



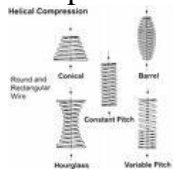
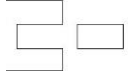



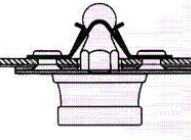




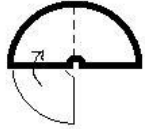







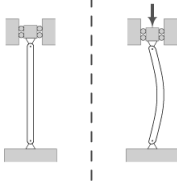












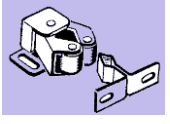








Fastening and Coupling Concepts: Quick Connects and MAV Applications

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<i>Snap Fit</i>	<i>Friction Fit</i>	<i>Catch and Release</i>	<i>Double Push</i>	<i>Elastic Fit</i>	<i>Geometric Fit</i>	<i>Multi-State Fit</i>	<i>Magnetism</i>	<i>Traditional Fasteners</i>
1. Snap Fit Blanking Plug 	8. Split Stem Bumper 	16. Spring Loaded Snap Fit 	26. Click Pen 	28. Spring in Tension or Compression 	30. Linear Mating Geometries 	34. Bi-stable Compliant Mechanism 	37. Magnets 	39. Nuts and Bolts 
2. Ball Stud Fastener 	9. Elastic Block 	17. Quick Connect 	27. Touch Latch 	29. Rubber Band 	31. Rotational Mating Geometries 	35. Slap Bracelet 	38. Magnetic Touch Latch 	40. Screws 
3. C-Clip	10. Friction Catch	18. Buckle			32. Puzzles	36. Buckled Beam		41. Grommets

<i>Snap Fit</i>	<i>Friction Fit</i>	<i>Catch and Release</i>	<i>Double Push</i>	<i>Elastic Fit</i>	<i>Geometric Fit</i>	<i>Multi-State Fit</i>	<i>Magnetism</i>	<i>Traditional Fasteners</i>
								
4. E-Clip 	11. Paper Clip 	19. Lock Pins 			33. Pins 			42. Rivets 
Snap Fit	Friction Fit	Catch and Release	Double Push	Elastic Fit	Geometric Fit	Multi-State Fit	Magnetism	Traditional Fasteners
5. Snap Button 	12. Sheet Cover Caps 	20. Ratchet Lock 						
6. Ziploc Bag 	13. Daisy Catch 	21. Velcro 						
7. Roller Catch	14. Push Clip	22. Tape						

<i>Snap Fit</i>	<i>Friction Fit</i>	<i>Catch and Release</i>	<i>Double Push</i>	<i>Elastic Fit</i>	<i>Geometric Fit</i>	<i>Multi-State Fit</i>	<i>Magnetism</i>	<i>Traditional Fasteners</i>
								
	15. O-ring 	23. Strike and Latch 						
		24. Push Latch 						
		25. Elbow Catch 						

These fastening concepts were obtained through ideation and internet searches. When considering complexity, time, and weight, the most promising connections seem to be the snap fit, friction fit, elastic fit, and geometric fit. A combination of these ideas seems to make the most sense for our application.

While a novel fastener could be developed with the multi-state concept, its complexity is a major drawback for our 6 week timetable. Likewise, the mechanisms of catch and release and double push also add needless complexity. Furthermore, weight considerations would seem to eliminate the concepts of magnetism and traditional metal fasteners. However, the plastic or custom carbon fiber counter-parts of the metal fasteners could be a viable solution.

To conclude, my proposed fastening scheme for the MAV platform consists of a geometric fit for alignment and stability purposes in combination with either a snap fit, friction fit, or elastic fit. Further discussion will lead to the final embodiment and fit concept.

Fastening Concept References

Snap Fit

1. http://www.hall-fast.com/product_detail_plastic.asp?PID=230
2. <http://www.boltproducts.com/tinnerman/stud-ball-fasteners.html>
3. <http://www3.towerhobbies.com/cgi-bin/wti0001p?&P=WR&I=LXFYN8>
4. <http://www.caddetails.com/mostdependable/parts.htm>
5. <http://haohann.manufacturer.globalsources.com/si/6008800026539/pdtl/Snap-button/1002520487/12.8mm-Plastic-Snap-Buttons.htm>
6. <http://www.madinaonline.com/items.asp?Cc=M37&iTpStatus=0&Tp=&Bc=>
7. <http://www.selbyhardware.com/m1.htm>

Friction Fit

8. <http://efc-furniture.com/productspec.asp?67,180,13555>
9. <http://www.evoeng.co.nz/productsServices.html>
10. <http://www.kennedyhardware.com/BP-48-Friction-Catch-p-16247.html>
11. <http://keysan.com/ksu5712.htm>
12. http://www.skiffy.com/docs/menufr.cfm?taal=gb&ID=xyxz2296655A6&pagina=inhoudfr.cfm&img_id=17&pag=imgindex2.cfm&order=order
13. http://www.customhardwaresolutions.com/daisy_catch.htm
14. http://www.wclco.com/Plastic_Components/Plastic_Fasteners.php
15. http://www.caskwidge.com/shop/index.php?main_page=index&cPath=3

