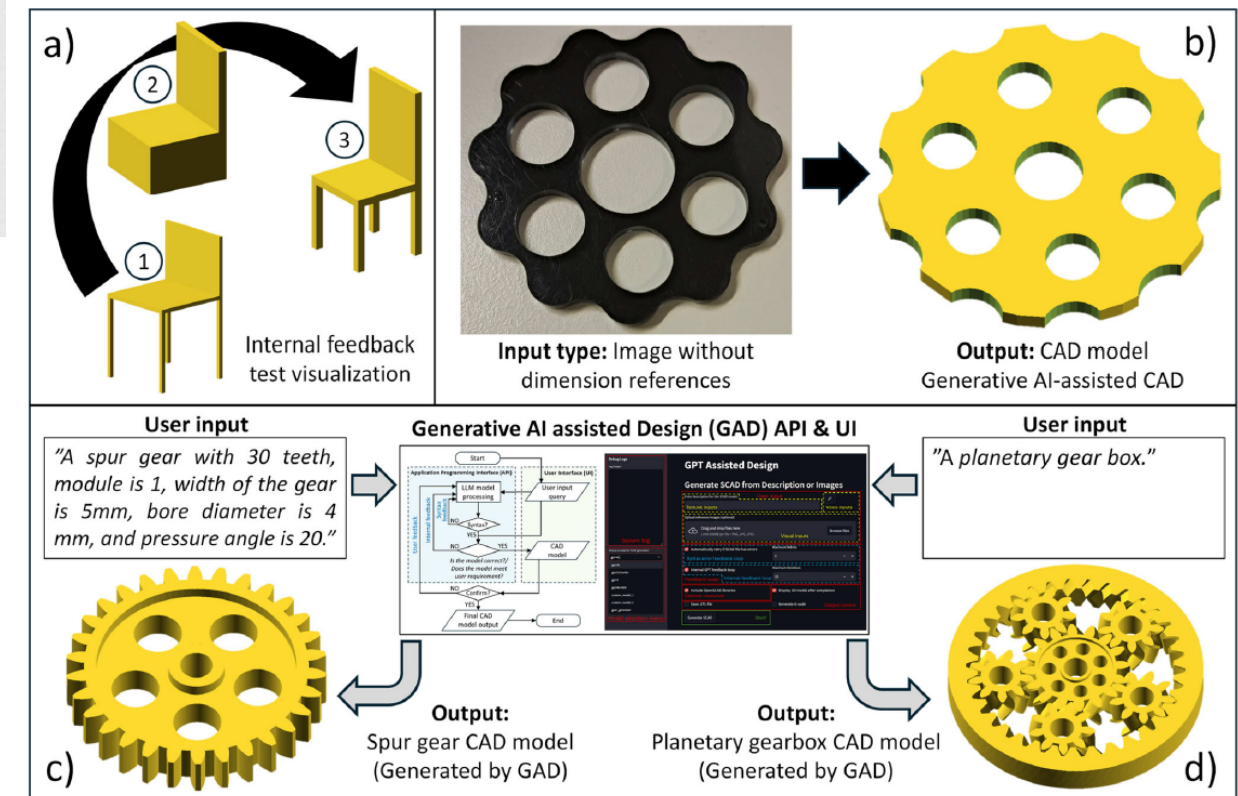


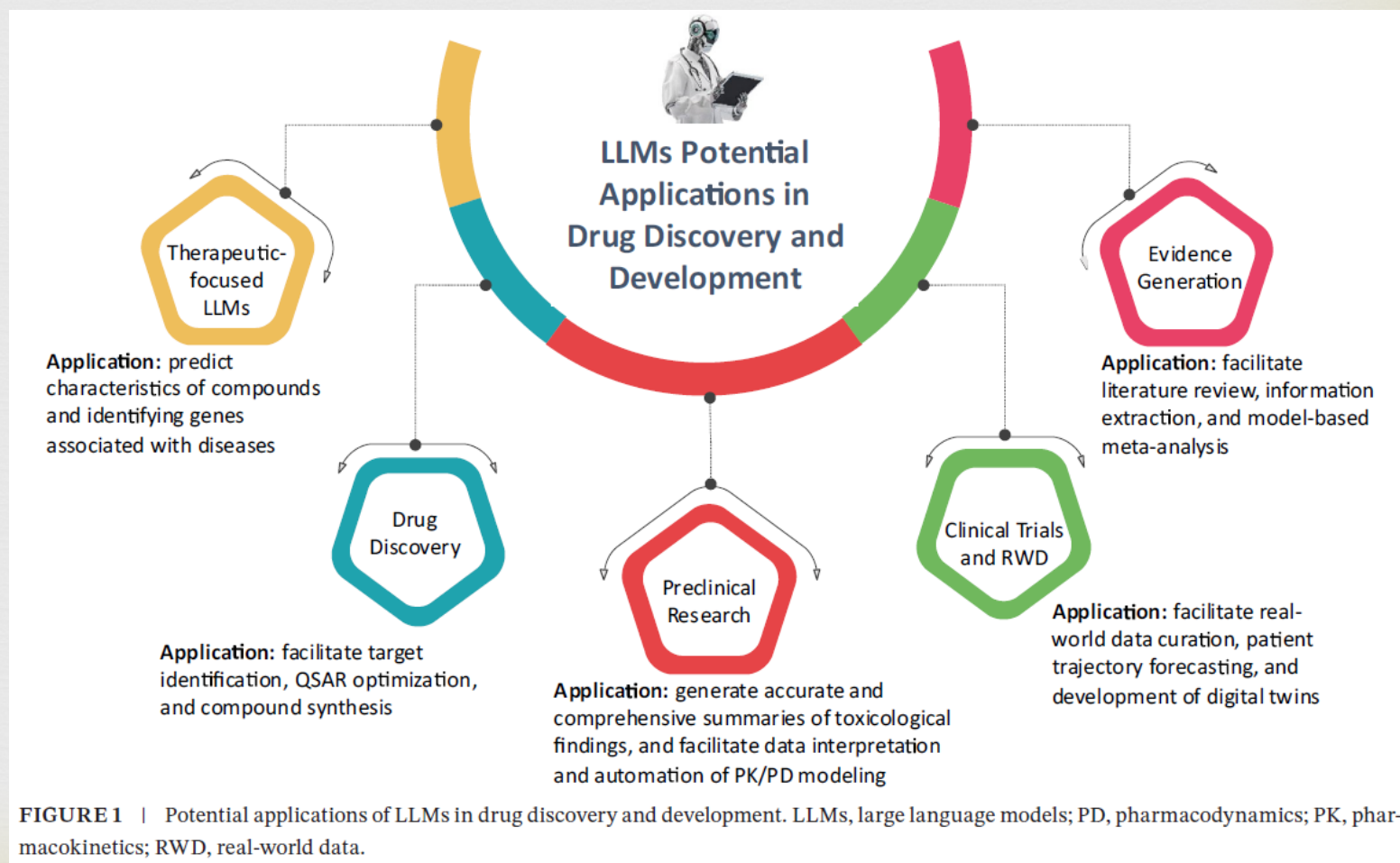
Fig. 3 GAD testing and validation results. a Investigation of internal feedback loop on the quality of results, b results extracted from GAD in case of only visual inputs, c GAD response to a complete user input, and d a planetary gear box generated by GAD

Automated Drug Design

(LLM Research Chemists)



Whether generating novel compounds with LLMs via 3D structure representations or streamlining their entire development process; the major accelerant promises, and technical hurdles associated with broad applicability are ripe for industrial investigation and Reaxys collaboration (Urbina 2024; Lin 2025).



Robotic Reactors

(Chemputing)



The next step Lee Cronin and NASA are taking in lockstep are monolithic “Chemputers”, fully robotic continuous flow systems whose chemical programming language dictates all reaction conditions and can be operated remotely (Adamo 2016). A boon for international science and published supplemental synthesis data. This must also be standardised outside niche commercial applications.

Fig. 1. Reconfigurable system for continuous production and formulation of APIs. (A) Labeled photograph of the stack of upstream synthesis modules. (B) Labeled photograph of the downstream purification and formulation modules. (C) Close-up examples of upstream units; PFA tube flow reactors in an aluminum shell for heating (left) and membrane surface tension-based separation units (right). (D) Images of some of the main components in the downstream unit including the (a) buffer tank, (b) precipitation tank, (c) filtration unit, (d) crystallization unit, (e) filtration unit, (f) formulation tank, (g) solution holding tank, and (h) formulated API. Details are in the supplementary text.



Project Joyous

(Non-Hallucinogenic Psychoplastogens)



Project Joyous (Eshun-Wilson 2021) endogenous monoamine syntheses were successful; we're now focused on adapting similar 3DP techniques to rapid-acting non-hallucinogenic psychoplastogenic antidepressants. Decades of labyrinthine progress, legislative roadblocks and failed clinical trials all lead towards Ariadne, isoTryptamines and other 5HT_{2A}r partial agonists (Cunningham 2023; Dunlap 2020; Olson 2018). Recent Psylo/Xylo patents reveal intensive closed-door investigation (Banister 2023; Gilles 2024). I'm convinced researching these compounds are in humanity's collective interest.

