

# Structure Underlies Other Organizational Determinants of Mental Health: Recent Results Confirm Early Sociotechnical Systems Research

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**Abstract** Workplaces are implicated in the current global epidemic of mental illness. This paper presents early results from an action research project designed to investigate and prevent mental illness at work. It treats the organization as an open sociotechnical system where mental health is measured by self report and the affects experienced at work. Sick days are also measured. The study finds that the second genotypical, organizational design principle creates enabling conditions for mental health, many of which enablers such as trust and equality have previously been hypothesized as determinants of mental health. But the enablers are themselves consequent to a design principle. The results show how the second design principle creates the jointly optimized sociotechnical system that leads to enablers and positive outcomes, for people *and* the bottom line. This research reinforces the conclusion from the first study of sociotechnical systems that structure is a determinant of mental health.

**Keywords** Engagement · Design principles · Innovation · Mental health · Productivity · Retention · Sociotechnical systems

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## A Global Epidemic

Mental illness was defined as an epidemic by the UN in 1992 (WHO 1996) and the nature of work and workplaces is implicated in its incidence. Different countries and regions have adopted different strategies (Oeij and Morvan 2004) with some methodological difficulties in evaluating the impact of measures adopted (e.g. Swedish National Institute for Working Life 2004). This study employs the concept of sociotechnical system within its broader framework of open systems theory that historically has a track record of delivering benefits for both mental health and organizational performance.

Workers today face additional pressures arising from increasingly global markets with increased pressure to do more with less, loss of loyalty between employers and employees with associated job insecurity (Payne 2000). Work hours and competition between workers have increased while personal control over work has decreased. The rise in flexible working conditions is having a particularly negative impact on women, particularly those in casual or contract jobs who are three times as likely to receive unwanted sexual advances as men and who show an increased incidence of health problems, particularly depression (LaMontagne 2007a).

One in twelve Canadian workers are unhappy, taking more than three times as many days off as happier ones (Buffett and Co 2006). Work has proven the largest source of 'stress' for most Canadians with 3/4 reporting they sometimes or frequently experience 'stress', about the same level as US workers (AP-ipsos 2007). High 'stress' is associated with depression (Statistics Canada 2002).

Costs are huge. In 2001, mental health problems were identified as one of the principal causes of workplace absenteeism (Watson Wyatt Worldwide 2000). Many studies document substantial lost work days as a result of mental illness, particularly depression (Druss et al. 2000; OMA Committee 2002; Dremsa et al. 2002; Goldman 2003). These work-related productivity losses cost Canada \$4.5 billion annually (Stephens and Jourbert 2001). Mental illness accounts for 30% of disability claims, translating into \$15 to \$33 billion annually in Canada (Sroujian 2003).

In Australia, six million working days are lost to depression every year. Psychological and illness claims increased 44% from 1993 to 2003 at a cost of nearly \$80 million per year. This increase has been accompanied by a corresponding growth in the number of people taking their grievances to the courts (CPD News 2003). More than half of an organization's absenteeism is caused by mental health problems but 68% of full time employees with depressive symptoms have not sought medical advice. Each employee with untreated depression and related conditions is estimated to cost their organization nearly \$AUD 10,000.00 a year. The presence of a psychological condition also adds significantly to days lost due to physical health conditions (Dremsa et al. 2002) and to costs, with depression costing the most (Druss et al. 2000).

Even more costly is 'presenteeism' where employees attend work but are minimally productive (Cutcliffe 2007). Fifty-three percent of staff took off one or more days but 77% attended work with a health problem in the last month with a drop of 45% in productivity. Depression is the highest contributor to presenteeism. While the direct cost to employers is \$17.6 billion, the total flow-on cost to the nation is about \$25.7 billion (Medibank Private 2007)

Some employees respond to increased pressures by becoming mentally ill but more frequently, they simply 'turn off', a common defence mechanism in hostile environments. The literature contains a plethora of survey results showing low engagement. Typical figures are engaged (30%), not engaged (54%) and actively disengaged (16%). A high proportion of employees are switched off, leadership has failed and things are getting

worse (Lundgaard 2007). Fifty three percent of Australian employees feel overwhelmed by pressure a significant amount of the time and this has a clear impact on their medical costs and work performance (AHRI 2006). Just 42% of Australian middle managers are satisfied with their current place of employment (Accenture 2007).

Many employers remain unconvinced that workplace pressures lead to a variety of physical and mental health problems despite 80 years of confirmatory research (Borger 2002). Only 15% of Canadian organizations have a wellness plan (Buffett and Co 2006) although 4% of their employees are depressed and 79% of those were unable to work for 32 days in the previous year (Statistics Canada 2002). Employers have been put on notice, however, by new legislation designed to better cover what is now known of the processes that lead to psychological injuries at work (WorkCover Queensland 2003; Elumina 2004; Minister for Workcover 2004; Pwclegal.com 2007).

