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On-Line Analytical Processing and the Time Dimension

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Introduction

Since managers see their firms as multidimensional entities (e.g., in terms of sales, expenses and profitability, by: product, region, channel, and time period, and on a budget vs. actual basis; see Figure 1 below), it is only logical that the OLAP or On-Line Analytical Processing software tools that are being increasingly deployed for organizing, analyzing, navigating through and visualizing the information needed by managers, should be seen as far more useful and meaningful than the conventionally used 2-D spreadsheets. Typically, OLAP tools allow users to interactively and more flexibly *roll-up* and *drill-down* (increase or decrease, respectively, the granularity or level of aggregation), *slice-and-dice* (select and project) and *pivot* or *rotate* (reorient a view of) multi-dimensional data. Additionally, customizable 2D- and 3D-graphics can be used to interactively improve the presentation of information, and accountants, for instance, can better monitor, control and correct account balances, etc., by multi-stage drill-down to the transaction level. Yet, if one goes beyond structural and procedural issues, and more deeply into how the real information needs of the manager or decision maker, could possibly be addressed with such tools, a number of questions still remain.

The emphasis, thus far, seems to be primarily on categorizing, manipulating, presenting and viewing *historical* data about the firm's performance, at different asset or time granularity levels, or by regions, currency, and so on. This of course begs the question: What about the future? Managers—who perforce have to look ahead at what could possibly be, rather than back at what was—need more than just a new way of looking at the historical information that comes from traditional accounting systems, even if it is made available in a timely, accurate, and understandable fashion. Why can't OLAP tools be potentially used, then, to drastically revamp the way information is made available to such forward-looking decision makers, and to help them formulate more effective strategies for the next year, and so on, as well as execute those strategies more effectively? If, indeed, the focus could shift from a retrospective to a truly prospective use of OLAP for managerial decision making based on accounting data, it follows that the role of time would have to be significantly redefined in this regard.

Essentially, OLAP tools are used only to provide “fast, flexible and friendly” access to multi-dimensional views of aggregate historical data (that was collected and stored earlier in a data-warehouse and retrieved depending on the user's information needs), and answer the usual “Who did what, where and when, and how much did the firm gain or lose as a result?”-type questions that are essentially retrospective in nature. It is always worthwhile for the manager to try to answer such higher level, analytical questions as: “Which are (were) the firm's most (least) profitable products/regions/channels/divisions/... this (last) year?” and “In which segment are customers most (least) loyal?” However, it would be far more logical to use OLAP tools with their ability to thus manipulate aggregate data, to provide *more meaningful* answers to such strategically more important questions as: “Which *will be* the most (least) profitable products/... *next year*, and under *what circumstances?*” and “What would the impact on customer loyalty be, if we advertised heavily, redesigned the product, revamped the supply chain, etc.?” and “Why should we choose the one and not the other approach, and if we do invest, how much should we invest in each case to achieve our target?” and so on.

Yes, it is true that OLAP tools are being used to answer questions of the latter type, which are more prospective than retrospective in nature. In fact, as the OLAP-Council's white paper suggests, “(w)hile OLAP systems have the ability to answer “who?” and “what?” questions, it is their ability to answer “what if?” and “why?” that sets them apart from Data Warehouses. OLAP enables decision-making about future actions. A typical OLAP calculation is more complex than simply summing data...” But the underlying models that are used seem to be based on a naïve projection of the past into the future (e.g., using time series trend analysis, etc.), rather than on an analysis of those factors, e.g., intangible assets, etc., that have affected the trajectory that the firm has taken thus far, and of those that could make the future different from the present and past.

A New Paradigm for the Third Wave

Echoing Toffler's (1982) theories about the third great wave—the information revolution that has supplanted the industrial revolution in the last five decades or so—Elliott (1992) has pointed out how woefully inadequate “second wave accounting systems (that) operate at the *w*' level, consider only tangible assets, focus inwardly on products, wait for events to occur before originating accounting entries, and lock in the hierarchical organizational form,” are for firms seeking to compete in the third wave. This is even more so now as virtual businesses that seamlessly, frictionlessly, and nearly costlessly offer 24-7 access to customers, anytime, anywhere, become the norm in a globally networked, hyper-competitive marketplace.

