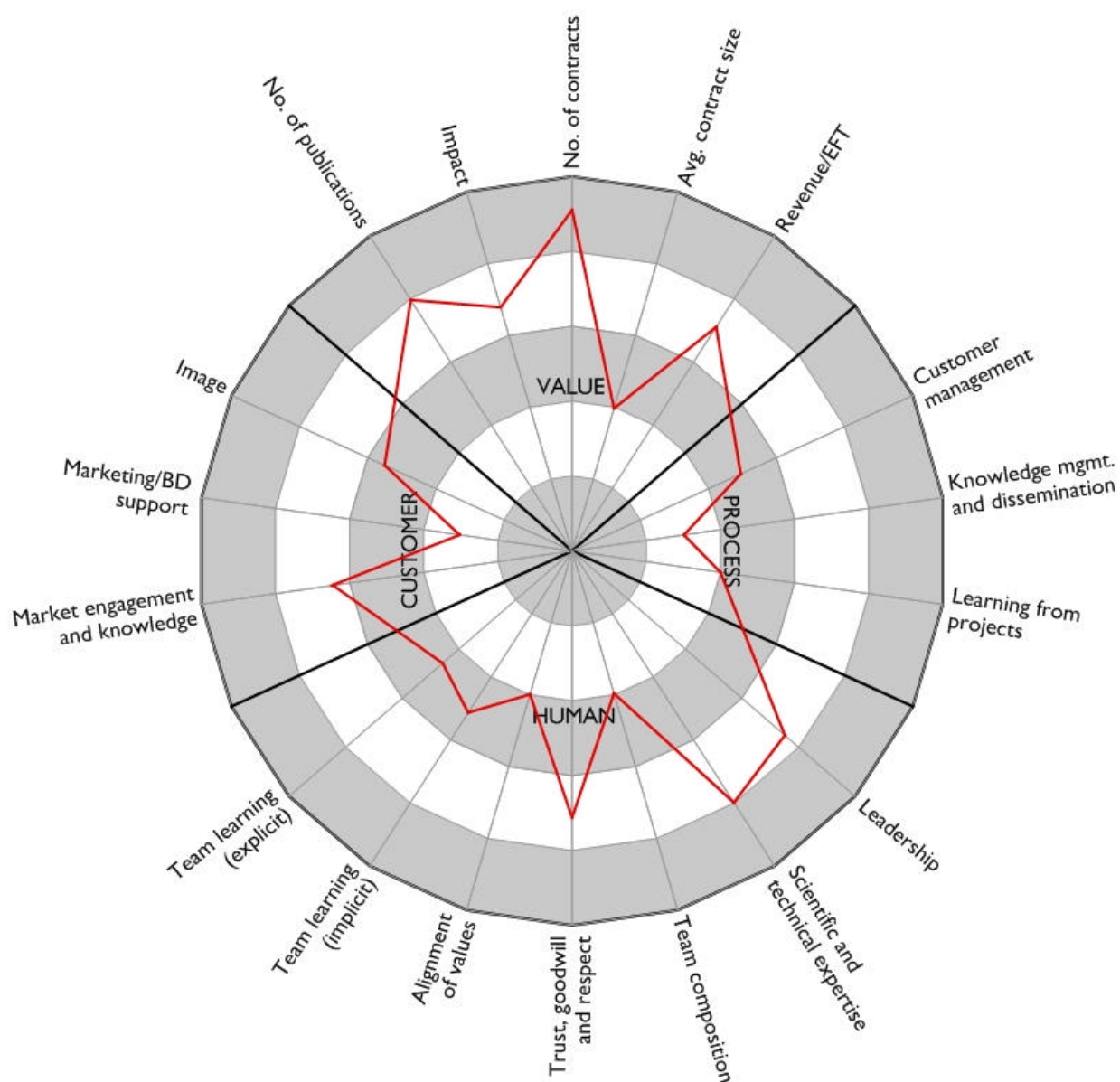


Intellectual Capital in Small Teams: Towards a Methodology for Capturing Intangible Assets



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Methodology for Capturing Intangible Assets***

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SUMMARY

The rise of knowledge-intensive industries in Western economies has highlighted the fact that the value created by software companies, internet startups, or scientific and financial consulting enterprises depends far less on their physical assets than on their intangible ones. These assets are often described as *intellectual capital* (IC), and they play the same role in these enterprises that plant and equipment do in manufacturing companies.

Recently, several attempts have been made at articulating a precise definition of IC and using it to understand value creation, as well as how it relates to the long-term sustainability of knowledge-intensive enterprises. Most of these definitions divide IC into three principal components: human, structural, and customer capital. This subdivision helps to clarify the nature of IC, but although corporate-level IC measures have been proposed and indeed published, little work has been done on auditing IC at a micro-level, for example, at the level of a research group within CMIS.

In this report, I will propose a methodology for just such an audit, using my own research group, Production Process Improvement (PPI), as a case study. I have adapted several different types of indicators from different sources and used them to carry out an IC audit. The results are displayed on a "radar chart" that summarizes all of them, and it provides a good overview of the group's current situation, as well as providing an idea of directions that it should be adopting in order improve its business performance.

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1 INTRODUCTION

1.1 INTELLECTUAL CAPITAL: A BRIEF BACKGROUND

The rise of knowledge-intensive industries in Western economies has highlighted the fact that the value created by software companies, internet startups, or scientific and financial consulting enterprises depends far less on their physical assets than on their intangible ones. These assets are often described as *intellectual capital* (IC), and they play the same role in these enterprises that plant and equipment do in manufacturing companies.

In one influential strand of the knowledge management literature, the IC residing in a company is defined as the difference between its market value – the price that investors are willing to pay for it – and its book value – the value of its physical assets according to standard accounting practices. So, a company like Microsoft, which in 1997 had a market value of USD119 billion and net assets of USD7 billion, has a considerably greater amount of IC than does General Motors, which despite having assets of USD222 billion in 1997, was worth about USD50 billion on the stock market! Yet, purely financial measures such as these, as striking as are, get us no closer to understanding the many facets of intellectual capital, nor do they explain how intangible assets create value.

Recently, however, several attempts have been made at articulating a precise definition of IC and using it to understand value creation, as well as how it relates to the long-term sustainability of knowledge-intensive enterprises. We will examine a few of these definitions later on, but with a few subtle differences, most of them divide IC into three principal components: human, structural, and customer capital. This subdivision helps to clarify the nature of IC, but although corporate-level IC measures have been proposed and indeed published, little work has been done on auditing IC at a micro-level, for example, at the level of a research group within CMIS. In this report, I will propose a methodology for just such an audit, using my own research group, Production Process Improvement (PPI), as a case study.

Of course, there are two ways of looking at an audit of intellectual capital, one static, the other dynamic. On one hand, an audit can function as a stocktake, a snapshot of where an enterprise is now, and it may be used to attach a dollar value to the organization, or it may be employed to uncover

'hidden' capital that is not being exploited. The recent audit of intellectual *property* in CMIS can be seen as a partial example of this. On the other hand, IC can be viewed in the light of changes that are taking place in the environment in which the enterprise operates. Hence, it can also be used to address the question 'What do we lack, or what do we need to improve, in order to be able to thrive in a new environment?'

1.2 SCOPE AND OBJECTIVES

In my initial proposal (Appendix A) for an intellectual capital audit of PPI, I implicitly defined IC to be what I have since found out to be human capital, that is, the implicit and explicit knowledge possessed by the group and its members. Although such an audit can be useful by itself, it is clear from recent work described in the literature that it is important to understand the *interactions* between the three forms of capital – human, structural, and customer – to be able to understand how value is created.

As a consequence, the scope of this work has expanded to encompass all three forms of capital, but its objectives are more modest. The imperative for this audit, however, remains the same – the need for PPI to examine and change the way in which it works in order to operate in a sustainable way in a changing external environment.

The objectives of this work, therefore, are:

1. To propose an intellectual capital model for a small group of workers in knowledge-based industries; and
2. To propose a methodology for carrying out an audit of intellectual capital at this micro-level.

The work described in this report should be seen as the first in a series of iterations to refine both the model and methodology, since not all the required information is available at the time of writing. Although PPI has carried out many elements of the audit that I describe below, we have yet to cast them in the framework that I propose. Nevertheless, as the model and methodology continue to be refined, I hope that the result will be seen as applicable to other knowledge-based teams within CMIS, and indeed as a piece of useful intellectual capital!

