Facing the Unknown Challenge
Structure and Modularity in Morphological Computation

Shai Revzen
Depts. of EECS and EEB, U. Michigan, Ann Arbor, MI, USA
shrevzen@umich.edu

Robotics is coming of age: more and more we are developing robots to function outside the controlled environment of the manufacturing floor and the lab. Robots are routinely used to interact physically with the world in places where humans should not, cannot or do not want to physically act. In handling ever more complex environments, we encounter a new class of robotic missions. These consist of deploying the robot to accomplish a few of a great many possible tasks, without knowing in advance which few tasks will actually be required in this instance of deployment. Even presuming that engineers could easily design a machine to execute each specific task, both the possibility of deploying so many different robots and the possibility designing and deploying one robot complex enough to perform all the tasks are often prohibitively expensive and risky. We refer to a mission where the absence of task definition is the limiting factor as an *Unknown Challenge Mission*. In our recent work on the CKBot modular robotic platform we have pioneered new approaches towards building robots quickly as tasks become known by fabricating the passive components of the robot body on the fly and connecting them to pre-existing modules. This fabrication can be performed either under remote control with materials such as foam[3] and hot-melt adhesive[1], or by humans using general-purpose parts – as illustrated by the ICRA robotics challenge competition[2] and LocoKit, or by humans using a carefully chosen collection of prefabricated parts – as illustrated by our ongoing work on the SEAL pack robots.

The ability to embed large parts of the task specific capabilities in a morphology that is synthesized in situ is best understood in the context of morphological computation, where adaptation of the morphology and ensuing changes in mechanical capabilities and dynamics are seen as an integral part of adapting a robot to its environment.

References

[1] L Brodbeck, L Wang, and F Iida. Robotic body extension based on hot melt adhesives. In *IEEE ICRA*, pages 4322 –4327, may 2012. DOI 10.1109/ICRA.2012.6225258.

[2] S Revzen, J Sastra, N Eckenstein, and Yim. Ckbot platform for the icra 2010 planetary challenge. In *Workshop "Modular Robots: The State of the Art", Proceedings of IEEE ICRA*, pages 11–12. IEEE, 2010.

[3] S Revzen, M Bhoite, J A Macasieb, and M Yim. Structure synthesis on-the-fly in a modular robot. In *IEEE/RSJ IROS*, pages 4797 – 4802. IEEE/RSJ, 2011. DOI 10.1109/IROS.2011.6094575.