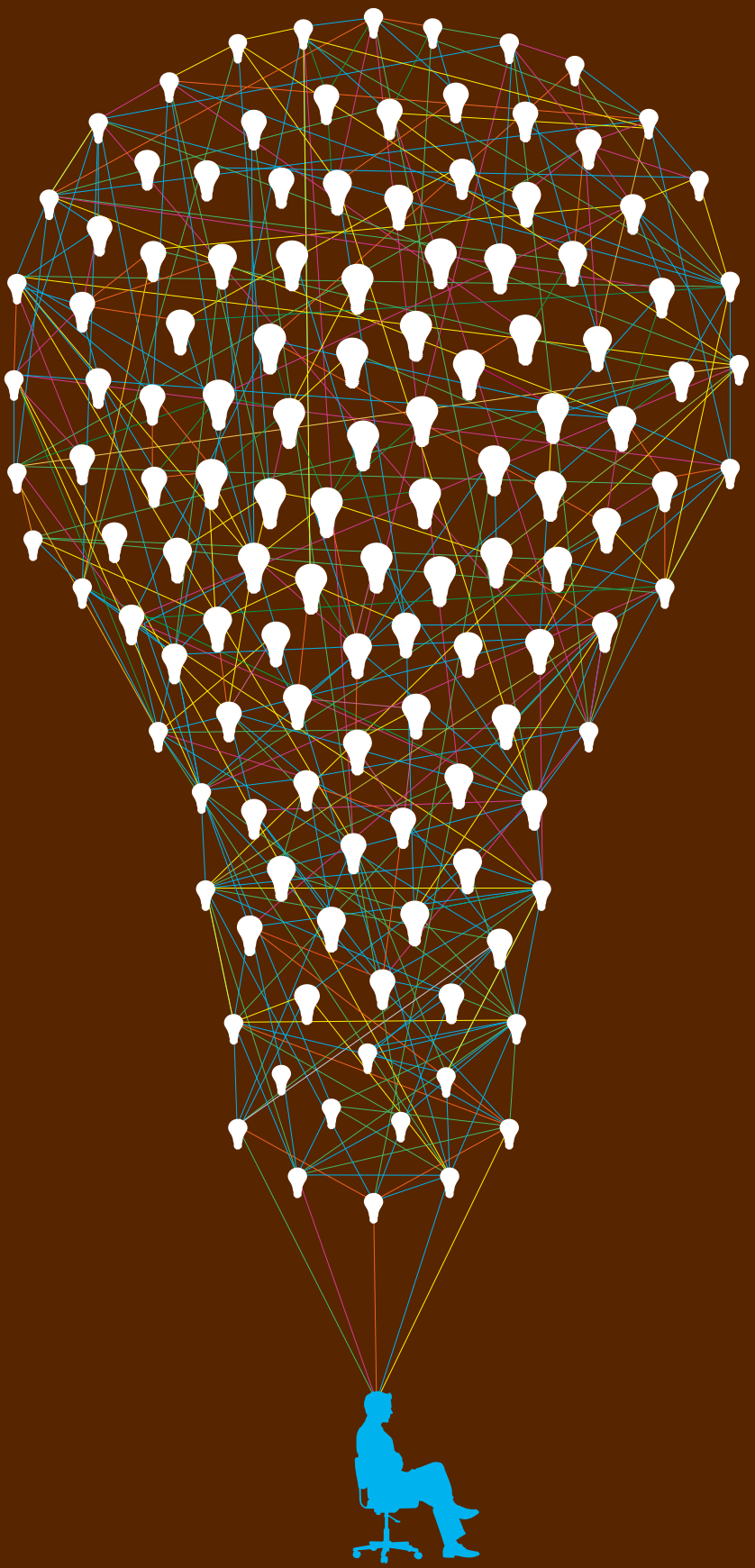


STRETCHING THE MIND: DEVELOPING AN ADAPTIVE LENS TO DEAL WITH COMPLEXITY

'Stretching' the mind to achieve both *breadth* and *depth* is a skill that will be of increasing value in our complex environment.

by **Mihnea Moldoveanu** and **Roger Martin**

AS INDIVIDUALS, WE RELATE TO our complex, uncertain and foggy world not only through our senses, but also through ways of *making sense* of what our senses sense. These 'ways of seeing' can be thought of as 'mental models', and our minds are filled with them, whether we are aware of it or not. In today's complex environment, the most successful thinkers can quickly and effectively abstract the best qualities of radically different ways of seeing from others and apply them to the situation at hand. In doing so, these thinkers develop an 'adaptive lens' on the bewildering phenomenon we call the world. We call these individuals *integrative thinkers*.

