George Spencer Brown's "Design with the NOR"

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George Spencer Brown's "Design with the NOR": With Related Essays

Edited by

PROF STEFFEN ROTH
La Rochelle Business School, France
University of Turku, Finland

PROF MARKUS HEIDINGSFELDER
Xiamen University Malaysia, Malaysia

MR LARS CLAUSEN
UCL University College, Denmark
University of Flensburg, Germany

DR KLAUS BRØND LAURSEN
University of Aarhus, Denmark

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About the Contributors

Mohammad Arif Sobhan Bhuiyan was born in Chittagong, Bangladesh in 1985. He received his B.Sc. and M.Sc. degrees in Applied Physics, Electronics and Communication Engineering from the University of Chittagong, Bangladesh, in 2006 and 2007, respectively. He received his Ph.D. from the Universiti Kebangsaan Malaysia, Malaysia in 2017. He is currently an Assistant Professor at the Department of Electrical and Electronics Engineering, Xiamen University Malaysia, Malaysia. His research interest is in the field of RF & Wireless Communication and low power IoT devices.

George Spencer Brown (1923–2016) engaged in multiple disciplines throughout his life. His first publication was a proposed doctoral thesis: *Probability and Scientific Inference* (1957). In 1969, his book "Laws of Form" was published for the first time and it has never been out of print since. It has been amended with numerous prefaces and appendices throughout the course of his lifetime. Later publications were sometimes published under the pseudonym James Keys. He had multiple connections to universities and business endeavors in the UK and overseas during his lifetime. His work on the foundations of philosophy and mathematics has inspired generations of thinkers across disciplines from the social sciences, physics, engineering, biology, and philosophy.

Lars Clausen is a Doctoral Candidate at Europa – University of Flensburg, Germany and Lecturer at the UCL University College, Denmark. He graduated from Aarhus University in Denmark in sociology. His research includes the history of design patterns in theory structures, the functions of diabolical communication, and applied interdisciplinary research.

Albrecht Fritzsche is Acting Chair of Technology and Process Management at Ulm University. He is also a Senior Lecturer at Friedrich-Alexander University Erlangen-Nürnberg. He holds a doctoral degree in philosophy from TU Darmstadt and another one in industrial management from Hohenheim University, Stuttgart. His research interests include design theory, innovation management, open laboratories, and service engineering.

Markus Heidingsfelder is the author of System Pop (2012) and Trump - beobachtet (Observing Trump, 2020). He was born in Cologne, Germany, in 1963, received his Ph.D. from the Ludwig Maximilians University Munich in 2009,

held appointments at DJS Munich, HCU Hamburg, FU Berlin, LMU Munich, Habib University (Pakistan), and is now an assistant professor in the Journalism Department of Xiamen University Malaysia.

Franz Hoegl studied communication design at TH Nuremberg. After graduating, he worked as a Freelance Designer and Illustrator; since 2011, he is the Creative Director of the Denkmalneu Gruppe. In the context of his work as a Designer, he also conducted intensive studies in the fields of philosophy of language and semiotics. After meeting the sociologist Peter Fuchs, from whom he learned about systems theory, he has since been publishing on topics such as the history of logic, communication, and language from a systems theory perspective. He is also a Passionate Banjo Player in the alternative country trio "The Sandbox Josephs."

Klaus Brønd Laursen is a Post-Doctoral Fellow in management at the Aarhus University, Denmark. His research interests include the economy of morality, temporality, and market studies.

Kelvin J. A. Ooi received his B. Eng. (Hons.) and Ph.D. degrees in Electrical and Electronic Engineering, from Nanyang Technological University, Singapore, in 2010 and 2014, respectively. He is currently an Assistant Professor at Xiamen University Malaysia (XMUM), affiliated to the Department of New Energy Science and Engineering, and the Department of Physics. Prior to joining XMUM, he served as a Postdoctoral Research Fellow, from 2013 to 2018, in the SUTD-MIT International Design Center, and also the Lee Kuan Yew Center for Innovative Cities, at Singapore University Technology and Design.