1.3 OUTLINE OF THE REPORT

Intellectual capital is a relatively new idea in the field of knowledge management, and Section 2 reviews some of the recent developments. Much of the work that has been done so far is aimed at *valuing* the intellectual capital of large enterprises, and although that is not what I have set out to do, it is possible to borrow some of those ideas, modify them, and then apply them at a much smaller scale. In Section 3, therefore, I present a model for IC, and a methodology for auditing it, that borrows heavily from existing work, but that is more appropriate to a small group of knowledge workers. Finally, Section 4 concludes the report with some remarks on the potential misuses of an IC audit, and the need for tact sensitivity, and honesty in carrying it out.

2 INTELLECTUAL CAPITAL

2.1 ORIGINS AND DEVELOPMENT

As some authors[6, 8] have commented, portions of what is now called intellectual capital have long been acknowledged by the accounting profession under the term ‘goodwill’. Although goodwill is intangible, investors have always taken it into account when valuing enterprises that, for example, have a recognizable and popular brand name or trademark. The rise of corporations whose knowledge base represents almost their entire value, however, forced companies, analysts, and management theorists to elaborate goodwill and other intangible assets into something that could be more clearly linked to value creation.

One of the earliest of these attempts centered upon knowledge management. First came the recognition that “know-how adds significantly to the value of a business”, and it was followed by the “quest to develop better systems for creating, capturing, and disseminating knowledge within organisations.” According to Sullivan[12], Karl-Erik Sveiby[13] was one of the first to explain how to manage intangible assets. His work inspired a burst of activity in the research and practice of both knowledge management and intellectual capital, and it culminated in the work of Edvinsson[5] with Skandia, a Swedish financial services company, that resulted in the release in 1994 of the first IC audit and valuation in a company’s annual

report*

In Edvinsson's model, IC consists of two elements – human and structural capital along with their interactions – and, with some modifications, it is still the basic formalism from which other models are derived. With this conceptual framework in place, attention has now turned to defining the precise elements of IC, and then devising accounting practices for measuring, valuing, and then reporting them in the same way that firms traditionally report material and financial assets. Luu *et al.*[8] provide a nice overview of some of these attempts, while Guthrie[6], Sullivan[12], and Roos *et al.*[11] summarize the origins and recent trends in intellectual theory and practice. Figure 1, taken from Roos *et al.*[11], illustrates conceptually how two different streams of thought – knowledge management and resource measurement, the latter arising from the resource theory of the firm, converged to intellectual capital.

Much of the work to date on implementing IC auditing and valuation schemes has shown that there is no universal prescription that is applicable to all types of enterprises. Hence, any approach must be carefully tailored to the composition, nature, objectives, and market of the organization. Furthermore, because of the perceived imperative among practitioners to link IC and stock market value, many of the measures that have been proposed (see, for example, Edvinsson and Malone[5]) are clearly inappropriate when the objective is to understand the elements of IC and how they create value at the micro-level. In the next section, we will examine some models and measures and see the extent to which they are applicable to a CSIRO research group.

2.2 MODELS, VALUE CREATION AND INDICATORS

Models for IC One of the earliest attempts at constructing a model for IC can be traced back to Skandia's 1994 annual report, so we begin the discussion of models by examining Edvinsson's[5] taxonomy, shown in Fig. 2. Skandia was ultimately interested in apportioning market value between traditional indicators – here labelled financial capital – and IC, and the company's basic premise was that market value was simply the sum of financial and intellectual capital. As Fig. 2 shows, the model is a hierarchical

*The 1997 annual report, along with other information on IC, is available from Skandia's web site at <http://www.skandia.com/en/ir/annualreports.shtml>.

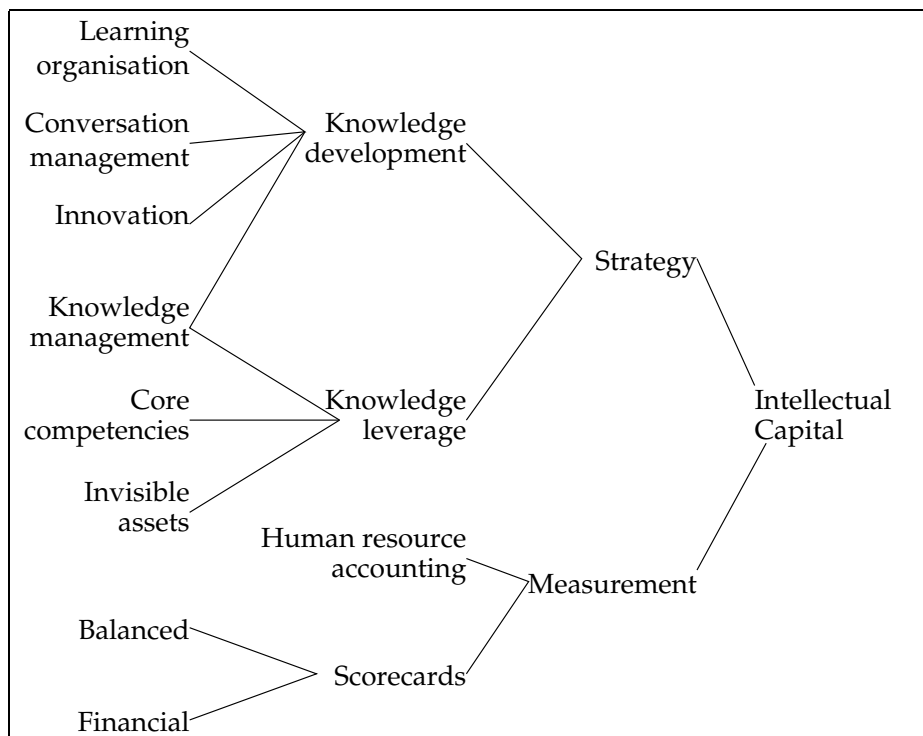


Figure 1. Conceptual roots of intellectual capital, showing the convergence of knowledge and measurement streams. Adapted from Roos *et al.*[11].

one, with the IC branch is expanded to show its constituent branches. The first and most important division is between human capital and structural capital, and it broadly represents the distinction between the intellectual assets of the employees and the structure, organization, and processes of the enterprise in which they work. The labels are, for the most part self-explanatory, and the terminal blocks in the IC tree are briefly described below.

Human Capital combines all the knowledge, capabilities, competencies, expertise, and creativity of the organization's staff. It is the most obvious component of IC, yet the most difficult to define precisely – humans are far too complex! Moreover, although knowledge and expertise can be either implicit or explicit, most of what constitutes human capital resides in people's heads and goes with them when they leave for home.

Customer Capital represents both customer relationships as well as customer databases. It could be argued that in many knowledge-based organizations such as consultancy firms (including CSIRO), that customer relationships should also be part of human capital. Customers may well have a relationship with the enterprise, but it will often be with a particular individual in a consulting firm.

Process Capital encompasses the organization's internal processes, and it includes the infrastructure that supports them – libraries, information technology, access to information, training programs. In short it includes, apart from intellectual property and intangible assets as defined below, everything that is left behind when employees leave for home.

Intellectual Property has traditionally come to mean unique know-how, trademarks and patents, and other form of knowledge that can be protected, either by confidentiality or by copyright.

Intangible Assets covers aspects such as organizational culture, ethos, and values.

Skandia's taxonomy represents only one possible model of many for imposing a structure on so amorphous an entity such as a knowledge-based