Integrative thinkers see their way clear to successful action in situations where others see only a choice between poor or mediocre outcomes. Theirs is a dialectical mind, or a 'diamind' for short – a mind that beholds at least two contradictory ways of seeing in any critical situation, gives each its full due, and instead of fearing and fleeing the resulting tension, embraces it and comes up with a third and better way that obliterates neither of the original ways of seeing but improves upon both. We believe that achieving a diamind is within the reach of anyone who is willing to think deeply about his or her own thinking and thereby 'stretch' their mind.

Old Habits Die Hard

Like much of human behaviour, our thinking is habitual, consisting largely of 'automatisms' – repetitive units of mental activity that occur on very short time scales. Sadly, most of the mental habits we develop to deal with our complex world close off opportunities for further thought and perception, and may or may not be useful, depending on the context you find yourself in. 'If you see a lion, run' is a useful mental routine when you are alone in the wilds of the Savannah, but not at the local zoo. Of course, the trick is to figure out *quickly* whether you are in the wild or at the local zoo, and act accordingly.

The problem is, in the realm of organizations, 'Savannahs' and 'zoos' do not come pre-labeled; it is easy to mistake one for the other, with disastrous consequences. So you have to figure out quickly and effectively the ecological value of your own thinking habits. The question isn't, 'Is it better to think more deeply about my problems?', but, rather, '*When* is it useful to think more deeply?'

Unlike behavioural habits, mental habits are difficult to spot, name and describe. Partly because they are covert and partly because they sneak up on us in moments of unawareness, they are also difficult to eliminate or change. This is why we need a *new kind of language* for describing patterns of mental behaviour: we need to learn to speak 'mentalese' – a language that will allow us to figure out quickly and effectively how we and others think.

The language of artificial intelligence ('AI') comes in handy for describing patterns of thought. For years, AI scholars have tried to teach machines how to do things, and as a result, they have had to learn to be very *clear* in their own thinking and to make useful and important distinctions such as the 'breadth-depth distinction'. In the modern workplace, this distinction is very useful. For instance, one finds that 'marketing people' pay attention to a lot of information: they are informationally *broad* in their thinking patterns; they constantly forage the world for new bits of information and compare that information with parts of their existing database – which they keep around in working memory – in order to arrive at action prescriptions or decision rules.

One could argue, however, that marketing people spend less time than, say, engineers thinking about each individual piece of information and about how the various pieces fit together. In other words, compared to engineers, marketers are logically *shallower* in their thinking approach. By contrast, one finds that 'engineering people' are informationally narrower but *logically deeper* in their thinking styles: they seek out far less information than their marketing counterparts; then, having gathered it, they strive for logical consistency amongst the various pieces of information they have deemed relevant. For instance, they look for ways in which what they *believe* connects to what they *know*. They look for the logical implications of what they already know or believe in order to decide what new beliefs to hold out for testing. They look for connections of the logical and causal type among facts and quasi-facts, rather than just associations and correlations.

Aware of this difference, we can ask: in what circumstances should logical depth dominate informational breadth, and vice versa? In what situations is *more thinking* better than *more foraging* or *more asking*, given that one can only think (or forage) more if one forages (or thinks) less? Having answered these questions, we can then ask: How can we get marketing people and engineering people to think together? How can we *integrate* the thinking patterns of informationally-broad thinkers with those of logically-deep thinkers in order to create *better* thinkers?

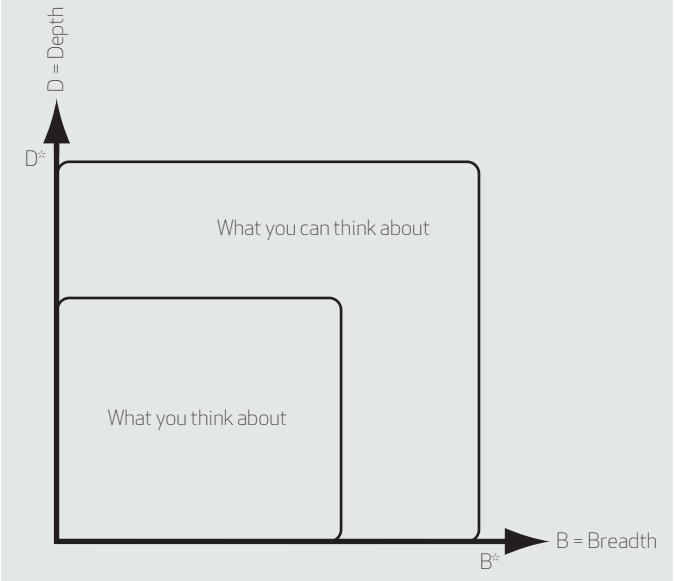
Expanding Your Mind's Window

Whether you are a marketer, an engineer or a baker, your mind has a 'window' through which it experiences the world. However, the edges of this window are hidden in such a way that you can see *through* it but cannot – without some training – see the window itself.