Steffen Roth is a Professor of Management at the La Rochelle Business School, France, and an Adjunct Professor of Economic Sociology at the University of Turku, Finland. His research interests include management and organization theory as well as the digital transformation of social theory.

Divyamaan Sahoo was born in Calcutta, West Bengal, India in 1995. He received his B.A. from Bates College in Lewiston, Maine, in 2017, majoring in Mathematics, Philosophy, and Music Composition, and recently received his M.F.A. in Studio: Sound from the School of the Art Institute of Chicago in Chicago, Illinois, in 2020. He is currently working as an Independent Researcher with Louis H. Kauffman and James M. Flagg in reviewing Appendix 9 of the revised Sixth English edition of George Spencer-Brown's "Laws of Form" (2015, Bohmeier Verlag, Germany).

Peter Zeiner studied Physics at TU Vienna. He received his Ph.D. from TU Vienna in 1998. After some years as Postdoc in Vienna and at the University of Nijmegen, Netherlands, he spent many years at Bielefeld University, where he got

his habilitation in Mathematics in 2015. Currently, he is an Associate Professor at the Department of Mathematics and Applied Mathematics at Xiamen University Malaysia. His research interests include discrete mathematics, algebraic number theory, and mathematical crystallography.

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List of Contributors

Mohammad Arif Sobhan Bhuiyan   Xiamen University Malaysia, Malaysia
George Spencer Brown   1923–2016, UK
Lars Clausen   UCL University College, Denmark
Albrecht Fritzsche   Ulm University, Sweden
Markus Heidingsfelder   Xiamen University Malaysia, Malaysia
Franz Hoegl   Denkmalneu Gruppe
Klaus Brønd Laursen   Aarhus University, Denmark
Kelvin J. A. Ooi   Xiamen University Malaysia, Malaysia
Steffen Roth   La Rochelle Business School, France
Divyamaan Sahoo   Independent Researcher
Peter Zeiner   Xiamen University Malaysia, Malaysia

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Acknowledgments

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Chapter 1

Editorial Note

Steffen Roth, Markus Heidingsfelder, Lars Clausen and
Klaus Brønd Laursen

The discovery of George Spencer Brown's then-yet unpublished typescript *Design with the NOR* was a perfect coincidence.

One of the co-editors, Markus Heidingsfelder, and his friend, photographer Mirko Ludwig, visited Spencer Brown in 2013 at his home in the small village of Horningsham, where his former student Lord Bath had provided a house for him. The villagers had made their peace with the "crazy professor" who – according to some of the stories they told – used to mow his lawn by burning it down with gasoline or went shopping in his underpants.

It was Heidingsfelder's second visit; after many interviews over the phone, Spencer Brown had finally agreed to meet him in person. But this time, Heidingsfelder also wanted to bring home some professional photographs of this cult figure of constructivism. The visit was well worth the effort of another trip to England, as the arresting black and white photo portrait of Spencer Brown proves. It has been illegally reproduced many times on the Internet (i.e., without giving credit to the photographer) and is shown legally (Photo 1).

Over five days, several interviews in his house were conducted. In the evenings, a stop at the local pub was an essential part of the program. Spencer Brown always drank his beloved Bloody Mary, whereas the guests limited themselves to British ale.

During one of the interviews, when Spencer Brown mentioned that mathematics keeps him alive, he pointed at the thick notebooks that stood behind him on the floor. All of them were black, with large white numbers written on their side. A thin, lime-green one stood out and thus attracted the interest of his visitors. Spencer Brown handed it to them. As it turned out, it wasn't a notebook – it was his typewritten 1961 report *Design with the NOR*.

A quick glance at it was enough for the visitors to realize the historical significance of the text, which marks the official beginning of Spencer Brown's career as a meta-logician: It was nothing less than the predecessor to his opus magnum and cult classic *Laws of Form*. The typescript was scanned – along with some pages of his notebooks and other materials – and the scans first sent to Dirk Baecker (2017) and Steffen Roth (2017), with the latter giving the inspiration to organize the June 2019 workshop "NOR. Reverse engineering the Laws of Form" at the Inter-University Center in Dubrovnik, the manifest outcome of which is the present book.