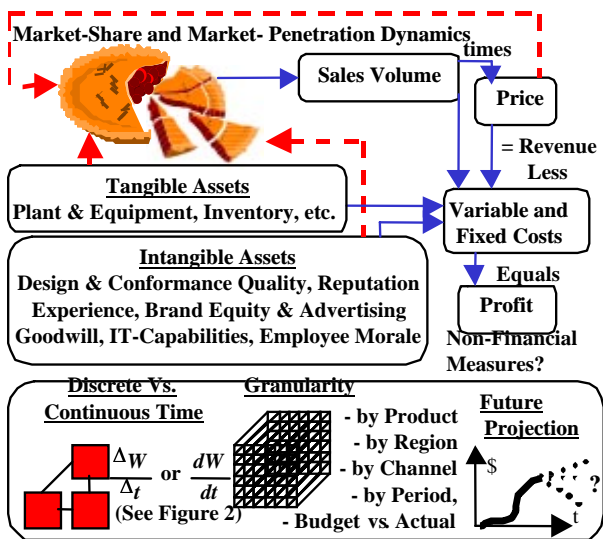


Figure 1. A Third Wave Business Paradigm

Fundamentally, we have to see whether the very assumptions underpinning the currently used 500-year old accounting paradigm need to be reappraised. Friar Luca Pacioli's invention served the world very well when all you had to know was the profit made on a single trip involving taking a shipload of European goods to the East and coming back with spices and silks that were then sold in Europe at highly inflated prices. It served the world reasonably well since 1494, mostly because nothing better was available. If conventional accounting systems fall short in any way, the problem is not with what they capture, but with what they ignore. The existing accounting paradigm ignores the dynamic impact of the firm's investment in any intangible asset, for instance, on its competitive position, and of similar investments made by its rivals on their competitive positions, and the industry-specific market-share and market-penetration dynamics (i.e., the sharing of the inter-temporal pie in Figure 1), in turn. Thus, we see that intangible assets and liabilities do significantly affect each firm's sales volume, revenue, and profitability, and implicitly its prospects for sustained growth or even survival in the long run.

To see why a new paradigm may really be called for in this respect, consider the extent to which, and the reasons why, forward-looking managers have found the traditional accounting approaches—that are better suited for scorekeeping—inadequate for making decisions that are vital for the firm's long term growth/survival prospects (e.g., Ijiri, 1986, and 1988, ascribes the manager's typically myopic orientation to the accounting systems that overemphasize income-based managerial goals and performance measures). Can accounting be made more prospective than retrospective in orientation, as advocated, e.g., by Allen (1994) and Kaplan and Norton (1996)?

Managers do realize the limitations imposed by their second-wave accounting systems in this post-industrial era. Elliott (1992), for instance, cites a highly successful software firm's CEO as saying that managing a firm based on conventional accounting information was like trying to fly an airplane that had only one dial which showed the sum of airspeed and altitude—if it was low, he knew he was in trouble, but he didn't even know why. "Flying blind," is how Prof. Robert Kaplan puts it in the first of the HBS *Balanced Scorecard* videos. To understand how much more needs to be done in terms of both theory and practice in this regard, one could, metaphorically and similarly, think of the firm's manager as driving a peculiar hybrid car. Assume this car has two energy sources: A) a conventional engine, say of the internal combustion-type, for cruising and normal driving, and B) a self-conserving storehouse of latent energy (replenished by regenerative braking and any excess energy produced by Source A, and so on), that is tapped only for going uphill or accelerating.

Thus, the energy in Source A is analogous to the firm's tangible assets and that in Source B is latent and pertains to the firm's intangible assets and deferred value reserves, e.g., market share gains, knowledge, experience, quality-based reputation, brand equity, advertising good-will, IT-capabilities, inertia, employee morale, etc. Note that the focus has conventionally been on measuring and analyzing source A and not B. Further, suppose this car is very poorly-equipped. Specifically, let it have:

1. no device to measure source B's latent energy store which could help sustain progress down the road;
2. an odometer-like integral device to gauge distance traveled and thus average speed (aggregate measures, e.g., income earned last month/quarter/year, that do not reflect its current state) but no speedometer- or accelerometer-like differential devices to capture the current state (the current rate at which income is being generated, and its rate of change) and provide more effective and useful real time feedback about the impact of any action (e.g., braking or accelerating, or alternately, investing in quality improvement, product differentiation, advertising and promotion, etc.), at a disaggregated level, or the need for changes, if any, to use Ijiri's analogy; and
3. a rear-view mirror (conventional accounting systems, capture, analyze and report historical, out-of-pocket costs, and not those that have yet to be borne) but no front windshield (for the manager to "see" what is "ahead," make strategically optimal decisions whose impact is realized only over time, and thus steer more sensibly and safely) to use Allen's analogy.