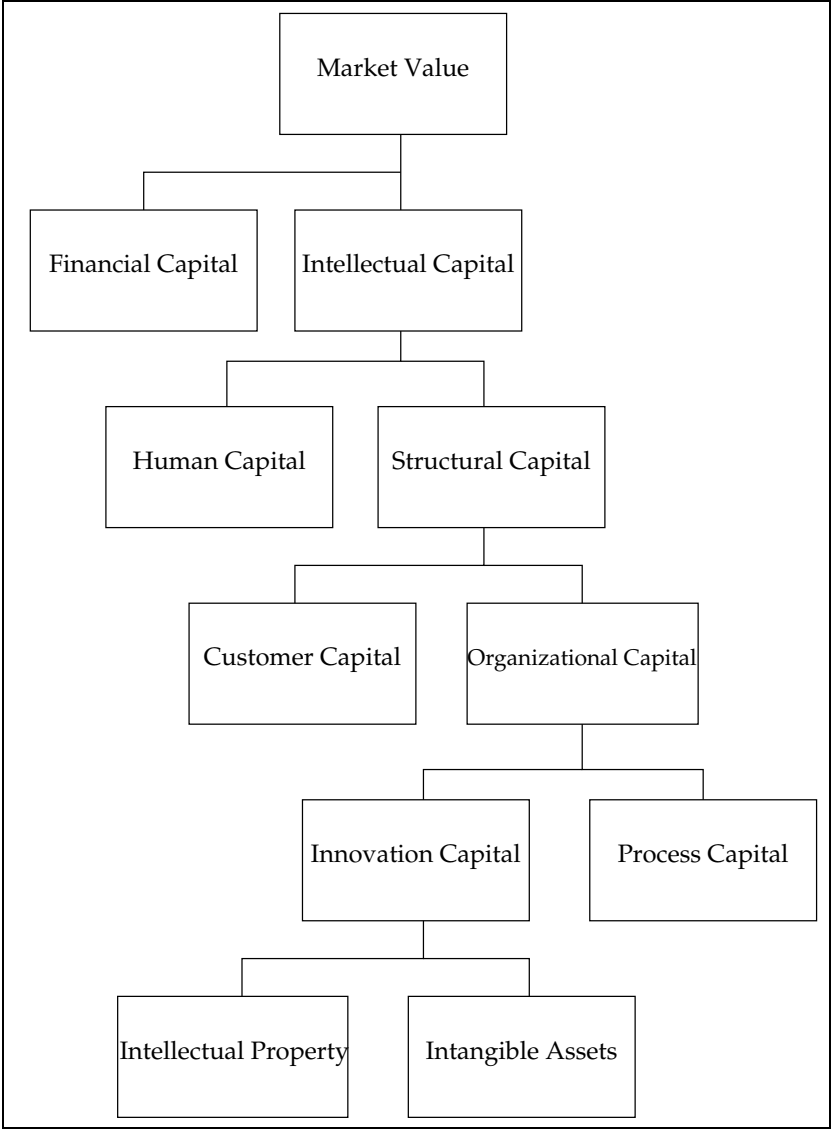


Figure 2. Skandia model of market value and intellectual capital. Adapted from Roos *et al.*[11] and Edvinsson and Malone[5].

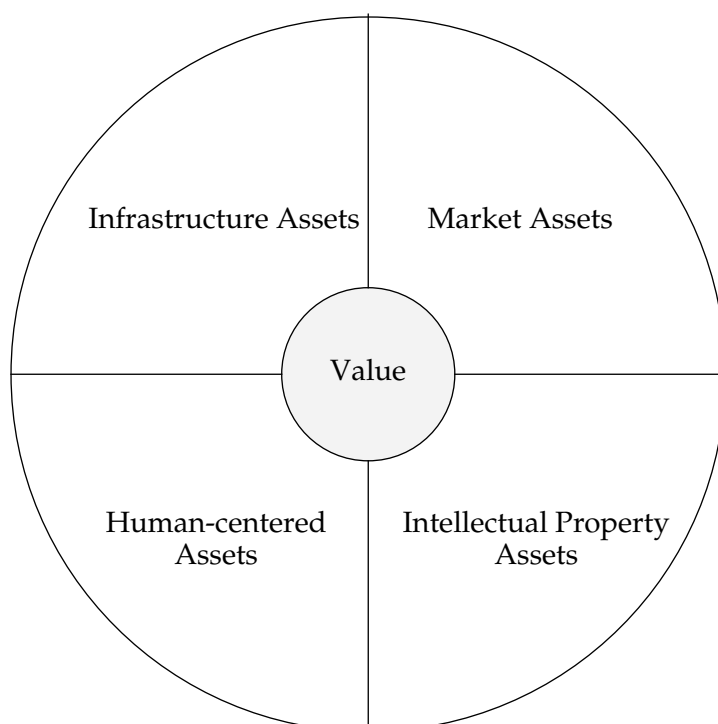


Figure 3. Brookings's[2] classification of IC.

enterprise, but most other models, though they may differ in details, adopt similar hierarchies. For example, Saint-Onge (cited in ref. [5]) prefers to break out customer capital as a separate category equivalent to structural and human capital in position. Brookings[2] defines yet another structure model that considers four main division: market assets, human-centered assets, intellectual property assets, and infrastructure assets. In her picture, the components of intellectual capital are presented as the quadrants of a circle (Fig. 3), and their intersection is what creates value.

Whichever structure we prefer, however, it is clear that *flows* between the different categories, that is, the flows of *capital*, must also be considered. For example, when employees learn from one another, there is a flow of knowledge. Sending employees on formal training courses requires a flow of financial capital, and the consequent increased competence of employees may result in increased innovation – creation of intellectual property or more value-creating activities. Few formalisms thus far have succeeded in

capturing the myriad of flows that can and do take place; hence, flows are not explicitly modelled but are implicit in the indicators that are defined.

Of course, neither Fig. 3 nor the Skandia classification are models in the sense of explaining *how* the many aspects of IC combine to create value, and unfortunately, the IC literature is frustratingly unclear on this rather important point.

IC and Value Creation The people working in knowledge-based enterprises know instinctively, if somewhat vaguely, that intellectual capital *must* be related to value, and that it is the engine of value creation, in precisely the same way that factory equipment and the decision-making and operating policies associated with the physical plant produce saleable goods. That rather utilitarian metaphor is preferable, I think, to the more picturesque ones that abound in the IC literature. Here, for example, is how Edvisson and Malone[5] describe IC:

If we imagine a firm as a living organism; for example, a tree, one can say that organisational plans, annual and quarterly reports, firm brochures, and other documents are the trunk, branches and leaves. The wise investor will examine the tree whether he can harvest ripe fruit. But to assume that we have now seen the whole tree because we have seen the visible is a grave mistake. At least half the tree is below surface in the roots. And while the taste of the fruits and the colour of the leaves make a good presentation of the present health of the tree, it is much more effective to look at what goes on in the roots if one wants to form an opinion about the health of the tree for the coming years. There may be rot below the surface, which as time goes may kill the tree that looks healthy presently. This is what makes intellectual capital – investigation of roots of a firm's value, measurement of the dynamic factors, which are found below the visible surface of a firm's buildings and products – so important.

Lovely as it is, this metaphor does not yield a useful model, or even a description, of *how* value is created from the interaction between the knowledge of individuals and the internal structure and processes within an organization. Moreover, as Mouritsen *et al.*[10] point out, although the IC literature is replete with measures of IC that have been used by different companies, they arise out of *descriptions* of IC rather than *models*. Such an omission is perhaps an implicit acknowledgement that the link between value and IC depends on the nature of the enterprise.

By contrast, Sullivan's[12] discussion of value creation and IC begins with the premise that the nature of the firm determines how it extracts value from IC. So, to take an example that mirrors CSIRO's situation, management consulting, accounting, and law firms extract value by selling the knowledge of their human capital, and they profit from the fees they receive for services provided to clients. Although such a view may not provide a model that takes inputs (IC) and produces outputs (value), its elaboration in any given instance forces us to think deeply about how value is produced from the knowledge and activities of the enterprise, and how that IC can *sustain* value-creation. For example, Table 1, adapted from Sullivan([12], p. 12) shows a matrix of value – both *direct* and *indirect* – sought from IC by two different types of firms: a commodity products firm (a bulk chemical manufacturer, for example) and a direct services company such as a management consulting firm. Both obtain value in the form of profits from the sale of goods or services, and both rely on reputation and customer loyalty to ensure repeat business. Where they differ most markedly,[†] however, is that the direct services company depends more on intangibles such as name recognition, leadership, and standard setting, and these are vitally dependent upon human capital.

So, by first examining how a particular enterprise creates value, we can explore how the different elements of its intellectual capital contribute to that value creation. In the case of a knowledge services organization, and more specifically a research group such as PPI, we will then be in a better position to devise sensible *measures* of intellectual capital.

Indicators of IC As we have seen earlier, one of the imperatives that motivated research into IC was the desire to value knowledge-based organizations using the fundamental relationship, taken as a matter of faith in one strand of IC research, that market value was the sum of financial capital and intellectual capital. Yet, although much subsequent work has been done on refining what should be reported in IC statements, there is as yet little research on the 'true' financial value of intangible assets such as human capital and customer capital. Indeed, if we examine the IC literature as well as the IC reports published by companies such as Skandia and other

[†]Sullivan may not have gotten all the ticks correct, but most would agree that the two types of firms would in fact have a different value creation and extraction profile.