We will try to describe this window by means of a graph (see **Figure One**). On the horizontal axis, plot *how much* you know about a given situation: the total number of co-varying entities or variables that are *salient* and that your mind makes use of *in real time* as it thinks. This axis measures the breadth of your mind: how much you can take into account when thinking, without either panicking or losing interest – that is, without becoming too anxious or bored to continue thinking. For example, if you can memorize one or more phone numbers (including area codes) correctly, your mind's memory can hold within it at least ten independent chunks of information while performing a simple task, such as copying that information onto a keypad as you dial. If you play chess at the masters' level, you can probably hold in your mind at least seven or eight possible 'scripts' for each move, each consisting of a sequence of three or four forward moves by each of the two players.

Now for the window's height. On the vertical axis, plot the level of difficulty of the tasks your mind carries out while it thinks – how many operations per unit of knowledge your mind can correctly perform in order to arrive at 'answers.' This measures the *depth* of your mind – the amount of 'pure thinking' you can or are willing to do without panicking or losing interest, given a certain amount of information. For instance, ordering a random list of names according to rank or alphabetical order will take you a number of operations that is roughly proportional to the number of names on the list. By contrast, figuring out how to play 'the perfect' chess game – the game that wins against all possible other chess games – will require a very large number of basic steps to solve – one that grows exponentially with the number of possible moves that you can make at any one point in time. Even though this problem can be solved in a finite number of steps, that finite number is so large that it has yet to be calculated.

Stretching the Mind Figure One



Now, put the two axes together, and let's mark the hypothetical points where your mind will 'cave in' from too much complexity: B* and D*. The quadrangle [0,0], [B*,0], [B*,D*], [0,D*] constitutes your mind's *window* on the world. You 'see' only what is *inside* the window and cannot see what is *outside* of it – unless you work at enlarging it by making your mind broader or deeper – or ideally, both.

We are now ready to take in some sobering news, courtesy of complex systems expert **John Holland**: most people can only keep track of – at most – three co-varying variables at the same time. This is rather disappointing: if you're a CEO for a manufacturing company whose quarterly profits, market share and advertising and R&D expenses co-vary even in simple ways; *and* if you vary your choice of 'generic' strategies ('profit from the core,' 'unrelated diversification,' etc.); *and* if you have to make 'real-time' decisions (as you would during a top-management meeting or a meeting with three or four key investors whose interests you have to balance) that affect these variables (and perhaps the ways in which they co-vary); *and* if you fall into the 'most people' category (a good assumption), then you're up the creek without a paddle: you can likely only make *local* judgments that don't necessarily make sense when put together, and hope for the best. What saves you, of course, is that you don't 'know' you're making these mental choices *while* you're making them – they feel like good judgments or common sense at the time you make them, so you are able to continue functioning without panic.

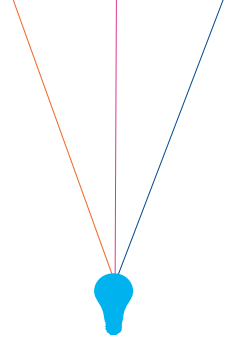
Well, you might retort, what good is thinking about *what I don't think about* if I can't think about it in the first place? Sure, it makes one look wise to talk about 'unknown unknowns', but in practical terms, what good does it do us if they remain unknown? The assumption on which this question rests, of course, is that they *have* to remain unknown and that you *can't* think about what you (currently) don't think about – which is precisely the kind of pickle that talk about 'most people's' patterns of reasoning gets us into: we confuse averages with laws of nature, and difficulty with impossibility.

Next, let's map different human ways of thinking onto our mind's window so that they start to look familiar. A logician – a software designer, theoretical physicist or economist – typically invests in *deepening* her mind. She truncates the number of variables she concentrates on and spends more time trying to figure out the connections among them and the logical implications of these connections. She solves 'logically deep' problems: mile-deep, inch-wide ones, such as, 'If all traders in a market were rational and interpreted relevant information in the same way, then what is the equilibrium price of a commodity that has just started trading following an IPO?'