In today's fast changing, globally competitive, high-tech. economic environment, basing all strategic and tactical decisions on conventional information generated by our existing historically biased accounting systems, is like asking the firm's manager to believe that the future is but the past extrapolated, and just drive on, or basically "fly blind." Can any manager—thus severely handicapped and usually assigned income-based goals and rewarded based on the momentum created by her predecessors—be blamed for focusing only on her decisions' near-term, supply-side consequences? Why, for instance, would she make Japanese-style investments in continuous quality improvement, as a matter of faith, if the long term gains are "unknown and unknowable," as suggested by Dr. Deming? Do these and other similar quantities really have to be as unknown or unknowable as they are made out to be, or can they be estimated, at least in theory, using the sort of OLAP tools that have now been deployed?

The problem with any OLAP-like analytical approach is that if the emphasis remains only on: i) wealth (tangible assets less tangible liabilities only) and ii) income or the first difference in wealth, i.e., the incremental wealth created in the last quarter or year (analogous to the distance covered in the last hour or so, as measured by the odometer); so that such determinants of the sustainability of the firm's current state as: iii) "momentum" or the rate at which income is being generated (the "speedometer" reading); iv) "force" or the rate of change of "momentum" (measured by the "accelerometer"); and v) latent energy levels; are ignored, then all such an approach can really do is to present historical data in new and different ways. To see how time can fundamentally alter the usefulness of the OLAP tools deployed, perhaps the time dimension ought to be revisited and reexamined more closely.

The Time Dimension

Of the three key features, viz., multidimensional views of data, calculation-intensive capabilities, and time intelligence, required by all OLAP applications according to the OLAP Council's white paper, it is the last which seems to be the most significant in this regard. Under the heading "Time Intelligence," the OLAP Council's white paper points out that "time is an integral component of almost any analytical application. Time is a unique dimension because it is sequential in character... Business performance is almost always judged over time, for example, this month vs. last month, this month vs. the same month last year... The time hierarchy is not always used in the same manner as other hierarchies... Concepts such as year-to-date and period over period comparisons must be easily defined in an OLAP system... In addition, OLAP systems must understand the concept of balances over time..." While concurring fully with all this, one still gets the feeling that more can, and will have to, be done in this regard. While actual balances can be compared with planned balances, etc., based on the consistent time references that transaction data are tagged with when being loaded into the data warehouse, and while time-based comparisons do allow business development trends to be identified, it should surely be possible to do more than just apply OLAP tools to historical data.

Ijiri has some valuable insights to offer in this regard. Just as going from distance to velocity and acceleration entails a continuous rather than discrete time approach, so also going from the conventional first-difference relationship (between wealth, W , and income, ΔW), as depicted in Figure 2, to a differential linkage (between W and momentum, $\frac{dW}{dt}$) and an integral one (between W and ΔW), and so on, involves viewing the firm's state over smaller and smaller intervals. And this is what quite plausibly could be done with OLAP tools which use consistently time-stamped or time-referenced inputs. But deeper, richer economic models that relate the financial and non-financial measures of the firm's strategic health to the value that has accrued to it in the past, is accruing to it at present and will accrue to it in the future (in the projected sense, but derived from its tangible and intangible assets and liabilities, etc., and not merely as a naïve extrapolation of the past into the future) are also required.

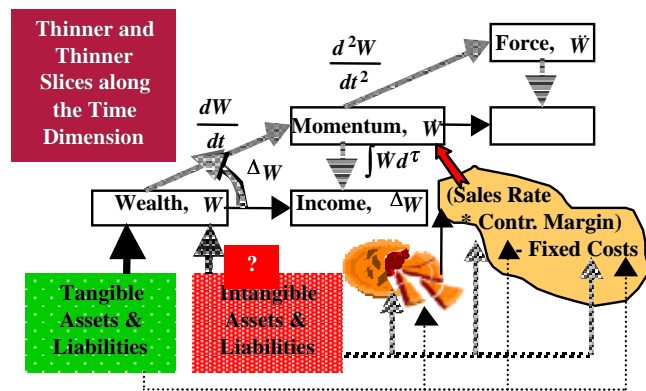


Figure 2. Ijiri's Momentum Accounting Framework

In essence, since OLAP tools can be used to take thinner and thinner slices along the time dimension, i.e., move from discrete time to nearly continuous time, the data could be manipulated so as to cast balance sheets and value flow statements (cf. Income Statements) in near-real time. Ijiri's Momentum/Force Accounting framework, thus operationalized, would then become more workable and useful than it is currently considered to be. Armed thus with a "windscreen" view of what is projected to come in addition to the rear-view mirror image of what was, and secure in the knowledge that readings of speed, acceleration and latent energy reserve levels are also being taken into account—in addition to the odometer readings, for measuring and rewarding performance—decision makers would probably be less reluctant to invest in the future, e.g., in any project that has a long gestation period, even if it entails some current sacrifice.

References

References are available upon request from the author (imkini@usthk.ust.hk)