In one of the interviews from 2013, Spencer Brown talks about the many coincidences that led to his fate as a mathematical philosopher and his sudden involvement with circuitry:

> I never got my Ph.D. Once I got the fellowship at Christ Church, I didn't go on with it. It's a much higher honor than a Ph.D. degree. I was teaching philosophy at Christ Church. But I also taught at Trinity in my final year.
>
> What happens if you get one of these research jobs, it lasts for usually five years, and then you're turned out with nothing. You're suddenly turned out to the world and you don't have anything. At the end of the five years at Christ Church, I had no money and nowhere to go. This is what happens when your fellowship comes to an end. You're out on the street. You've lived like a millionaire for the last five years. You get all your meals free and you get free servants and free set of rooms and you don't realize that if you want such a thing in commercial life it's going to cost a great deal, it's going to cost something like 80,000 a year. I didn't realize in fact that to get such a standard of life outside the university would be extremely costly. In fact, you can't really get it. Because at the university you have all these expert companions and everything. You can't get that in a firm.
>
> What I did was, I rang up a friend whom I met at the Chess Congress before. He was straight from school, I was from the service. He had joined a firm, Mullard Equipment Limited, engineers, electronic engineers. And I said: I've nowhere to go, my Christ Church fellowship has come to an end, I sold all my books,

can I come and stay with you? He said yes. So I stayed with him for a year. I had a room in his flat, and he gave me hand-outs to buy food and things like that, finally, I said to him: Can you get me a job in your firm? He said: Yes, of course! I thought you didn't want a job. I thought you just wanted to laze about doing nothing. I said: No, I'm desperate for a job. So he got me a job in his firm. At that stage control engineering was a question of controlling things like lifts or elevators the circuit required. They used relais, and transistors had recently been invented. And so my job was to turn the relais circuits into transistor circuits. Now for this they used Boolean algebra which is not at all suitable. So I invented an algebra in which every operator was one transistor and then you just had to manipulate the algebra to get fewer transistors. What I developed was a calculus which every time you used the transistor it had one sign, and that was the cross. (Heidingsfelder, Knaut, Sichler, & Ludewig, 2019)

Our book starts with this typescript, which is published here for the first time. It consists of two parts: "Part I: First Principles" and "Part II: The Use of a Calculus." In the first part, Spencer Brown describes the technological background of his discovery of his now-notorious cross. He draws the reader's attention to the NOR transistor and highlights, that notwithstanding its widespread industrial application, the true potential of this technological implementation of logical NOR has not been tapped yet. In the second part, he pulls his cross out of a brief and condescending discussion of the work of predecessors like Peirce and Sheffer just to unfold it into a series of axioms and theorems that anticipates the form and content of the later *Laws of Form*.

As suggested by the title of his essay, "Transcending Engineering Practice — NOR on the Path from Transistor Technology to Universal Indeterminacy," to *Albrecht Fritzsche*, the NOR typescript is the work of not only an engineer, but also a philosopher-mathematician, and an artist. Albrecht introduces the readers to the state of transistor technology in the 1950s and early 1960s before he shows how Spencer Brown's invention and use of the cross in the NOR typescript already anticipates the later expansion of the embryonal *Laws of Form* beyond the concrete context of circuit design. Thus, the typescript also foreshadows the digital transformation of a society, in which programmers can code software without any deeper knowledge of the underlying hardware systems. Albrecht concludes that the typescript constitutes more than an act of electrical engineering theory development. With the cross, everything "moves from the vertical to the horizontal. In the term itself, one argument is simply put behind another; nothing else matters." In this sense, the typescript is the early work of an artist who entered philosophy into a Turing machine, and thus empowered both our love to wisdom and the machine.