The mile-deep mind cuts through the messy complexities of human action and much of 'reality' – for instance, the reality that actual traders may well interpret the same information in radically different ways; that some traders are much more savvy than others (which these *others* know, so that they 'follow the leader' and get into speculative bubbles); that some of these 'leaders' may not trade on religious holidays, which can cause significant disruptions in the market and significant gains for those who are willing to speculate on this behaviour by the appropriate methods; that many traders may lack the intelligence to determine the logical consequences of their beliefs and/or the fortitude to act on those beliefs (or on their consequences, if they have figured them out.) Needless to say, finance theorists have a field day examining models (again, inch-wide and mile-deep) of 'herd behaviour,' 'rational bubbles,' 'irrational bubbles' and so on. Yet they remain anchored in a sparse set of assumptions and look at a narrow set of variables that are deemed 'salient': they all try to *explain a lot by a little* – the avowed aim of economic theorists, and perhaps of the scientific mind more generally.

Contrast the *mile-deep, inch-wide mind* with the *mile-wide, inch-deep mind* – that of the historian, the journalist, the salesperson and the marketer, documenters of the particular and the immediate. The inch-deep, mile-wide mind is all about describing events 'thickly,' using many facts and different perspectives on the same observations, and possibly making use of a lot of evocative allusions and connotations, rather than explanations and denotations alone. The mile-wide mind does not care about explaining 'a lot by a little': it is perfectly happy to explain 'a lot by a lot' or even 'a little by a lot'.

More often than not, we have been trained to simplify and specialize; but at the same time we are often rewarded as 'people of action' in the world of business for being closely connected to 'the facts' – however messy, complicated and contradictory they may be. This tension is hard to deal with. One often feels like asking, 'OK, do you want me to know a lot *or* to think a lot?' – the implication being that there is a one-for-one trade-off between the two. But is there? The question is not as rhetorical as it seems. After all, why



The typical stance of the diamind is to 'go wide' when faced with deep thoughts and to 'go deep' when faced with wide thoughts.

can we not have a division of mental labour in business and society such that mile-deep, inch-wide minds do mile-deep thinking requiring no more than an inch's width of 'data' while inch-deep, mile-wide minds do no more than an inch's depth of thinking about at least a mile's worth of data? Ponder this question for a moment before proceeding further.

The answer: of course you can have such a division of labour! We see it evolve quite naturally between experimental and theoretical physicists, and between engineering and design groups on one hand and marketing, sales and business development groups on the other. All of these different groups rely on an 'invisible mind' that has designed the basic language, coordination framework and problem statements they focus on, and this invisible mind is the diamind, which can see the advantages of mile-wide *and* mile-deep thinking and which can design problems, languages and interactions that make optimal use of both styles.

Achieving Depth and Breadth Together

We can build a diamind by 'squaring the mind' – that is, by stretching it, working our way 'northeast' to enlarge its depth and breadth at the same time. This is the distinguishing characteristic of the diamind: the willingness to resist making the trade- offs between 'generalizability and goodness of fit,' between the ability to *explain a lot by a little* (the hallmark of the mile-deep mind) and the ability to *see and observe a lot*, come what may.

If you have to calculate 2^6 and you know nothing else, then you have to compute 'from scratch' – 2 x 2 = 4 x 2 = 8 x 2 = 16 x ... – all the while *counting* the number of times you're multiplying 2 by itself. But if you know *certain* powers of 2, like 5 (32), 10 (1,024), and 16 (32,768), then all you need to do to get to 2^6 is multiply 32 by 2; to get to 2^9 is divide 1,024 by 2, and so forth. Get it? All you have to do is *get good at the switcheroo* – that is, get good at adaptively switching back and forth between *remembering* and *calculating*.

A more practical example: how long does it take for $1 million to double in value at a compound interest rate of 25 per cent? Finance students will get out their calculators or laptops (pre-programmed, of course), but the two minutes and 35 seconds it takes for the laptop to boot is way too long in the midst of a final negotiation for buying 10 per cent of 'FastFlyer.com'. That is *not* what seasoned investment bankers do: they have a simple rule that optimally combines remembering with calculating, as follows: if you want to know how many years it takes for an investment to double in value at a compound rate of Y per cent, just divide 71 by Y. So, 2.8 for a Y of 25.

