## Artist Statement and Bio

Robert R. Bruner

The drawings exhibited here are used to carry out certain algebraic calculations. A 4-fold periodicity is evident in each of them. In two, the periodicity is perfect: the same patterns recur every four steps. In the other two, each time a pattern reappears, it carries additional echoes of its history. These drawings exhibit just the first 8 steps of patterns which continue forever.

Each drawing consists of two parts. The more complex part contains internal structure which is not visible in the more schematic summary, but also has arbitrary aspects, unlike the simpler summary, which is completely deterministic.

The drawings are a particularly effective way to perform algebraic calculations which are relevant to 'connective real K-theory', which links distinct aspects of geometry known as 'cohomology' and 'bundle theory'.

BA Amherst College '72
SM University of Chicago ' 73
PhD University of Chicago '77
Professor of Mathematics, Wayne State University.
Author of 20 papers and 2 books, editor of another.
Organizer of research conferences in algebraic topology.
Author of software used in algebraic topology.
He has given numerous lectures in the US, Europe, and Asia.
In addition, he has spent longer periods of time at several universities, including

- Vietnam National University, Hanoi, Vietnam
- University of Oslo, Oslo, Norway
- University of Sheffield, Sheffield, England
- Centre de Recerca Matematica, Barcelona, Spain

Robert Bruner is a research mathematician with a long-standing interest in art and philosophy. He is particularly interested in the nature of consciousness and understanding. His research is motivated by aesthetics: elegance, grace and naturality are evidence of understanding, and contribute to it, in the fields he addresses. In addition, he finds delight in the particular mathematical objects which appear, such as those exhibited here.

The Sphere

$$
\begin{aligned}
& \begin{array}{l}
\mathbf{F}_{2} \\
\uparrow \epsilon \\
\mathcal{A} \\
\left.\uparrow \begin{array}{ll}
S q^{1} & S q^{2}
\end{array}\right]
\end{array} \\
& \Sigma^{1} \mathcal{A} \oplus \Sigma^{2} \mathcal{A} \\
& {\left[\begin{array}{cc}
S q^{1} & S q^{1} S q^{2} \\
0 & S q^{2}
\end{array}\right]} \\
& \Sigma^{2} \mathcal{A} \oplus \Sigma^{4} \mathcal{A} \\
& {\left[\begin{array}{cc}
S q^{1} & S q^{2} S q^{1} S q^{2} \\
0 & S q^{1} S q^{2}
\end{array}\right]} \\
& \Sigma^{3} \mathcal{A} \oplus \Sigma^{7} \mathcal{A} \\
& \uparrow\left[\begin{array}{ccc}
S q^{1} & S q^{2} S q^{1} S q^{2} & 0 \\
0 & S q^{1} & S q^{2} S q^{1} S q^{2}
\end{array}\right] \\
& \Sigma^{4} \mathcal{A} \oplus \Sigma^{8} \mathcal{A} \oplus \Sigma^{12} \mathcal{A} \\
& {\left[\begin{array}{cccc}
S q^{1} & S q^{2} S q^{1} S q^{2} & 0 & 0 \\
0 & S q^{1} & S q^{2} S q^{1} S q^{2} & 0 \\
0 & 0 & S q^{1} & S q^{2}
\end{array}\right]} \\
& \Sigma^{5} \mathcal{A} \oplus \Sigma^{9} \mathcal{A} \oplus \Sigma^{13} \mathcal{A} \oplus \Sigma^{14} \mathcal{A} \\
& \uparrow\left[\begin{array}{cccc}
S q^{1} & S q^{2} S q^{1} S q^{2} & 0 & 0 \\
0 & S q^{1} & S q^{2} S q^{1} S q^{2} & 0 \\
0 & 0 & S q^{1} & S q^{1} S q^{2} \\
0 & 0 & 0 & S q^{2}
\end{array}\right] \\
& \Sigma^{6} \mathcal{A} \oplus \Sigma^{10} \mathcal{A} \oplus \Sigma^{14} \mathcal{A} \oplus \Sigma^{16} \mathcal{A} \\
& \uparrow\left[\begin{array}{cccc}
S q^{1} & S q^{2} S q^{1} S q^{2} & 0 & 0 \\
0 & S q^{1} & S q^{2} S q^{1} S q^{2} & 0 \\
0 & 0 & S q^{1} & S q^{2} S q^{1} S q^{2} \\
0 & 0 & 0 & S q^{1} S q^{2}
\end{array}\right] \\
& \Sigma^{7} \mathcal{A} \oplus \Sigma^{11} \mathcal{A} \oplus \Sigma^{15} \mathcal{A} \oplus \Sigma^{19} \mathcal{A} \\
& \left.\uparrow \begin{array}{ccccc}
S q^{1} & S q^{2} S q^{1} S q^{2} & 0 & 0 & 0 \\
0 & S q^{1} & S q^{2} S q^{1} S q^{2} & 0 & 0 \\
0 & 0 & S q^{1} & S q^{2} S q^{1} S q^{2} & 0 \\
0 & 0 & 0 & S q^{1} S q^{2} & S q^{2} S q^{1} S q^{2}
\end{array}\right] \\
& \Sigma^{8} \mathcal{A} \oplus \Sigma^{12} \mathcal{A} \oplus \Sigma^{16} \mathcal{A} \oplus \Sigma^{20} \mathcal{A} \oplus \Sigma^{24} \mathcal{A}
\end{aligned}
$$

