# Winnowing of Free Motion Concepts

Five ideas have been created to facilitate free motion of the tool in 3D space. A physical assessment of PT1 lead to the development of PT1b to improve user feel. An estimated envelope size has been generated and plotted using MATLAB

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| **Name** | **Description** | **Evaluation** | **Status** | **Feasibility** |
| PT1 | 1: rotational, joint 2: rotational, joint 3: fixed, joint 4: rotational | Poor user feel – tool position is limited to specific paths, limited envelope | PA[[1]](#endnote-1), EP[[2]](#endnote-2) | NO –  PT1b has been design to improve user feel by increasing the angle between the linkages during operation. For PT1b the average angle between link 1 and 2 is 90 degree |
| PT1b | joint 1: rotational, joint 2: rotational, joint 3: fixed, joint 4: rotational, tool is positioned in the same plane as joint 2 | Limited envelop, likely to have poor user feel due to fixed joint 3 | EP, no PA | Requires PA Review |
| PT2 | joint 1: rotational, joint 2: rotational, joint 3: rotational, joint 4: rotational | Good user feel, will require multiple hard constraints | PA, EP | NO –  Multiple hard constraints increase controller complexity and speed requirements |
| PT3 | joint 1: rotation, joint 2: linear, joint 3: fixed, joint 4: rotational | Envelop plot shows improved vertical travel, but is still limited | EP, no PA | Requires PA review |
| PT3b | joint 1: fixed, joint 2: linear, joint 3: rotational, joint 4: rotational | Envelop plot shows a significant improvement in vertical travel | EP, no PA | Requires PA review  Current best alternative |

1. PA stands for Physical Assessment, a review of the mechanism feel and envelop through user testing of a model [↑](#endnote-ref-1)
2. EP stands for Envelop Plot, an estimate of the useable workspace of the mechanism created by moving the each linkages through a range of a angles and plotting the cutting tool position [↑](#endnote-ref-2)