	<i>Commodity Products</i>	<i>Direct Services</i>
<i>Profit Generation</i>		
Product or Service		
Sale	✓	✓
License	✓	✓
Joint venture	✓	
Strategic alliance	✓	
IP Income		
Sale	✓	
Lic. royalties	✓	
Joint Venture	✓	
Donation	✓	
Price Premium		✓
Increase in Sales		
Convoyed		✓
Repeat		✓
Long-term		✓
<i>Strategic Position</i>		
Market share	✓	
Leadership		✓
Standard setting		✓
Name recognition		✓
Branding		✓
Trademarking	✓	✓
Reputation	✓	✓
Customer loyalty	✓	✓

Table 1. Value sought from IC by two different types of firms. Adapted from Sullivan([12], p. 12).

knowledge-based organizations, we soon realize that although these enterprises report IC, they do not attempt to attach a dollar value to it. What they do include, however, are quantitative measures of the different facets of IC that they feel to be important to report to shareholders and investors.

Table 2 shows some of the measures reported by Skandia in a supplement to its 1997 annual report. Clearly, 'Financial Focus' represents the output to which the other four categories, representing intellectual capital, are meant to be linked. Yet, if we examine the measures that characterize human, customer, process, and renewal and development focus – and it is clear that the picture in Table 2 derives from the conventional taxonomy of IC – they somehow miss the essence of intellectual capital, at least as it is described in the rhetoric of its proponents. The four human capital measures, for example, do not take into account the level of knowledge or capabilities and competencies of the employees, merely their numbers and their gender makeup. Moreover, although the supplement defines the measures, there is little attempt to link them explicitly to value creation.[‡] But perhaps that was never the intention. As the IC supplement makes clear, the process of reporting the elements of intellectual capital is meant to “*describe* [italics added] the company’s strategic development and value creation.” In that sense, perhaps Bukh *et al.*[3], in a paper that ‘deconstructs’ intellectual capital statements, are correct when they say that IC statements constitute “a set of loosely linked non-financial indicators that do not add up to any grand conclusions even though they support a grand story” about the company and the image that it wishes to project to the outside world.

Luu *et al.*[8] provide a useful summary of some recent attempts by the accounting profession to attach a monetary value to IC. They recognize that although “failure to account for intellectual capital can lead to a misallocation of investments, in both tangible and intangible assets,” “[t]he difficulty and imprecision with which intellectual capital is measured can result in incorrect valuations . . . that can mislead users of financial information.” And, they conclude, “measuring, valuing and reporting intellectual

[‡]The report does contain, however, a plot that shows how an index associated with each ‘Focus’ (a numerical value derived from “the various IC indicators’ relevance, robustness and relative weight”) increased between 1994 and 1996, the idea being to demonstrate that as the IC indices increased, so too did financial performance. No description of how the indices were constructed is given, nor is there any discussion of how, for example, the human capital indicators are *necessarily* linked to financial value.

<i>Financial Focus</i>	<i>Human Focus</i>
Return on capital employed (%) Operating result (SEK) Value added/employee (SEK)	Number of employees Number of managers Of whom, women (%) Training expense/employee (SEK)
<i>Customer Focus</i>	<i>Process Focus</i>
Number of contracts Savings/contract (SEK) Surrender ratio (%) Points of sale	Number of contracts/employee Adm. expenses/gross premiums (%) IT expense/admin. expense (%) New contract processing (days)
<i>Renewal and Development Focus</i>	
Share of gross premiums written from new launches (%) Increase in net premiums written (%) Development expense/adm. expense (%) Share of staff under 40 years (%)	

Table 2. Measures of IC reported by Skandia in its 1997 annual report.

capital remains a challenge” Tim Draper[4], on the other hand, is a venture capitalist who presents a much more scathing view of the merits of reporting and then valuing IC as it is depicted in Figs. 2 or 3 or in Table 2, and instead offers a more hard-headed alternative based on evaluating the prospective company’s business model and plan, its products or technologies, and the track record of its employees. Ironically, though Draper’s criticism of attempts to value and report corporate IC to the market have been echoed by others, his prescription for evaluating start-up companies can in fact be seen as an attempt to link the intellectual capital of a small team to future value creation, which is precisely what I am trying to do here!

Intellectual Capital and Business Process Improvement It may well turn out that standards for reporting and valuing IC may never attain the same level of rigour and acceptance that current accounting practice has achieved. Nevertheless, there is a considerable amount of activity and success in using intellectual capital as a framework for business process improvement. The *Intangible Assets Monitor* (IAM) developed by Celemi, § a knowledge management consulting firm headed by Karl Erik Sveiby, one of the found-

§<http://www.sveiby.com.au/articles/IntangAss/CompanyMonitor.html>.

ers of the IC movement, exemplifies this tradition of IC management. The IAM is clearly an IC reporting, not valuing, system. If we examine some of the elements of the monitor, we see that though many of the measures of IC may not be meaningful to an external observer, they can provide an *internal* observer with a meaningful overview of the organization's present operation and, to a certain extent, future sustainability.

Table 3 reproduces the elements of the monitor, in which indicators of intangible assets are grouped into three main categories representing external structure, internal structure, and competence indicators. They broadly correspond to customer, process, and human capital, respectively. Below these main groupings are further subgroups (growth/renewal, efficiency, and stability) that contain the individual indicators of IC. As the information on the Celemi website makes clear, not all indicators are appropriate for all organizations in every circumstance, and there may be others not listed in the IAM that may be useful. Hence, the IAM is not a universal prescription but one that must be tailored; specifically, the indicators that are chosen must take into account some notion of how the enterprise creates value and how value creation is linked to the elements of intellectual capital.

Celemi's *Intangible Assets Monitor* and other such IC management tools provide useful frameworks for clearly setting out the elements of intellectual capital that have a direct impact on value generation. Some large organizations have attempted to use such tools to tell a 'grand story' to shareholders and the outside world, but I believe that such usage is flawed. First, of all, a large multi-faceted organization, CSIRO for example, cannot be captured in a single IC audit, no matter how many indicators we might devise for it. Hence, I believe that IC audits can be more sensibly carried out for small enterprises or teams. Second, the indicators that are chosen must above all be meaningful *to the members of that enterprise*, especially when such an exercise is used to improve the performance of the team. In the next section, we will see the extent to which frameworks such as the IAM can be modified to audit the intellectual capital of a small knowledge-based team such as PPI.

<i>External Structure Indicators</i>	<i>Internal Structure Indicators</i>	<i>Competence Indicators</i>
<i>Growth/Renewal</i>	<i>Growth/Renewal</i>	<i>Growth/Renewal</i>
Profitability/customer Organic growth Image-enhancing customers	Investment in IT Structure-enhancing customers	Years in the profession Level of education Training costs Competence-enhancing customers
<i>Efficiency</i>	<i>Efficiency</i>	<i>Efficiency</i>
Satisfied customers Sales/customer Win/loss index	Number of support staff Values/attitudes index	No. of professionals Leverage effect Value/employee Value/professional Profit/employee Profit/professional
<i>Stability</i>	<i>Stability</i>	<i>Stability</i>
Fraction of big custom. Age structure Devoted customers ratio	Age of organization Support staff turnover Rookie ratio	Professional turnover Relative pay Seniority

Table 3. Celemi's *Intangible Assets Monitor*.

3 INTELLECTUAL CAPITAL IN SMALL TEAMS

3.1 IC, VALUE AND TEAM DYNAMICS

The approach that I propose takes as its starting point Sullivan's[12] discussion of how different types of organizations extract value from IC. First, we need to understand how PPI generates value, and this will give us some indication of the elements of IC on which to focus. As we saw in the previous section, there is a plethora of indicators of IC that we could select or indeed invent in the three fundamental categories of human, process, and customer capital, but we need to choose a manageable number tied to value creation. Although I adopt the basic framework of IC as depicted in Fig. 3, I have only used some of the indicators that appear in tools such as the *Intangible Assets Monitor*. By examining intellectual capital at the micro-level, I have extended these presentations to include factors that have been identified as being crucial to the success of knowledge-based teams. These factors are drawn from the work of Belbin[1] and Marshall and Lowther[9], who take different yet complementary approaches to analyzing what makes

teams successful. Many of them such as trust, knowledge-sharing, alignment of values or team composition do not appear explicitly in standard presentations of IC, but they provide an alternative and I think more specific examination of how intellectual capital affects value generation.

Value Generation Like many knowledge-based teams, PPI generates value by combining the many different aspects of its human capital with its process and customer capital. In concrete terms, PPI (and other research groups within CMIS) generates three related types of outputs: external income, impact on clients, and research in applied statistics. It does so primarily by selling the services and expertise of its staff, and it operates in an external environment – the Australian economy, CSIRO, CMIS – and an internal one – the working environment generated by the workings of the group itself and its individual staff members.