The Moore Space


The Joker

$$
\begin{aligned}
& \uparrow\left[\begin{array}{ll}
S q^{1} & S q^{2} S q^{1} S q^{2}
\end{array}\right] \\
& \Sigma^{4} \mathcal{A} \oplus \Sigma^{8} \mathcal{A} \\
& \uparrow\left[\begin{array}{ccc}
S q^{1} & S q^{2} S q^{1} S q^{2} & 0 \\
0 & S q^{1} & S q^{2}
\end{array}\right] \\
& \Sigma^{5} \mathcal{A} \oplus \Sigma^{9} \mathcal{A} \oplus \Sigma^{10} \mathcal{A} \\
& \uparrow\left[\begin{array}{ccc}
S q^{1} & S q^{2} S q^{1} S q^{2} & 0 \\
0 & S q^{1} & S q^{1} S q^{2} \\
0 & 0 & S q^{2}
\end{array}\right] \\
& \Sigma^{6} \mathcal{A} \oplus \Sigma^{10} \mathcal{A} \oplus \Sigma^{12} \mathcal{A} \\
& \uparrow\left[\begin{array}{ccc}
S q^{1} & S q^{2} S q^{1} S q^{2} & 0 \\
0 & S q^{1} & S q^{2} S q^{1} S q^{2} \\
0 & 0 & S q^{1} S q^{2}
\end{array}\right] \\
& \begin{aligned}
& \Sigma^{7} \mathcal{A} \oplus \Sigma^{11} \mathcal{A} \oplus \Sigma^{15} \mathcal{A} \\
&\left.\qquad \begin{array}{llll} 
\\
& {\left[\begin{array}{cccc}
S q^{1} & S q^{2} S q^{1} S q^{2} & 0 & 0 \\
0 & S q^{1} & S q^{2} S q^{1} S q^{2} & 0 \\
0 & 0 & S q^{1} & S q^{2} S q^{1} S q^{2}
\end{array}\right]}
\end{array}\right)
\end{aligned} \\
& \Sigma^{8} \mathcal{A} \oplus \Sigma^{12} \mathcal{A} \oplus \Sigma^{16} \mathcal{A} \oplus \Sigma^{20} \mathcal{A} \\
& \uparrow\left[\begin{array}{ccccc}
S q^{1} & S q^{2} S q^{1} S q^{2} & 0 & 0 & 0 \\
0 & S q^{1} & S q^{2} S q^{1} S q^{2} & 0 & 0 \\
0 & 0 & S q^{1} & S q^{2} S q^{1} S q^{2} & 0 \\
0 & 0 & 0 & S q^{1} & S q^{2}
\end{array}\right] \\
& \Sigma^{9} \mathcal{A} \oplus \Sigma^{13} \mathcal{A} \oplus \Sigma^{17} \mathcal{A} \oplus \Sigma^{21} \mathcal{A} \oplus \Sigma^{22} \mathcal{A} \\
& \left.\uparrow \begin{array}{ccccc}
S q^{1} & S q^{2} S q^{1} S q^{2} & 0 & 0 & 0 \\
0 & S q^{1} & S q^{2} S q^{1} S q^{2} & 0 & 0 \\
0 & 0 & S q^{1} & S q^{2} S q^{1} S q^{2} & 0 \\
0 & 0 & 0 & S q^{1} & S q^{1} S q^{2} \\
0 & 0 & 0 & 0 & S q^{2}
\end{array}\right]
\end{aligned}
$$