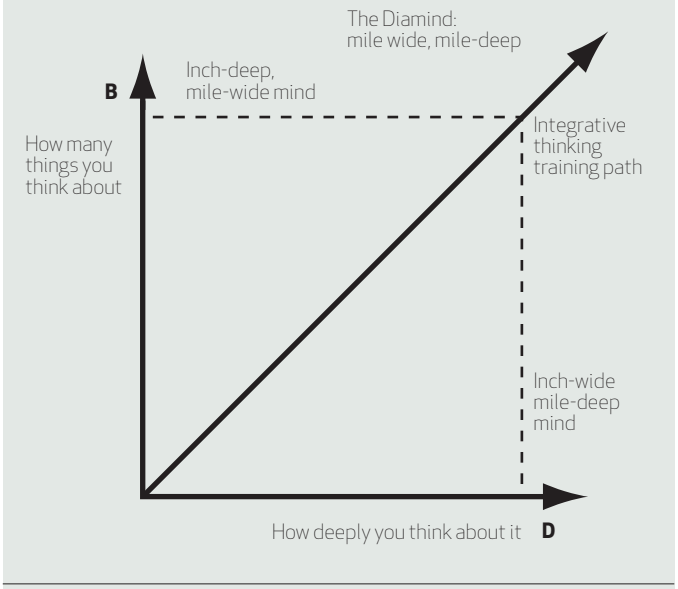
Of course, when you ask any professional what it is that makes her do what she does as well as she does it, she will give you *theories*; then, when you watch her in action, in the real-time tumult of life, the only thing you will see is a set of *tricks*. But there will be a method to those tricks: they will all be *mind stretchers*. The diamind can think 'on its feet' so that it can afford to behold a large number of emerging facts without feeling overwhelmed – and in this sense it is mile-wide. It can switch between thinking deeply and thinking broadly, and it can integrate between the two.

Can diamonds be educated and developed? A quick examination of our 'mind's window' metaphor will reveal that typical IQ, MQ, EQ and other-Q tests are not likely to reliably pick up diaminds from a population of random individuals. And, since these tests are the foundation of most other standardized tests, their blindness is likely to translate into the blindness of the traditional ways for selecting for quality in human capital.

What is needed is a new set of skills, and a new development program for nurturing them. Specifically, we need to develop ways of building better 'on-one's-feet thinkers', which we can only do by precisely articulating the kinds of thinking needed for business problems. These skills are varied, but they rest on an ability to *think about thinking while thinking*. That is, to think about what you are thinking about – about the complexity of the problem you are trying to solve, while at the same time, thinking through various solutions to the problem. Diaminds do this naturally, and because the skill is precisely articulable, it can be transferred.

How do you transfer a cognitive skill? You use the same principle that humans have used for thousands of years for transferring know-how to one another, from genome maps to atom bombs to

Stretching the Mind's Window Figure Two



quantum computers: you break down the skill into intelligible parts and transfer each part separately. In this way, a complicated behaviour like 'turning at the end of a swimming pool' can be learned and taught: thrust your hind up, pull down with your arms – front arm leading – feel the end of the pool with your toes, thrust forward. Repeat until mastered.

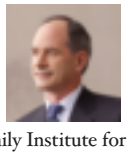
To master thinking about thinking while thinking, develop your mentalese – your language that represents what your mind is doing at any one point in time, and what it is trying to accomplish – and get good at flipping back and forth between your 'everyday language' (which unreflectingly looks for solutions even though it may have run out of time a long time ago) and mentalese, wherein you can ask yourself: what are the minimal characteristics of a good solution? How many steps will it take me to get there from here? Is there a faster, cheaper, better alternate path? What has changed about the solution space? How far off am I from the solution?

Understanding why such flipping is useful is, of course, not the full picture: the flip itself is hard, which is why diaminds are so few and far between. But our research indicates that the flip is also teachable, which bodes well for the growth and proliferation of the world's diamind population.

In closing

Stretching the mind – a cornerstone of the diamind's way of being in the world – is all about the willful augmentation of the mind's faculties of real-time thinking (the vertical axis of our window) and beholding (the horizontal axis of our window). The typical stance of the diamind is to go wide when faced with deep thoughts and to 'go deep' when faced with wide thoughts.

At stake in figuring out how mind stretching works is no less than achieving a better mind – one that can remain connected to 'reality' while retaining the ability to think its way past the immediate pull of various elements of that reality. The development of a tight, precise language for representing what your mind is doing while it is doing it goes a long way towards providing a pedagogical solution to the development of diaminds. ***R***



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