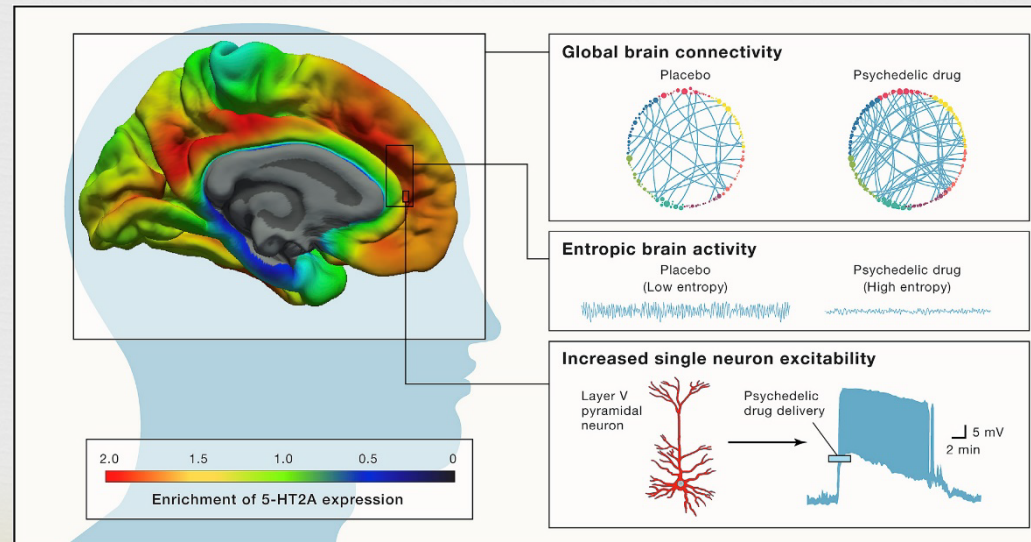
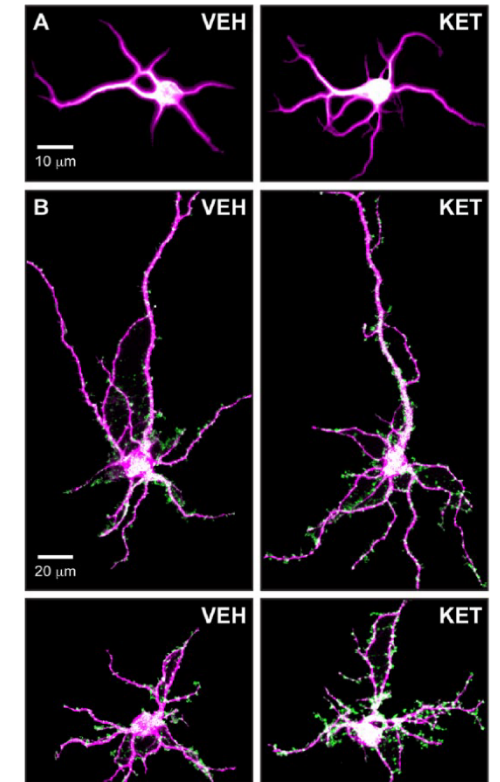


Figure 1. Ketamine is the prototypical psychoplastogen. (A) Immature cultured cortical neurons (DIV6) treated with ketamine display increased dendritic branching compared to vehicle-treated neurons. (B) Mature cultured cortical neurons (DIV20) treated with ketamine display increased synapse formation relative to vehicle-treated neurons. VEH, vehicle; KET, ketamine; magenta, MAP2 staining; green, synapses determined by colocalization of pre- (VGLUT1) and postsynaptic (PSD-95) puncta.

Advanced Extra-Terrestrial Synthesis

(Space)



Pharmacodynamics and kinetics change in spaceflight. Cosmic rays degrade medications. Sending blueprints of more potent and less resource-demanding pharmaceuticals for independent synthesis is mission-critical.

Medication shelf life: 2-3years

Earth-Mars travel time: >1.5years

Mars mission duration: >5years



In Summary



We discussed how symbiotic feedback loops between AI and biochemical could echo across the solar system, if it'd place fine chemical manufacture onto everyone's bench and what Polymath Pharmaceuticals is doing to further this work.

OLYMATH PHARMACETUCIALS

Thank You



Any questions?

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