The external environment will, to a certain extent, affect whether PPI can generate value; for example, during an economic downturn, companies are less likely to spend money on outside consulting, or there may be structures within CSIRO and CMIS that inhibit research groups from carrying out as much research as they would like to. Far more important to the creation of value, however, is the internal environment of the group, and many of the traditional indicators of human capital do not adequately capture the relationships and flows of capital (knowledge sharing, for example) that are vitally important to the successful operation of a team. The literature on teams and team dynamics is too vast to summarize here, but of the many frameworks for analyzing the composition and performance of teams, two tools – Belbin Team Roles (BTR)[1] and the Research Team Effectiveness Questionnaire (RTEQ)[9] – seem to me to be the most useful because they are grounded in empirical research. I have drawn upon them to devise some of the indicators of human capital.

Team Dynamics Belbin Team Roles examines the different roles that are present in successful teams, and posits that there are nine fundamental roles, described in Table 4, that are essential to success. Each role has its core strengths but also its allowable weaknesses. Moreover, although most people tend to have one dominant role that they are comfortable with, they are also capable of fulfilling other roles. In this way, a small team of four

<i>Role</i>	<i>Description</i>
Co-ordinator	Controls the way a team moves forward by making best use of resources
Shaper	Shapes the way effort is applied; imposes shapes or pattern on discussions or outcomes
Plant	Advances new ideas or strategies; breaks cycles
Resource Investigator	Explores ideas and resources outside the group; builds external contacts/networks
Monitor-Evaluator	Analyzes problems; evaluates ideas; assists team decision-making
Team Worker	Supports members; improves communications between team members; fosters team spirit
Implementer	Turns concepts and ideas into practice; carries out team plans
Completer-Finisher	Quality control – protects team from mistakes; helps to meet deadlines
Specialist	Provides technical or professional advice and input

Table 4. Belbin team roles and their descriptions.

or five people can cover all roles. Depending on the purpose for which the team was formed, however, one or more missing roles may mean that it fails to perform to its fullest potential. Hence a BTR analysis is useful for identifying which roles are present in a team and which are absent. This identification is carried out via a two-part questionnaire in which each team member carries out a self-assessment as well as an assessment of each of his/her colleagues.

In contrast to the BTR, which takes a bird's-eye view of teams, research leading to the Research Team Effectiveness Questionnaire identified factors that were essential for high-performing teams as well as those that discriminated between high- and low-performing teams. These factors are grouped into four categories – Leadership, Resources, Dynamics, and Processes – and they are listed in Table 5. For the most part the factor labels are self-explanatory, and we shall defer discussing the precise definitions until the next subsection. The most interesting conclusion of Marshall and Lowther's work[9] is that although high-performing teams scored highly across all factor groups, the factors that discriminated best between high- and low-performing teams were 'soft' (Dynamics and Process) factors such as trust, team learning, respect for individuals, and team brainstorming. As in the Belbin Team Roles team members fill out a questionnaire, and

<i>Leadership</i>	<i>Resources</i>	<i>Dynamics</i>	<i>Processes</i>
Inspirational leadership	Scientific and technical expertise	Appropriate pressure	Conflict management
Project management	Equipment and facilities	Respect for individuals	Team brainstorming
Clarity of purpose	Information sharing	Goodwill and cooperation	Team learning
Autonomy	Market/client awareness	Alignment of values	Creative dialogue
		Trust	

Table 5. Factors identified by RTEQ as being important for the successful functioning of teams.

scores on the 17 factors listed in Table 5 are then calculated by filtering them through a structural equation model[¶]. Though Marshall and Lowther[9] do not explicitly use the term ‘intellectual capital’, it is possible to see in Table 5 yet another taxonomy of IC. Indeed, many of the indicators that I suggest, mainly for human capital, are rooted in the RTEQ.

3.2 A PROVISIONAL LIST OF INDICATORS

Indicators of IC Table 6 shows the provisional set of indicators of intellectual capital and value that I have selected. Of the many taxonomies of IC that are available I have chosen the simplest one that divides IC into human, process, and customer capital, and the individual indicators are grouped accordingly. Before describing each of the indicators, it is worth revisiting the descriptions of each of the three constituents of IC, and they are followed by the indicators themselves. I have modified the definitions of human, customer, and process capital somewhat to take into account elements that I feel to be important but that are not included in standard descriptions. Some of the indicators of these three forms are drawn from RTEQ, and their definitions too have been altered to reflect the specific circumstances of a research group within CMIS, or where I feel that the definition is inadequate or incomplete. We shall defer discussing how to *measure* them until after they have been defined.

Human Capital traditionally encompasses all the knowledge, capabilities,

[¶]See Appendix B for the results of an RTEQ for PPI carried out at the end of 2001.

<i>Human Capital</i>	<i>Process Capital</i>
Alignment of values	Knowledge management & dissemination
Team composition	Customer management
Trust, goodwill & respect	Learning from projects
Team learning (tacit)	
Team learning (explicit)	
Scientific & technical expertise	
Leadership	
<i>Customer Capital</i>	<i>Value Creation</i>
Market engagement & knowledge	Revenue/EFT
Marketing/BD support	Average contract size
Image	Number of contracts
	Impact on customers
	Number of publications

Table 6. Provisional list of indicators of intellectual capital.

competencies, expertise, and creativity of the team’s staff, but I have also included indicators of team chemistry and dynamics.

1. *Purpose and Alignment* This combines two RTEQ factors: clarity of purpose – the extent to which the goals and objectives of the team are clear to all members – and alignment of values – the extent to which individual values are aligned with that purpose. To make the definition of the former more useful, I would extend it to include whether the team has a clearly defined purpose in the first place. Then, once that *raison d’être* is clear to all members, they may or may not choose to subscribe to it, and alignment of values is one measure of whether team members believe that their personal objectives are furthered by their membership in the team. If, for example, an individual feels that his membership in the group is incompatible with his personal objectives, that will certainly affect how he works with others, in particular, whether he exhibits “team behaviours” that further the team’s objectives and not solely his own. Some of those team behaviours will be reflected in the indicators below.
2. *Team Composition* Does the team have all the roles required of

effective teams? Are there specific roles that are lacking that would move the team forward? As the discussion above points out, Belbin Team Roles is a useful tool to point out gaps in team composition. The existence of these gaps is well-documented in CSIRO research teams^{||} – with some exceptions, groups within CSIRO tend to lack the roles of Resource Investigator, Shaper, and Team Worker.

3. *Trust, Goodwill, and Respect* combines three RTEQ factors: Trust is “the extent to which members feel they can be open, honest and direct and can rely on each other for support”, Goodwill is “the capacity of the team members to cooperate and achieve results through informal and intuitive understandings, and Respect is “the extent to which the different capabilities and personal styles or preferences of individual members are respected and valued. There are many more aspects to these factors, but they are manifest when team members feel free to air their views with an expectation that those views will be given a fair and respectful hearing; when members are able to share their ideas freely and be given appropriate credit for good ones; when team members feel able to share their *ignorance* with one another; when the contributions of all are genuinely valued; and when individuals believe that they can indeed learn from others in the group.
4. *Team learning (explicit)* Knowledge grows when it is shared, or so goes the knowledge management cliché. Explicit learning occurs, for example, when the group shares knowledge, information and expertise through seminars and reports or when individuals regularly consult technical journals. Within PPI, knowledge of this kind includes, but is not limited to, knowledge about statistical theory, principles, and methodology.

Team learning, as I define it, includes whether team members learn from each other, *not* as in RTEQ whether the team evaluates its performance and learns from its mistakes. There is a close connection between team learning and Knowledge Management and Dissemination (see below) – there has to be some

^{||}Giuseppe Gigliotti, Personal Communication.

process for making accessible reports and written by group members, but underlying both explicit and implicit learning is something more fundamental. Is there a culture of learning within the team – do members, as part of their own professional and personal development, *want* to learn from others and from written sources?

