Principle 6 Follow-through & Overlap.

Just as the anticipation is the preparation of an action, follow through is the termination of an action. Actions very rarely come to a sudden and complete stop, but are generally carried past their termination point. For example, a hand, after releasing a thrown ball, continues past the actual point of release.
5. Follow Through & Overlapping Action
High-level control

- Walking style
- Physics
- Aesthetics
- Expressivity
- Goal-driven

Digital Actor/Character

http://robotics.stanford.edu/~latombe/cs326/2002
Some Applications

Autonomy

- Completely Autonomous
- User-controlled

Interactivity

- Off-line
- Real-time

- Key-frame Animation Systems
- Digital Actors
- Urban / Factory Simulation
- Historical Narratives
- Video Game Adversaries
- Virtual Tour Guides
- Semi-Autonomous Characters
- Web Avatars

[Kuffner, 99]

http://robotics.stanford.edu/~latombe/cs326/2002
Manipulation

Reach

Transfer

Return

Grab

Release

http://robotics.stanford.edu/~latombe/cs326/2002
Treadmill Method: Motion Planning + Motion Capture

http://robotics.stanford.edu/~latombe/cs326/2002
Behaviour planning

Behavior Planning for Character Animation
[with audio]

SCA 2005

Manfred Lau and James J. Kuffner
Carnegie Mellon University
Behaviour planning
Behaviour planning

START

JUMP

CRAWL

JOG FWD

JOG LEFT

JOG RIGHT

END
Algorithm 1: BEHAVIOR PLANNER

Tree.Initialize($r_{init}$);
Queue.Insert($r_{init}$, DistToGoal($r_{init}$, $s_{goal}$));
while !Queue.Empty() do
    $s_{best}$ ← Queue.RemoveMin();
    if GoalReached($s_{best}$, $s_{goal}$) then
        return $s_{best}$;
    end
    $e$ ← $E(s_{best}, time)$;
    $A$ ← $F(s_{best}, e)$;
    foreach $a$ ∈ $A$ do
        $s_{next}$ ← $T(s_{best}, a)$;
        if $G(s_{next}, s_{best}, e)$ then
            Tree.Expand($s_{next}$, $s_{best}$);
            Queue.Insert($s_{next}$, DistToGoal($s_{next}$, $s_{goal}$));
        end
    end
end
return no possible path found;
Behaviour planning

- Behaviour is a sequence of actions
- Action has pre-conditions and post-conditions
- Action has preparation, execution and follow-through
- Behaviour planning finds a minimal sequence of actions achieving the required goals
Figure 1: Specification of a Walking Motion (a) plan view of footprints (b) timing diagram.

Figure 2: Block diagram for motion synthesis from footprints.
Paper 6 - From footprints to animation

**Figure 3:** Footprints with timing information and manipulation handles.

**Figure 4:** Automatic footprint generation from a path.
Paper 6 - From footprints to animation

Figure 5: The generic biped model.

\[ E = \int_{0}^{T} (\varepsilon_{\text{physics}} + \varepsilon_{\text{comfort}}) \, dt \]

\[ \varepsilon_{\text{physics}} = |F + mg - ma| \]

\[ \varepsilon_{\text{comfort}} = k\left( \ell - \ell_{\text{nom}} \right)^2 \]