1. Recreational aesthetic- who will use the trail, what kind of experiences they expect or desire. A trail must ultimately integrate into the site and users. Determined on a site by site basis.

The Trail Design Process:

1. Concept Stage: Define the intent and purpose of the trail, gather support and initial conceptual approval, and set design parameters
2. Survey Stage: Identify Control Points (on paper and in the field)
3. **Layout Stage**: Connect the points (map, walk, and flag), Bring it all together (the balancing act)
    - If possible analyze existing local trails to see what works and doesn't
4. Approval Stage
5. Final Layout and Construction Planning Stage: Pin flag final line and create construction plan
6. Begin Construction, Adjust Layout and Plan as revealed conditions warrant.

Your own experiences will be your best teacher. Others' experiences produced these **Best Practices:**

1. Understand the trail user base
2. Minimize tread grades
3. Design drainage into the trail alignment/layout rather than construct them post facto
4. Build on a slope (a "resistant alignment" across slopes, not down them)
5. Avoid Flat Areas and Fall Lines (and switchbacks if possible)
6. *Understand trail building techniques, required construction skillsets, and required labor
7. Identify potential construction resources (local or imported)
8. Avoid ridge tops (primary transportation corridors for wildlife; often used by Native Americans; noise from ridge-top trails is broadcast over a wider area)
9. Create loops and avoid dead end trails for a sense of purpose
10. Avoid crossing water (however, streams/rivers can be natural sound barriers)
11. If crossing water, descend into and ascend out of water crossing so the stream does not jump and follow the trail.
12. Put trails through thick vegetation to conceal the trail, reduce noise, and keep users on the trail
13. Put intersections at rises with open sight lines (to reduce collisions)

Terminology and Other Concepts

1. **Bench cut** or **side hilled** trail- a trail bed cut into a side slope
2. Braiding- new social trails or shortcuts next to the intended path (due to inefficient layout)
3. Compaction- the compression or consolidation of the trail bed (can increase durability and/or runoff)
4. Creep/downhill creep/soil creep- the movement of a side slope down a hill (curved trees, cracking, slumping…)

5. Cross slope or out slope- the grade or slope of the tread perpendicular to the direction of travel (intended to shed water off the trail, typically 5%, but may vary with running grade)
6. Displacement- (user based) movement of trail soil or rocks from the trail bed
7. **Efficiency**- an efficient means of getting from A to B, whether A to B is 10 miles or 10 feet apart. Will users cut corners, shortcut, or create a new social trail?
8. Erosion's externalities:
    a. Increased turbidity: decreased sunlight/photosynthesis (vegetation, and diatoms); decreased oxygen
    b. Increased Sediment: smoother water bottoms; reduced turbulence/oxygen; possible phosphorus boost
    c. Increased Organic Matter: from turbidity killing plant life; from direct organic matter input; both feed anaerobes, reducing oxygen
9. **Erosion Potential** = Water Volume + Speed (sheet flow becomes rills, becomes gullies, becomes channels)
    a. Depends on multiple factors:
        i. Area and steepness of the (tread) watershed or "catchment"
        ii. Length, grade, and width of trail within watershed
        iii. Tread compaction and "Soil" (Horizon) composition
10. **Fall line-** the line water or a ball would travel down a slope
11. **Flow**- how the trail unfolds in front of users
    a. Horizontal/lateral flow- left to right
    b. Vertical flow- ups and downs (grade reversals)
12. Frost heave- soil swelling due to ice crystal lens growth (susceptible: silty, loamy; less so: dense clays, gravel, sand). Low wet areas are more susceptible as they provide water for the growing lenses.
13. **Grade reversal**- a running grade change from descending to ascending, or vice versa
    a. Aligned Crests and Dips or troughs- layout or alignment includes "Grade Reversals" in design
    b. Constructed Crest/Dip or trough- Post construction additions due to poor layout or user dynamics
        i. Drainage Dips, Knicks, Rolling grade dips, water bars
        ii. Earthen Constructed Reversals: 0 to 20% grades
        iii. Water bar or Steps leading to Dip: 20% to 30% grades
        iv. Water bar followed by Stone Steps: 30% or greater
14. **Grade/slope/running grade**- the inclination of a trail surface compared to a horizontal plane
    a. **A percentage**- rise/run x 100 or 100 x tan(slope degrees)
    b. A ratio- of rise to run (1:10, 10:100, 1/10, 10/100)
    c. An angle- (rise/run) $\tan^{-1}$ or $\tan^{-1}$ (slope%/100)
    d. 10% is often considered the max sustainable *prevailing or overall* grade for trails
        i. applies to most soils (rocky or durable, to mixed loamy)
        ii. steeper trails often cause displacement by traffic (not as noticeable in low use situations)
        iii. unless the tread watershed provides a large volume of water to the trail, water will not gain enough speed at 10% or less (assuming it is adequately out sloped)
        iv. a 10% grade in sandy or fragile soils may erode

15. **Half Rule**- keep trail grades at less than half the fall line; %grade < fall line%/2
16. Negative control point- a point resource managers do NOT want users (sensitive habitat, unsafe areas…)
17. **Positive Control Point**- a point of interest where resource managers want people to go (destinations/end points, a peak, valley, natural feature, vista…not the only components of a good trail)
18. Safety- A trail that feels dangerous will lead to an unpleasant experience, while one that is too protective will feel tame and incomplete. Safety is often relative to the user group(s). Determining the degree of safety is ultimately a factor of who the majority of users will be and the type of experience being created.
19. **Side slope**- the hill or mountain's slope, steepest down the fall line
20. Slope Stability- how stable is the slope that a trail traverses?
    a. Friction angle- angle of repose at which a soil is on the verge of slumping/sliding or failing
    b. Check local road cuts for "potential" safe angles (or slopes) to traverse (but they may have plates piles)
    c. Sample friction angles:
        i. Clay (dry lump) 25–40° or 46-84%; Clay (wet excavated) 15° or 26%
        ii. Gravel (loose dry) 30–45° or 57-100%; Gravel (natural w/ sand) 25–30° or 46-57%
        iii. Sand (dry) 34° or 67%; Sand (water filled) 15–30°or 26-57%; Sand (wet) 45° or 100%
21. **Sustainability**- "to endure." For trails this means:
    a. low environmental impact
    b. low maintenance requirements (minimal construction, reconstruction, and maintenance)
    c. high user satisfaction and efficiency (safe, and exciting, with minimal user conflict)
22. **Tread**- the trail surface
23. **Tread watershed** or **catchment**- the watershed above a trail (that could potentially erode the trail)
24. **Visual guides:** lead, draw, or ground users along the trail to keep them on the trail
    a. **Anchors**- a focal point or ornament (a large rock, an isolated tree…)
    b. **Gateway**- a passage or hallway between items (slots, 2 rocks, 2 trees, rock and tree…)
    c. **Edges**- provide contrast between spaces while adding drama to the experience (cliffs, a water body, a rock garden, vegetation changes…)

Texture	**Feel**	**Ribbon**
Sand	Grainy	Can't form a ribbon
Loam	Soft with some graininess	Thick and very short
Silt	Floury	Makes flakes rather than a ribbon
Sandy Clay	Substantial graininess	Thin, fairly long—50 to 76 mm (2 to 3 inches)—holds its own weight
Clay	Smooth	Very thin and very long—76 mm (3 inches)