5. *Team learning (tacit)* Tacit knowledge knowledge that is difficult to codify precisely, but it is something that is transferred not in seminars or papers and reports, but by people working together, either on consulting assignments or research projects. For example, there are a few books from which one might learn something about how to be an effective statistical consultant, but a much better way would be pair up experienced and inexperienced consultants so that the latter can learn by observing first-hand the art of consulting.
6. *Scientific and technical expertise* is defined by RTEQ to be “the quality and diversity of scientific and technical expertise relevant to the team’s work.” PPI has in the past done a stock-take of the statistical knowledge of its members. With time, people pick up new knowledge, but knowledge, skills, and understanding that are little used may become obsolete over time. Furthermore, there may be specific skills that the group as a whole lacks that prevents it from undertaking new research in certain areas.
7. *Leadership* Much has been written on leadership of knowledge-based teams, and it would be unrealistic to think that a single item could capture all aspects. RTEQ, for example, has four categories under this heading – Clarity of Purpose, Inspirational Leadership, Autonomy in Operation, and Project Management – and I retain the latter three. I have chosen to combine clarity of purpose with alignment of values (see above) because, given its definition (“the extent to which the goals and objectives of the team are clear to all members and each understands his/her role”), I do not believe that it is necessarily a leadership factor. Of the three factors that I have retained, I would amend the definition of Inspirational Leadership (“the capacity of the designated leader(s) to develop a shared vision, stimulate creative

thinking and gain the commitment of members”) slightly so that the leader shares in the development of a vision. In the relatively democratic structure that most CMIS groups adopt, the team’s purpose and objectives are defined by the entire group and not imposed by the leader. Moreover, as Marshall** makes clear, “successful knowledge teams require a consultative leadership style” where “a major role of the leader is to facilitate the team processes rather than direct and control the team.” I retain the RTEQ definition of Autonomy in Operation (“the degree of control and flexibility within the team to plan and conduct its work”) but alter the definition of Project Management (“the capacity of the designated leader(s) to gain resources, set performance standards and deliver results within time and budgets”) so that the third criterion includes administrative efficiency and competency.

Process Capital includes the team’s internal processes and infrastructure.

I have not included aspects of the broader organizational structure such as access to information and technology in CMIS – they are uniformly excellent across the division.

8. *Knowledge management and dissemination* All research groups generate considerable explicit knowledge that is contained in research or discussion papers and in consulting reports. This indicator measures the effectiveness of processes to manage and disseminate these explicit forms of knowledge. For example, is there a central repository on a network drive or in a cupboard where reports and papers are accessible? Is the group informed when a report is issued or when a manuscript is submitted to the Divisional publications process? Or, more generally, do group members keep each other apprised of new or relevant developments in a subject area of common interest? Note, however, that the existence of a knowledge management and dissemination process does not guarantee that people will actually use it!

**The RTEQ report that accompanies an analysis of a team’s results contains an extended discussion of each of the four categories.

9. *Customer management* Does the team have in place any customer management processes and how effective are they? These may be process that have been mandated by the Division or they may have been put in place by the group itself. For example, is customer feedback sought at the end of a consultancy and how is that information used to improve the provision of services? Are there standard processes within the group for managing customer expectations before, during, and after a consultancy and do people use them?
10. *Learning from Projects* This indicator appears in RTEQ as Team Learning, "the ability of the team to evaluate its performance, build on its successes and learn from its mistakes". Above, what I call Team Learning refers to transfer or exchange of knowledge, both tacit and explicit. Learning from Projects is an indicator that asks whether the group has processes in place to extract lessons from, say, consulting projects that have just been completed, and whether that information is used to modify how actions are carried out in the future.

Customer Capital generally represents customer relationships, but I have extended the definition to include such things as the team's knowledge of market conditions and related aspects.

11. *Market engagement and knowledge* measures the extent to which group members actively engage in marketing activities, for example, going out to visit prospective clients to assess their needs, or more generally keeping abreast of trends in the marketplace by attending appropriate conferences or trade meetings, publishing articles in trade journals, or contributing to broader business development activities within the Division. The level of market knowledge thus attained will to a certain extent be a reflection of that engagement.
12. *Marketing/BD support* Support services such as marketing and business development could also be categorized under Process Capital, but I have chosen to classify all customer-related indicators under the same umbrella. The Belbin framework defines

roles in a relatively context-free environment, so a specific role such as marketing/BD support does not appear explicitly. However, given the commercial environment in which CMIS groups in particular have to operate, such a role is an important element in ensuring that scientists have assistance in generating business opportunities as well in the more strategic function of helping the group to define its market segment, target its research, and identify prospective clients.

13. *Image* Although image may at first seem to be an indicator that is more applicable to the larger organization (CSIRO) than to a small group, it is nevertheless true that even within the circumscribed context in which a team operates, image can be an important contributor to its success. For example, a team – or certain members within it – may have developed a reputation for high expertise in a certain domain, or it may simply be known in the marketplace for doing a competent job on time and on budget. There are many other facets to image, and it is no doubt also affected by the extent to which the team maintains good customer relationships.

Indicators of Value If we accept that PPI and indeed all research groups produce three main types of value – revenue, impact, and research – then the indicators we choose must reflect them. Table 6 shows three financial indicators and one each for impact and research.

1. *Financial Indicators* The three financial indicators chosen here are of course related to one another, but they shed light on different aspects of revenue generation. Revenue/EFT is meant to be an indicator of whether the group exceeded or did not meet its revenue target, whereas average (perhaps median) contract size in dollars and number of contracts reflects how that external revenue was generated – through lots of small contracts or alternatively, a few large ones.
2. *Impact* measures the value to clients of the work that the group does. It need not be cast in explicitly financial terms, for impact cannot always be expressed as the amount of money saved, nor can it always be accurately quantified. Post-project client surveys are often a good

way of getting some idea of the impact of the work.

3. *Publications* Under the heading of publications, I include not only papers in refereed journals, but also conference presentations and publications in trade magazines. All of these, I believe, are indicators of a vibrant research program, but there are a couple of caveats to consider. First, the group's refereed publications need not always reflect its main thrust or purpose – that has certainly been said about PPI! Secondly, publications that appear in the present, especially those in refereed journals, were actually written in the past, so perhaps papers in the pipeline would be a better indicator of current research activity than papers appearing say in the previous 12 months.

3.3 DISCUSSION

When we compare the provisional list of indicators in Table 6 with those used by Skandia and Celemi in Tables 2 and 3, respectively, there are two contrasts that stand out. First, the difference in scale of the enterprises being analyzed means that indicators for large organizations are necessarily high-level ones, whereas for smaller groups of people, they can focus on how individuals interact with each other and with their external environment. Second, Skandia's and Celemi's indicators (for example, Training expense/employee, Administration expenses/gross premiums, IT expense/administration expense, etc.) seem to me to be output *measures* rather than causative agents. That is, they measure an aspect of intellectual capital, but it is unclear what that aspect is and how it is related to value generation. So for example, if we accept that the ratio of expenditure on IT expense to administration expenditure is a valid indicator (measure?) of some aspect of intellectual capital, does that stem from our belief that a comparatively large IT infrastructure relative to administrative structure assists in value creation? I do not believe so. For that reason, many of the measures in Tables 2 and 3 are not appropriate in any context – large or small. In accepting them, we implicitly accept mechanisms of value creation that do not always make sense.

That being said, one possible criticism of my indicators is that they are too context-specific, that they merely reflect back the particular circumstances of PPI and the criticisms that have been made of it in the past (See

Appendix A). That may be true to a small extent, but I believe that the underlying model – essentially that correct team composition, appropriate team behaviours, and good processes for knowledge sharing and customer management are required for sustainable value creation – is universally applicable to small teams. The precise indicators that are used *are* and *must be* context-specific; not only that, they must be meaningful to the team members, because the ultimate objective of attaching measures to these indicators is not to come up with an aggregate index by which to compare different groups but for groups to understand how to improve their operation and performance over time.

Clearly, any set moderately-sized set of indicators cannot capture every aspect of intellectual capital. A partial solution is to combine several aspects into a single label as I have done above. In addition, the group can use a set of indicators to provide an overall picture of the current state of IC and value generation, but at the same time consider them to be a starting point for a much deeper exploration of the aspects of the group's operation that need to change in order to increase value creation.

3.4 MEASUREMENT AND REPRESENTATION

Measurement Having devised a list of indicators, we need some way of measuring and representing them so that an overall picture of intellectual capital and value generation can be obtained. There is no unique way of doing so, however, and what I adopt below is only one of many possibilities. The process I have in mind is again self-assessment, that is, the team itself constructs a picture of intellectual capital.

