Design from zeroth principles
Synthesizing intuitive designs through transmission chains

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Information transmitted from person to person along a chain will come to reflect their shared perceptual, inductive, and reconstructive biases. Here, we leverage this technique to synthesize intuitive designs.

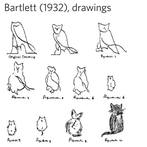
BACKGROUND

On intuitive design.

Users have expectations about how to interact with the world to accomplish their goals, and a good design conforms to those expectations. Practices such as A/B testing, usability research, and focus groups are one way to discover when a design is unintuitive.

On transmission chains.

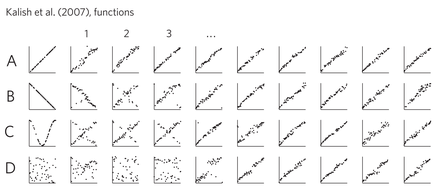
Bartlett (1932), drawings



Bartlett (1932), stories

One night two young men from Egulac went down to the river to hunt seals and while they were there it became foggy and calm. Then they heard war-cries, and they thought: "Maybe this is a war party." They escaped to the shore, and hid behind a log. Now canoes came up, and they heard the noise of paddles, and saw one canoe coming up to them. There were five men in the canoe, and they said: "What do you think? We wish to take you along. We are going up the river to make war on the people." One of the young men said, "I have no arrows." "Arrows are in the canoe," they said. "I will not go along. I might be killed. My relatives do not know where I have gone. But you," he said, turning to the other, "may go with them." So one of the young men went, but the other returned home. And the warriors went on up the river to a town on the other side of Kalama. The people came down to the water and they began to fight, and many were killed.

Kalish et al. (2007), functions



On design from zeroth principles.

If a good design is one that fits the expectations of its users, then any difficulty in perceiving, learning, or remembering a design indicates that it may be inconsistent with the user's cognitive biases. By passing the design through a transmission chain, the users' perceptual, inductive, and reconstructive biases will transform the initial design into one that is better fit to human cognition. In this way, it becomes possible to improve a design without appealing to first principles of design — thus we call it *design from zeroth principles*.

EXPERIMENT 1. STIMULUS–RESPONSE MAPPINGS

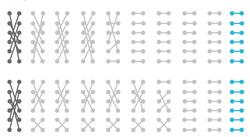
In which direction should a screw be turned in order to drive it further into wood? Which light switch should be flipped to turn off the patio light? And which knob should be turned to light the front left stove burner? Assigning these mappings are design decisions, and some mappings are better than others. Designs with stimulus–response compatibility offer a simple and clear mapping between an action and a response, leading to shorter reaction times and lower rates of error (Fitts & Seeger, 1953; Proctor & Reeve, 1989; Kornblum, Hasbroucq, & Osman, 1990). Exp. 1. finds intuitive stimulus–response mappings through design from zeroth principles.

Stimulus.

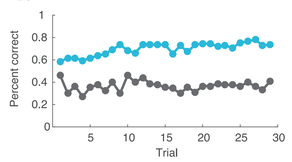
Participants.
A. 100 people from Amazon Mechanical Turk (AMT).
B. 200 people from AMT.

Tasks. A. Learn the mapping by observing switch flips, then get tested on it. 10 chains of 10 people. *B.* Learn a mapping from the beginning of the chains in A; vs. from the end of the chains in A.

A.



B.



EXPERIMENT 2. VANITY PHONE NUMBERS

A vanity number is a telephone number with an easily remembered sequence of digits — e.g., 1 (212) 222-2222, 1 (800) 800-8000, or 1 (202) 456-1111. Businesses often use them in radio and television advertisements, and occasionally, as in the case of 1-800-Flowers.com, Inc., incorporate them.

Participants.
40 people from Amazon Mechanical Turk (AMT).

Stimulus.
10-digit strings formatted as (XXX) XXX-XXXX, sampled randomly from those following the North American Numbering Plan.

Task.
Remember the # for 4 seconds, then reproduce it. 20 chains of 40.

Table 1. Features used to predict telephone-number pricing and their weights in the model. Pricing data from Twilio and phonenumberguy.com.

Feature	Example	β (log USD)
Millions	1 (415) 700-0000	1.67
Seven in a row	1 (415) 777-7777	3.48
Six in a row	1 (415) 877-7777	1.16
Hundred thousands	1 (415) 870-0000	1.69
Thousands	1 (415) 626-8000	0.60
Hundred-thousands	1 (415) 500-6000	1.20
Double repeater A	1 (415) 888-7777	1.96
Double repeater B	1 (415) 866-7777	0.49
Mid repeater	1 (415) 888-2465	0.65
№ of unique digits	1 (415) 326-9087	−4.27
Eight 9s in a row	1 (419) 999-9999	3.70

Table 2. Change points in a chain seeded with a random telephone number and estimated values in USD. The first column is the generation index.

I	Number	$
0	(603) 639-5026	91
1	(603) 639-7843	90
2	(603) 639-0000	214
8	(603) 693-1234	91
9	(603) 693-1294	91
10	(603) 693-0000	216
20	(800) 963-0000	218
24	(800) 936-0000	217

Result.
$119 vs. $548 per number, 6.95 vs. 9.29 digits remembered

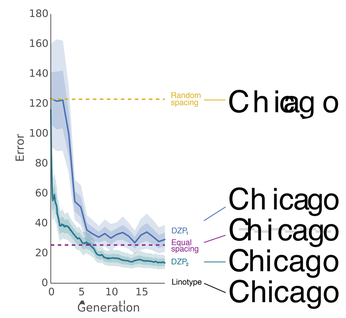
EXPERIMENT 3. LETTERPL ACEMENT

Typographers adjust the placement of letters in typeset words to improve the text's readability and legibility. With a lifetime of exposure to printed text, people have strong expectations about letter placement. In Exp. 3, we use these expectations to derive letter placements through design from zeroth principles.

Participants. 200 people from AMT.

Stimulus. Fifteen words set in Helvetica: Typical, frogs, vacuum, hunchback, Chicago, Year, Egypt, the, eye, kiln, milk, WAVE, fjord, Bring, and Pile,

Task. Observe the word, then reproduce it. 20 chains of 10.



We evaluated design from zeroth principles *in three domains: stimulus–response mappings between light switches and lights; vanity phone numbers; and letter placement in typeset words. In each case, seeding a transmission chain with a random design and then running it forward improves the design, making it easier to learn and harder forget.*

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