In "NOR: Truth table, true distinction," Steffen Roth shows how design with the NOR might facilitate social theory design beyond traditional Gutenberg-galactic approaches and enable social researchers to initiate a calculus of "true

distinctions." This possibility emerges from the discovery that, in the NOR type-script, the cross corresponds to a transistor unit implementing logical NOR. As the classical representation of logical NOR, and hence the cross, is a truth table, and as one generally associates the cross with (the) distinction, Steffen conceptualizes the NOR as a tool for the distinction between true and false distinctions as well as for the translation between different social concepts of truth. As a result, the cross emerges as the basic building block for the much-needed digital transformation of social theory.

"Theory, Society and George Spencer Brown" by *Lars Clausen* outlines the historical setting of the NOR manuscript. He first draws our attention to the geopolitical situation and technological context of the manuscript: Cuba Crisis, Korean War, Sputnik Shock, Space Conquest, the Emergence of the Silicon Valley, to name just a few events and advances that had direct or indirect impact on the prototype of the Laws of Form. He then shows how the typescript inspired fundamental paradigmatic shifts in science in general and social sciences in particular, with his main focus being on the social systems theory of Niklas Luhmann. He concludes that NOR design might give direction to the digital transformation of social theory.

In his essay "Meaning Negation," *Franz Hoegl* takes up the cross to negate the idea that Spencer Brown's cross is the primordium of logical negation. Franz shows how Spencer Brown appropriated and redesigned the Sheffer stroke to "write down" what the NOR transistors at Mullard Equipment Ltd. actually did in practice. As a notation of NOR, the cross does not presuppose but rather contains NOT. It is hence the perfect continence of the cross that motivates Franz to see the NOR typescript as a prelude to a programmatic aestheticization of mathematics and logics. In looking at the *typescript*, we see that for the human–computer Spencer Brown computation still meant *manuscripture* performed in a specifically controlled and, as Franz insists, particularly elegant way. Franz concludes that negation is an integral aspect of both the operation indicated by the drawn sign(s) and of the sign-process itself.

The Platonic and Aristotelian legacies are the twin towers of western philosophy. In his visually stunning chapter on "Diagrammatics," *Divyamaan Sahoo* identifies the inspirational source of Spencer Brown in Heraclitic, Vedic and Daoist concepts of existence as flow. Driven by an intuitionistic analysis, the chapter unfolds a common core between the NOR typescript and the later Laws of Form. The diagrammatic perspective of orthonormal spaces opens the opportunity to reimagine an extended calculus of loops inducing loops. The diagrammatics of the Spencer Brownian variance of the Heraclitean notion of "everything flows" develops a typology of time, strangely unfamiliar to western linearity of universal time. Sahoo concludes that his diagrammatic approach is a worthwhile entry into the hidden basics of the Calculus developed by Spencer Brown.

In the final chapter of this book, *Markus Heidingsfelder*, *Peter Zeiner*, *Kelvin Ooi Jian Aun*, and *Mohammad Arif Sobhan Bhuiyan* excel with a disciplinary exegesis by "Marking the Mark," an interdisciplinary attempt to explain why the calculus of indications has gained so much attention in the discipline of sociology and so little in the one it belongs to – mathematics. For the authors, its attractiveness lies in the vagueness of its central symbol, the "impertinent connective" of

the mark that defies any meaningful mathematical interpretation but allows for a high connectivity in the language-based disciplines of science. By tracing the development of the calculus from its very first stages in the NOR typescript to its final form in the *Laws*, they do at the same time justice to the historical as well as the theoretical dimensions of the work, whose failure in the field of mathematics does not affect its usefulness in the field of sociology.

The editors are grateful to *Thomas Wolf* for his consent to the publication of the NOR typescript as well as to Spencer Brown's long-time publisher, *Johanna Bohmeier*, who is responsible for the long-lasting effect of his work, if not its sustainability. We are indebted to thank the universal genius of George Spencer Brown, who generously shared us with the NOR typescript. There is still a lot to discover. Thus, we hope this book may not only contribute to a better and deeper understanding of the "norigins" of Spencer Brown's opus magnum "Laws of Form," but also mark the start of a renaissance of appreciation of Spencer Brown's oeuvre, which includes further so-far unpublished texts such as "On Clarity" and "Introduction to Reductors."