For all of the human, process, and customer capital indicators, a numerical scale of 0,1,2,3,4,5 where 0 denotes 'Poor', 3 'Adequate', and 5 'Excellent' is probably sufficient to assess their states. Some of those IC indicators have been taken from RTEQ without modification, others have been adapted. The latter can be assessed directly, by assigning a score, whereas, the former by carrying out an RTEQ analysis of the team and then mapping the resulting RTEQ scores (which are normalized to a scale of 1-10) onto the 0 (Poor) – 5 (Excellent) scale. Alternatively, RTEQ factor scores can be used as a starting point from which the team comes up with a score on the 0–5 scale. Why is such adjustment necessary in the first place? In our (PPI's) experience with RTEQ, the normalized scores that were ob-

tained after our responses to the questionnaire had been filtered through the embedded structural equation model did not always correspond to our view of the team's performance on certain factors. That, of course, begs the question of whether it is simply easier and more reliable to assess the indicators directly, without recourse to RTEQ. To a certain extent, yes, but I think that RTEQ, or for that matter, any related team assessment tool, is a convenient vehicle for enforcing reflection and discussion about team dynamics, and how the manner in which the team works affects its research and financial outputs. The same too goes for the Belbin survey, which stimulates analysis of the roles that different people play within a team, and which is required to assess the indicator Team Composition. RTEQ and especially Belbin need not be carried out every time the team assesses its IC. For a stable team that audits its IC every 6 months or every year, doing an RTEQ and Belbin survey the first time is essential, with only condensed discussions of their underlying elements required thereafter.

RTEQ and Belbin are not the only tools that the group should use, however. Along with honest self-assessment, it is important to incorporate feedback from clients, from Divisional management as well as other scientists, and from Divisional BD staff.

Measures of value indicators are, for the most part, straightforward to obtain. Financial indicators – Revenue/EFT, average contract size, and number of contracts – and numbers of publications in the pipeline are readily available. Impact is more difficult to measure, but it can be assessed by the team from client and Divisional feedback. Also, people working on a consultancy will generally have some idea of the influence of their work on the client. Like the human, process, and customer capital indicators, image can be measured a Poor – Excellent scale.

Representation There are several ways of visually representing the measures of IC described above. In related work, Kululanga and McCaffer[7] used a radar chart to depict the level of different aspects of knowledge management within construction companies, as do Brooking[2] and Celemi's Tango^{††} simulation to represent intangible assets. RTEQ, on the other hand, uses a linear representation to represent team effectiveness measures (see Appendix B). I prefer a radar chart to a linear graph, and it is shown in

^{††}<http://www.celemi.com/simulations/business/tango/index.php>

Fig. 4. The three elements of IC and the value they produce are shown as (unequally-sized) quadrants, and the value of their indicators is marked on lines that radiate outwards from the centre of the graph. Five concentric polygons make up the radar chart, so the indicators that are measured on a scale of 0–5 are straightforward to represent. The indicators of value, apart from Image, require different scales, depending on the range that their numerical values might take. For example, Publications could be measured on a scale of 0–20 in intervals of 5 corresponding to the edges of each polygon.

The results of a hypothetical audit are shown in Fig. 5, and we can see at a glance which aspects of human, process, and customer capital that the group needs to improve in the future. If team composition and function are relatively stable, charts resulting from subsequent audits can be compared to see what changes have or have not been made and their resulting consequences. Alternatively, trends in the indicators (e.g. is the level of customer management increasing or decreasing compared to previous audits?) could be depicted by drawing arrows to indicate their direction.

4 THE WAY FORWARD

In condensing the entire discussion of intellectual capital into a single radar chart, it would seem that an audit of IC could be done easily, in an almost cursory fashion, by simply placing dots at the appropriate points along each of the indicator radii without thinking too deeply about the details underlying each indicator. That would constitute a misuse – the value of the IC chart to a small team lies in the discussion and negotiation required to produce it as well as in its effort to come up with strategies to improve upon the picture it represents. Moreover, it would be tempting, say for organizational managers, to audit *different* groups using such a radar chart and then compare the scores on all indicators. For reasons that I have briefly mentioned earlier, namely that not all teams would necessarily have the same indicators or give the same weighting to them, this too is a misuse.

Carrying out an audit in the manner I propose does involve a lot of open and honest discussion, and the need for tact and sensitivity in these discussions is obvious. In particular, the team leader is the only individual whose ‘performance’ is assessed in a rather public way. That does not

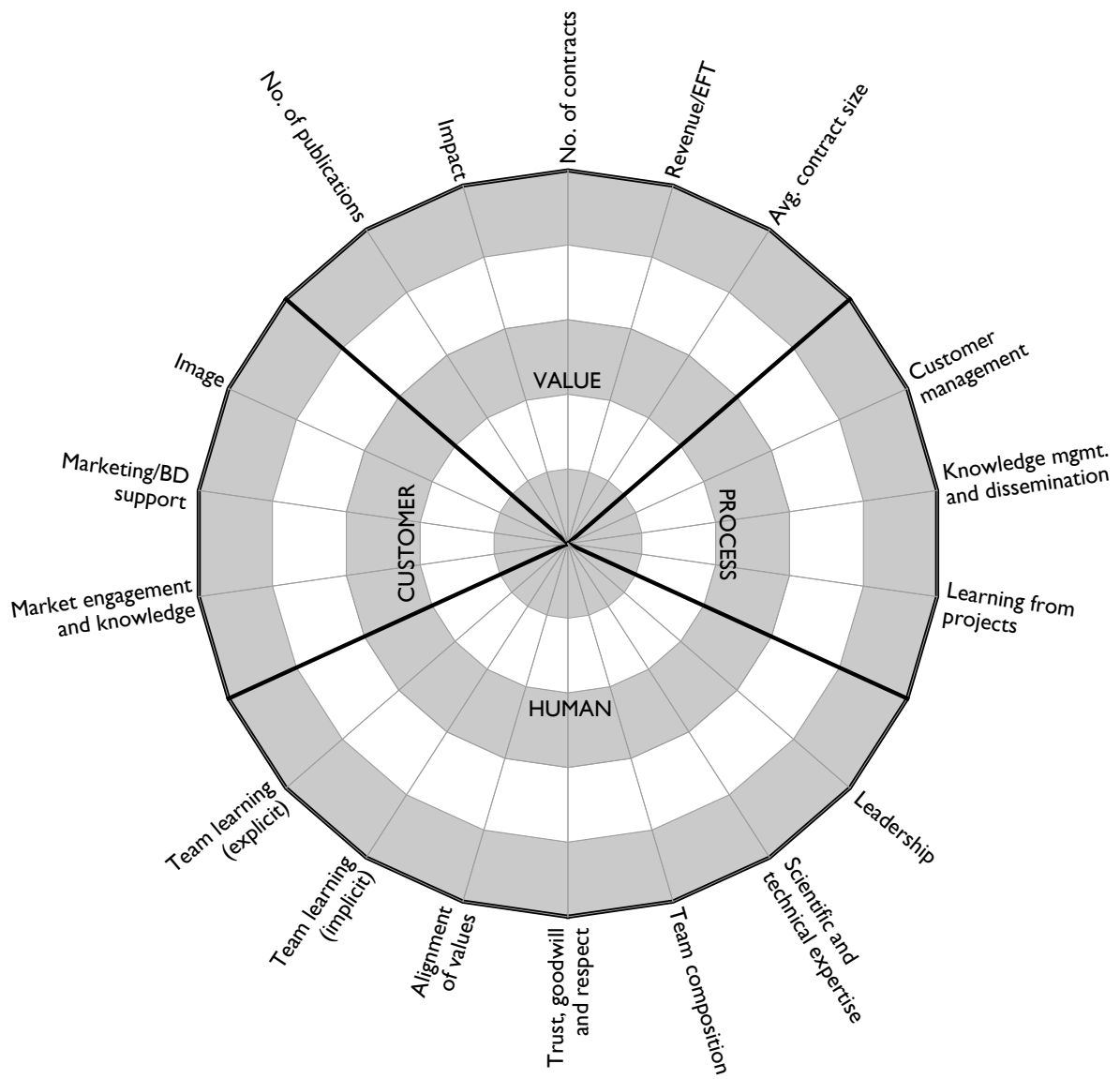


Figure 4. Radar chart showing quadrants for value generation, the three basic forms of intellectual capital, and their corresponding indicators.

