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Christian Artmann

The Value of Information Updating in New Product Development

Dr. Christian Artmann
Immenstadt, Germany
christian.artmann@whu.edu

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To my family

Preface

Ever since I learned to fly airplanes, I am passionate about long-distance gliding in the Alps. Every time I take off in the early morning, I never know exactly which challenges I will have to overcome during the day. Especially the weather conditions are constantly changing, making it impossible to forecast even the thermal behind the next mountain range with certainty. Despite this lack of information, I have to decide whether it is worthwhile to "jump" over the ridge into the next valley towards my target. To obtain the experience how to instantly study the new conditions, reassess the previous plan, and adjust the route accordingly was a tough process, ending several times in an acre instead of my home airport. But most other times, when it worked out, I was rewarded with great moments and majestic impressions.

New product development projects resemble long-distance flights in many aspects. They are also exposed to numerous uncertainties and require continuous adjustments of the development efforts in order to successfully launch the product. While decision making during a flight is relatively straightforward and can be based on experience, it is far more complex for development projects. The basic principle, however, remains the same. Additional information obtained during the process has to be considered in the decisions for the remaining periods. Although this process is intuitive and follows the natural way of making decisions, it has hardly been formalized for development projects so far. It became the goal of this work to develop a decision model that explicitly takes information updates into account in order to better manage uncertainty. I hope it will be instrumental to managers and academics alike when facing difficult decisions in complex new product development projects. This work was submitted in fulfillment of the requirements for the doctoral degree at WHU, Otto-Beisheim School of Management, in the department of Production Management, chaired by Professor Dr. Arnd Huchzermeier.

I would like to thank Arnd Huchzermeier for his guidance and the inspiring environment he creates at his department, including the opportunity for me to study and research at Stanford University. I am deeply indebted to Rainer Brosch for the great intellectual and personal support during all these years, and for the many unforgettable moments. Furthermore, my thank goes to Daniela Schmitz-Wiehenbrauk and Christoph van Wickeren, who have been great colleagues and friends, making my time enjoyable not only at WHU. I also thank Stefan Spinler who was ready to help whenever necessary. I owe special gratitude to Georg Strasser who has been a dear friend since studying together in Karlsruhe. Driven by his expertise and enthusiasm, he added different perspectives and ideas in the many enriching discussions I had with him. Moreover, I appreciate the financial support from the German Ministry of Education and Research that funded this dissertation.

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Immenstadt, August 2008

Christian Artmann

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List of Abbreviations, Variables, and Functions

*	(indicates optimality)	G	Gamma distribution
α_t	Improvement cost at stage t	I	Initial investment cost
a_t	Managerial action (i.e., continue, improve, or abandon) chosen at stage t	IG	Inverse Gamma distribution
c_t	Continuation cost at stage t	i.e.	id est (that is to say)
cf.	confer (compare)	$k(a_t)$	Expected performance state improvement if action a is selected at stage t
d	Market performance requirement	μ	Mean of market performance requirement distribution
$E(\cdot)$	Expectation operator	M	Upper bound of profit margin
e.g.	exempli gratia (for example)	m	Lower bound of profit margin
Eq.	Equation	N	Normal distribution
et al.	et alii (and others)	N_k	Multivariate normal distribution (k dimensions)
$f(\cdot)$	Distribution density function	NPD	New product development
f., ff.	following	NPV	Net present value
γ_t	Cost of market performance requirement update at stage t	OV	Option value

XVIII List of Abbreviations, Variables, and Functions

$\Pi(x)$	Expected market payoff if launched product has performance level x	τ	Updating point in time
$\Pi(x, z)$	Expected market payoff after update with signal z if launched product has performance level x	θ	Unknown parameter of market performance requirement distribution (true market performance requirement)
P	Market payoff	T	Project duration
$P_t(x, z)$	Posterior project value in state x at stage t if prior managerial policy is applied	$tr(\cdot)$	Trace of a matrix argument
$P_t^\tau(x)$	Expected project value in state x at stage t for an update at τ if prior managerial policy is applied	$V_t(x)$	Project value in state x at stage t (no updating possibility)
p, pp	page(s)	$V_t(x, z)$	Project value in state x at stage t after update with signal z (posterior project value)
$\Phi(\cdot)$	Cumulative probability function of a distribution	$V_t^\tau(x)$	Project value in state x at stage t in expectation of information update at time τ ($t < \tau$) (expected project value)
post	(superscript) Posterior value, i.e., after update with signal z	$V_t^I(x, z)$	Value of information update with signal z in state x at stage t
prior	(superscript) Prior value, i.e., before update with signal z	$V_t^{I,\tau}(x)$	Expected value of information in state x at stage t for update at time τ ($t < \tau$)
QFD	Quality Function Deployment	Wi_k	Wishart distribution (k dimensions)
QR	Quick Response	X_t	Performance state of project at beginning of stage t
r	Discount rate	ω_t	Development uncertainty at stage t
R&D	Research and Development	z	Observed market performance requirements in follow-up study (signal)
Σ	Covariance matrix		
σ	Standard deviation of market performance requirement distribution		
ζ	Prior standard deviation of market requirement mean		
St	Student's t distribution		
St_k	Multivariate t distribution (k dimensions)		