Catch and Release

16. <http://www.monstersteel.com/Spring-Loaded-Snap-Fit-Captive-Bead-Ring-316-L-nid-826.html>
17. <http://news.thomasnet.com/fullstory/482188>
18. <http://www.itwnexus.com/>
19. <http://www.jergensinc.com/pins.aspx>
20. http://www.knapeandvogt.com/965_Ratchet_Lock.html?page=details.400
21. http://www.seattlefabrics.com/dry_bag.html
22. http://www.boxshop.uk.com/acatalog/packing_tape.html
23. <http://www.itw-fastex.com/catalog/index.php/dw/oc/a/1/c/1>
24. <http://www.sugatsune.com/products/products.cfm?CATID=5&SUBCATID=7>
25. <http://www.outdoorsuperstore.com/product.asp?prod=253004>

Double Push

26. <http://commons.wikimedia.org/wiki/Image:Ballpoint-pen-parts.jpg>
27. http://www.hardwarestore.com/Store_ViewProducts.asp?Cat=1385

Elastic Fit

28. http://www.masterspring.com/products/compression_springs/default.html
29. http://tipcorp.trustpass.alibaba.com/product/11314687/Esd_Rubber_Band.html

Geometric Fit

32. <http://www.puzzlecentre.com.hk/>
33. http://www.germes-online.com/catalog/17/789/275594/pin_shaft_nut_etc.html

Multi-State Fit

34. <http://research.et.byu.edu/llhwww/special/bistable.html>
35. http://www.partyalooza.com/Merchant2/merchant.mvc?Screen=CTGY&Store_Code=PFSFK&Category_Code=slap
36. http://content.answers.com/main/content/wp/en/5/54/Buckled_column.png

Magnetism

37. <http://www.kjmagnetics.com>
38. <http://hardware.hardwarestore.com/74-catches-latches-locks.aspx>

Traditional Fasteners

39. <http://www.boltmotorcyclehardware.com/index.php>
40. <http://www.mobilephone-spares.com/parts/screw.htm>
41. <http://forums.evolutionm.net/showthread.php?t=150981>
42. http://www.ezhottubs.com/parts/spa_high_limit_switches.htm

References - Literature Review

1. Burns, R.H., 1964, “The Kinetostatic Synthesis of Flexible Link Mechanisms,” PhD. Dissertation, Yale University, New Haven, CT.
2. Dangel, Tim M. “Snap Fit Lock with Release Feature.” U.S. patent 5577779 November 1996.
3. Fahnestock, Archie P. “Insulating Bushing.” U.S. patent 1483218 February 1924.
4. Frish-Fay, R., 1962, *Flexible Bars*, Butterworth, Washington, D.C.
5. Gorski, W., 1976, “A Review of Literature and a Bibliography on Finite Elastic Deflections of Bars,” *Transactions of the Institute of Engineers, Australia, Civil Engineering Transactions*, Vol. 18, No. 2, pp. 74-85.
6. Hehl, Klaus F. “One-Piece Fastening Element.” U.S. patent 3905270 September 1975.
7. Jensen, B. D., “Identification of Macro- and Micro-Compliant Mechanism Configurations Resulting in Bistable Behavior”Tranitina, G. G., Minnichelli, M.D., 1987, “Automated program for designing snap-fits”, *Plastics Engineering*, August, pp. 39-41.
8. Jensen, B.D., Howell, L. L., and Salmon, L.G., 1998, “Introduction of Two-Link, In-Plane, Bistable Compliant MEMS,” *Proceedings of 1998 ASME Design Engineering Technical Conferences*, DETC98/MECH-5837.

9. Knapp, K. N., II, 1994, “Experimental Characterization of the In-Plane Cantilever-hook,” MS Thesis, Rensselaer Polytechnic Institute, Troy, NY.
10. Kobler, Robert J. “Electrical Housing Member.” U.S. patent 3648213 March 1972.
11. Lewis, Dean Q., et al, “An Investigation of the Compressive Hook Integral Attachment Feature.”
12. Lewis, Dean Q., et al, “A Finite Element Investigation of the Bayonet-and-Finger Integral Attachment Feature.”
13. Mall, Arthur W. “Quick Detachable Coupling.” U.S. patent 2021241 Nov 1935.
14. Murphy, Howard J., et al. “Snap Fasteners FOB Trimming and Like Strips.” U.S. Patent 2327328 August 1943.
15. Murphy, Morgan D. “Compliant Fastener.” U.S. Patent 5366332 November 1994.
16. Oh, Jun S., et al, “Java Based Design Calculator for Integral Snap-fits”, ASME 1999 Design Engineering Technical Conferences, Las Vegas, NV, September 12-15.
17. Opdahl, Patrick G., et al, “An Investigation into Compliant Bistable Mechanisms”, ASME 1998, Mechanisms Conference, Atlanta, GA.
18. Opdahl, Patrick G., et al, “Modeling and Analysis of Compliant Bi-Stable Mechanisms Using the Pseudo-Rigid-Body”, 1999, M.S. Thesis, Brigham Young University, Provo, Utah.
19. Raymond, Albert V, et al. “Plastic Panel Clip.” U.S. patent 3029486 April 1962.
20. Rousseau, D., Kolberg, R., and Hotra, Z., 1990, “Structural Analysis of Snap-Finger Performance in Automotive Connectors,” SAE International Congress and Exposition, Detroit, MI.
21. Ziegler, H., 1956, “On the Concept of Elastic Stability,” Advances in Applied Mechanics, Vol. IV (Ed.: H.L. Dryden and Th. Von Karman), Academic Press, Inc., New York, NY