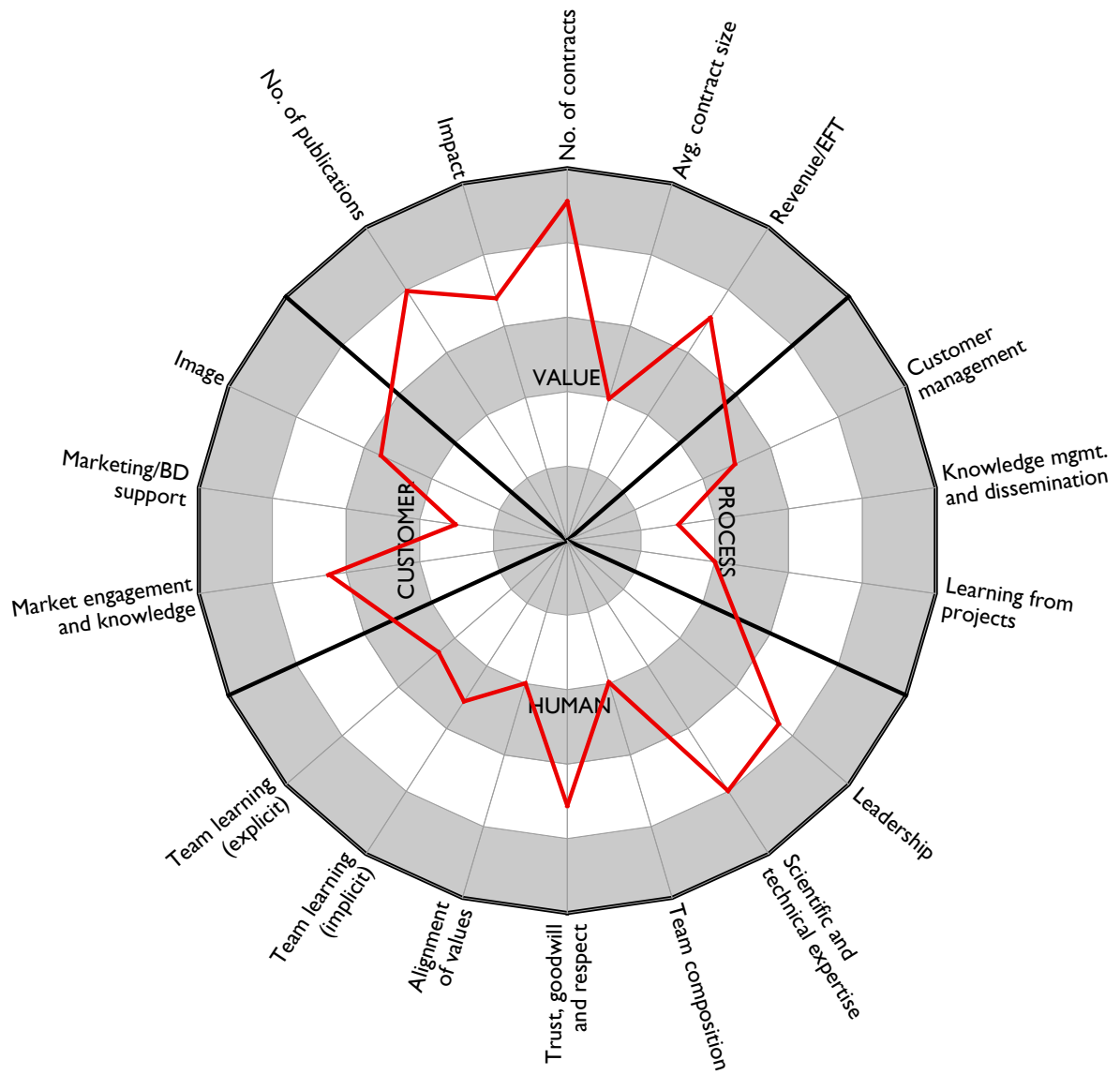


Figure 5. Radar chart showing the results of an hypothetical IC audit.

mean, however, that other members can hide behind indicators that apply to the whole team. After all, improving Trust, Alignment of values, and Team Learning demands that *individual members* examine and possibly change their behaviour.

In PPI, we have in the past often carried out discussions of how we can increase external revenue, impact, and research effort. We have also carried out Belbin and RTEQ analyses, and sometime in the distant past did a stocktake of the team's technical skills, its market offerings, and its image. To a certain extent, however, these analyses were not connected to one another, and I believe that the IC radar chart, and more broadly, looking at the different elements of team processes and performance from an IC perspective, provides an integrated approach for business process improvement.

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Appendix A PROPOSAL FOR ACTION LEARNING PROJECT
(25/10/2001)

**What Do We Really Do?
Taking Stock of Intellectual Capital in PPI**

Purpose

1. To undertake an audit of the intellectual *capital* (as distinct from intellectual property) that resides in the Production Process Improvement (PPI) group.
2. To use the results of the audit to help PPI to define and focus its scientific, marketing, and business development activities within the framework of the CSIRO Strategic Action Plan (SAP) and other market research initiatives carried out by PPI.

Having a clear focus and sense of purpose will ensure that PPI continues to thrive in the new CSIRO.

Corporate Relevance The manner in which PPI has historically earned external funds – largely through small, short-term contracts - cannot be sustained in the operating environment mandated by Geoff Garrett. This project will, in part, help PPI to redefine itself and its offerings to clients, and in so doing will clearly allow us to determine where and how we fit into the CSIRO investment model.

Background For as long as it has been in existence, and well before Geoff Garrett became CEO, PPI has been asked to focus its activities. At every annual group review, “focus” is the first and most important message from the evaluation committee. We are involved in far too many industry sectors; even within the discipline of statistical science, our research and professional interests span an extremely broad range. Consequently, the group’s business and scientific activities have little common purpose, except perhaps to meet external earnings targets. As a result, we do not control our own destiny but are instead carried along on the crests and troughs of business cycles. With the changes currently sweeping CSIRO, however, such operation is clearly untenable. Yet, our many discussions have yielded few concrete ideas about how we should operate, partly, I believe, because:

1. we do not have a clear idea of what our customers (whoever they might be) require, and
2. we do not have a firm grasp of what we are currently good at doing or what we can do in the future.

In this project, I will be using an audit of PPI's intellectual capital to address the second point.

Description To address the first deficiency, PPI is planning to undertake market analyses in a few important sectors; furthermore, in response to SAP § 6.3.2, which urges us to “*substantially enhance our licensing and new enterprise creation,*” an audit of intellectual capital is being undertaken to determine whether it can be commercially exploited. *I believe, however, that the audit can be used as a basis to address the second deficiency.* Only by taking stock of what we have actually done in the past can the whole group get a sense of where its strengths lie; in doing so, we will be able to move beyond thinking of ourselves as experts in particular statistical methodologies and instead be able to define more clearly and unambiguously what services and products we are capable of offering to industry.

Information gathering will constitute a large part of this project, but the most important element will be its synthesis in the light of current and future trends in industry, business and statistical science. Hence, understanding and analyzing these trends will be a secondary, yet important activity. Also, this project will be conducted in parallel with other business development activities within PPI, for example, market analyses of the mining/minerals processing and food processing/wine industries.

Results The outcome of the project will be a report that:

1. summarizes and synthesizes the results of the audit;
2. identifies recent trends in industry, business and statistical science;
3. shows where PPI's strengths lie and discusses them in the context of those trends and of market analyses being carried out; and
4. suggests ways in which the results of the audit can be integrated with market analyses to yield a viable model for how PPI should operate, one that is consistent with the CSIRO Investment Model

Most importantly, the whole group can then use the report as input into discussions about its future operation.

Key Activities

1. Discuss with other PPI members the rationale and outcomes of this project.
2. Determine time frame for audit of PPI intellectual capital;
3. Gather information on consulting reports, external publications, patents, computer programs, internal memoranda, etc. produced by PPI;
4. Identify trends in industry, business and industrial statistics, examine how similar organizations operate in commercial environments;
5. Distill results of audit and answer the question “What does PPI really do?”
6. Integrate results of points 4 and 5 in report.

Performance Indicators

Output Indicators

1. The report is delivered on time and to the specifications required by the PLP.
2. The report is prepared to a high standard that is acceptable to the members of PPI.

Effectiveness Indicators

1. PPI group members see the project as a worthwhile activity that helps them define PPI’s core competencies and focus.
2. The report provides defensible, convincing conclusions that will lead to a sustainable model of how PPI should operate in the new CSIRO, in particular, within the new Investment Model.

Resources Required The main resource required for this project is my time, between 60 and 70 hours during the period October 2001 and February 2002. Although much of the work can be done from my desk, the task of carrying out the audit may involve spending two days at CMIS Clayton. I also require input from the members of PPI, including Marcus Zipper.

Client Role and Commitment The principal clients will be the members of my group, in particular, the project leader Richard Jarrett. Their input and co-operation during the audit will be crucial to the success of the project. To a lesser extent our Science and Industry Manager, Frank de Hoog, will also be a client. Because this project does not explicitly address market analysis, CMIS business development staff will act in an advisory capacity rather than as clients.

My Role and Commitment I am responsible for carrying out the project and ensuring that the report is delivered on time (4 February 2002). Because I am geographically isolated from the other members of PPI, I will have to ensure constant communication with them and in particular with my group leader.

Appendix B RTEQ RESULTS FOR PPI (2001)

