Understanding Siteswap Juggling Patterns

A guide for the perplexed by Greg Phillips, greg.phillips@juggler.net

Core rules (for all patterns)

C1 We imagine a metronome ticking at some constant rate. Each tick is called a "beat."

C2 We indicate each thrown object by a number that tells us how many beats later that object must be back in a hand and ready to re-throw.

C3 We indicate a sequence of throws by a string of numbers (plus punctuation and the letter x). We imagine these strings repeat indefinitely, making 531 equivalent to ...531531531... So are 315 and 153 — can you see why?

C4 The sum of all throw numbers in a siteswap string divided by the number of throws in the string gives the number of objects in the pattern. This must always be a whole number. 531 is a three-ball pattern, since $(5+3+1)/3$ equals three; however, 532 cannot be juggled since $(5+3+2)/3$ equals three and a third.

C5 Throws must balance catches. By rule **C4**, 432 appears to be a three ball pattern — but it can't be juggled since the 4, 3 and 2 would all need to be re-thrown at the same time and the pattern says they aren't. By shuffling the numbers we find 423, which *can* be juggled — try it!

Visualizing the numbers

At any given beat rate, higher siteswap numbers mean higher throws. A faster beat means lower throws for all numbers. You can understand the numbers as meaning roughly:

0 — an empty hand

1 — a quick pass across, as in a shower

2 — a quick "throw to the same hand" (normally just a hold)

3 — a three-ball cascade throw

4 — a four-ball fountain throw

5 — a five-ball cascade throw… and so on up to 9, then

a — a ten-ball fountain throw (write a instead of 10 so we don't confuse "ten" with "one-zero"; read a as "ten")

b — an eleven-ball cascade throw… and so on.

Asynchronous siteswap (alternating throws)

Many juggling patterns are based on alternating right and left-hand throws. We describe these using asynchronous siteswap.

A1 The right and left hands throw on alternate beats.

Rules **C2** and **A1** together require that odd-numbered throws end up in the opposite hand, while even numbers stay in the same hand. Here are a few asynchronous siteswap examples:

3 a three-ball cascade

42 two balls juggled in one hand, a held ball in the other

330 a three-ball cascade with a hole (two balls)

51 a three-ball shower

53 a four-ball half-shower

64 three in one hand with one hand, two in one hand with the other (each at its regular height — this is *hard*)

73 a five-ball half shower (the harder one!)

615150 a three-ball shower with a "leak"

Synchronous siteswap (simultaneous throws)

Some juggling patterns involve both hands throwing at the same time. We describe these using synchronous siteswap.

S1 The right and left hands throw at the same time (which counts as two throws) on every second beat. We group the simultaneous throws in parentheses and separate the hands with commas.

S2 We indicate throws that cross from hand to hand with an x (for 'xing').

Rules **C2** and **S1** taken together demand that there be only even numbers in valid synchronous siteswaps. Can you see why? The x notation of rule **S2** is required to distinguish patterns like (4,4) (synchronous fountain) from (4x,4x) (synchronous crossing). Unlike a 2, a 2x must always be thrown since it changes hands. Here are a few examples:

(4,4)(4,0) three-ball columns (a.k.a. Two Up, One Up)

(4,2) appears identical to 42 — The Fake, The Yo-yo, etc.

(4,2x)(2x,4) The Box

(6x,4x) the easier five-ball half shower

(6,6)(6,6)(6,0) Enrico Rastelli juggling five plates

Multiplex throws

In both alternating and synchronous patterns we can throw multiple objects from the same hand at the same time.

M1 Multiple objects thrown from the same hand count as one throw. We enclose their numbers in square brackets.

Applying **C4** and **M1** to the siteswap [33], we sum the throw numbers $(3+3)$ and divide by the number of throws (one) to give six — so [33] is a six object pattern. Note that in multiplex patterns twos inside square brackets are almost always thrown rather than held. A few multiplex examples:

[33] six balls juggled in groups of two as a three-cascade

4[43]1 a pleasant four ball variant of 441, itself quite fun

[32] five-ball splits

([44],[44])(4,0) Four Up, One Up

A few siteswaps worth learning

Here are a few reasonably easy but fun siteswap patterns:
501, 423, 441, 4413, 531, 5313, 534, 55244, 561, 633 (easier with bounced sixes), [33]33, [33][33]3, [33], [43]1421, 4[43]1, [32], (4,4)(4x,4x)
Training for five: 50500, 52512, 55500, 50505, 552, 55550

What siteswap doesn't show

Siteswap notation doesn't show us *how* a throw is made; for example Mills Mess has a siteswap of 3, which completely ignores the sinuous arm crossing that makes it beautiful and fun to juggle. On the other hand it *is* useful to know that both Burke's Barrage and Windshield Wipers are juggled as 423, even if that doesn't tell the whole story. Happy juggling!