Cancale, Kuala Lumpur, Haderslev, and Aarhus, July 2020

The Editors

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Chapter 2

# Design with the NOR

George Spencer Brown

Part I — First Principles

Recent years have seen the development of an electronic device, the transistor NOR unit, which, among other applications, is taking the place of relays in industrial automation and control systems. With a new unit so unlike the old, it is not surprising that the forms of algebra suitable for relays have proved unsuitable for NOR units. Whereas it has not been difficult to build up an <u>ad hoc</u> arrangement of such units for a given function, the lack of suitable calculus has hitherto restricted both the assessment and the choice of such arrangements in practice.

The following account, in two parts, aims to give some of the principles of control design with NOR units, or K-units as they will later be called, showing how, starting with intuitive methods, we can proceed to the use of more general rules. It will become clear that some of the problems we have had to solve have a bearing outside of the field of control design, and we have given a fuller account of this elsewhere.

The Unit

A typical NOR circuit is shown below with the explanation of each external lead.
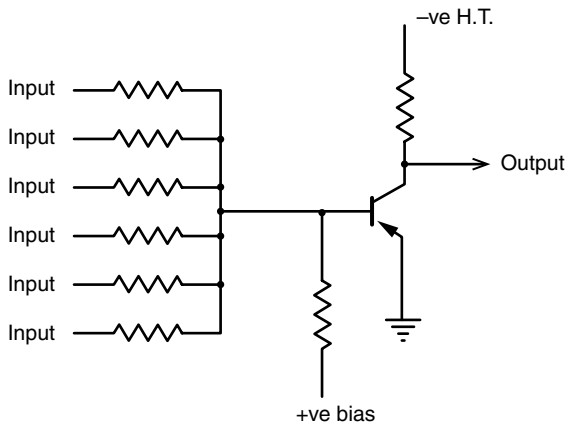
Finally, it will be convenient to represent a negative potential, which will be taken as the operative condition, by '1' and an earth potential by '0'.

2. Standard Functions with the NOR

A NOR unit performs one operation* Neither A nor B nor C nor … It can be shown that this is sufficient for any function, and standard functions, in terms of NOR configurations, are given below.

NOT

OR

AND
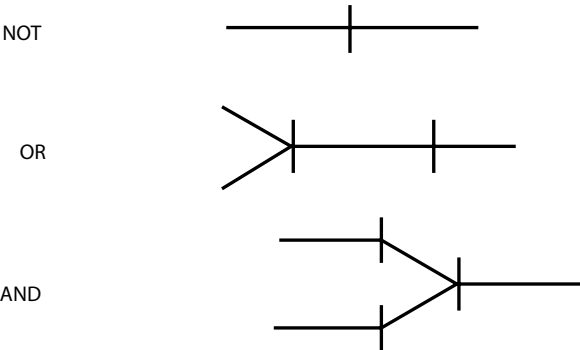
Suppose we have a car with four doors, and suppose it is required that the passenger light should be on when any door is open and off when they are all closed. Our function for the light on is required to operate when A or B or C or D, where A, B, etc., stand for doors in the open position.

A
B
C
D
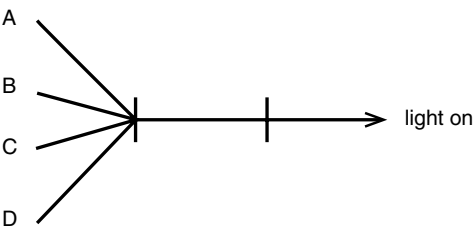
light on

As we are only interested in the change of state, a 0 can be made to switch the light on and a 1 to switch it off: so we can dispense with the final unit.

1   A
1   B
1   C
1   D

0 light on