The Australian Prudential Regulation Authority has now widened its focus to ensure openness and accountability throughout the organization. Taking a ‘whole of business approach’, all directors and managers are now “required to take personal responsibility that the institution is in compliance” with all relevant legislative and financial obligations (Byres 2005). Ignoring or not addressing mental health problems in the workplace not only puts employees at risk of psychological injury; managers and directors are also clearly exposed to legal action. Australia has some highly publicized law suits (Masanauskas 2007; LaMontagne 2007b).

This new legislation and the action flowing from it is designed to combat the rising incidence of mental illness and the World Health Organization’s (WHO 2008) projection that by 2020, depression will reach 2nd place of the ranking of DALYs (disability adjusted life years) calculated for all ages and both sexes. It is already the 2nd cause of DALYs in the age category 15–44 years for both sexes combined and the leading cause of disability as measured by years lived with disability.

## **Factors in Preventing Mental Illness in the Workplace**

Evidence that mental health in the workplace is a complex systemic issue has been accumulating around the world for some time. From Lewin (1942, 1946) onwards, research has attempted to isolate the factors that either cause or mediate mental health and there are many such factors as well as many indices of mental health (Tomkins 1962; Abbey and Andrews 1985; Emmons and Diener 1985; Horley and Little 1985; Aranya et al. 1986; Markowitz 1987; Wolff and Ratner 1999; Frederickson & Losada 2005). The question then becomes ‘what lies behind this variability in apparent causal and mediating factors in mental health in organizations?’

### **Birth of Sociotechnical Systems**

The answer to that question began to emerge in 1949 with a natural experiment in organizational structures. It occurred when new technology was put into a coal mine to improve productivity. The new, mechanized ‘longwall’ method did not produce the expected productivity increase but did produce extensive ‘psychosomatic’ and neurotic disorders. The old hand-got method was characterized by the functional interdependence, shared goals and cooperativeness of a small group. The new structure produced isolation, anxiety, and four major types of defence designed to ameliorate these negative effects (Trist and Bamforth 1951).

The four defences were labeled ‘informal organization’, ‘reactive individualism’ or putting self first, ‘mutual scapegoating’ or buck passing and ‘self-compensatory absenteeism’ or justifying absences to preserve the self. Only one set of teams, the rippers whose work remained untouched by the mechanization, retained “intact their total task, their multiple skills, their artisan independence and their small group organization” (Trist and Bamforth 1951, p. 82). They stayed healthy.

Trist and Bamforth realized that the new ineffective social structures were also implicated in low morale, low recruitment and increasing turnover. If this description above sounds strangely modern, it is because these ineffective structures are endemic in today’s workplaces.

By restoring ‘responsible autonomy to primary groups throughout the system’ (p. 83), Trist and Bamforth ensured a whole task per group, and some flexibility which reduced the distress. This restoration marked the birth of a new concept, *the sociotechnical system* where social and technological systems can be jointly optimized (Emery 1959). Joint optimization improved both productivity and mental health.

During the 1960s, extensive exploration of jointly optimized sociotechnical systems primarily in Europe and the UK, documented their superiority at producing benefits for both people and organizations (Trist and Murray 1993). O’Toole (1974) documented direct negative health and mental health effects from bureaucratized work, primarily in the USA.

### Genotypical Design Principles and Psychological Requirements for Productive Work

The Norwegian Industrial Democracy Project (1962–1969), then established that jointly optimized sociotechnical systems better meet the psychological requirements for productive work (Emery and Thorsrud 1969), increase productivity and decrease costs, particularly those associated with human dissatisfaction and unhappiness (Emery and Thorsrud 1976). Emery also discovered the genotypical design principles (Emery 1967).

‘Genotypical’ is the term used to convey the most fundamental level as in the DNA. It is opposed to ‘phenotypical’ which describes appearances, the superficialities. While you may die your hair, when the die washes out, your hair goes back to its genotypical colour. While every organization is different (phenotypically), most share a genotypical structure, that given by the first design principle.

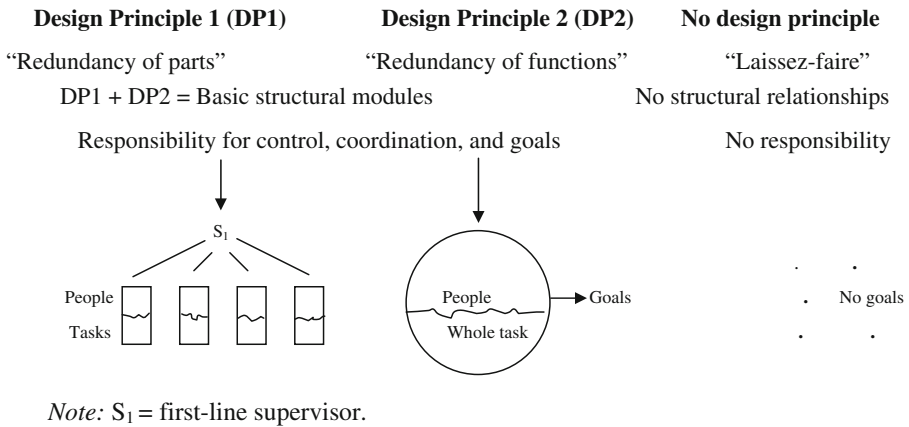
Figure 1 illustrates the very different basic modules or sets of structural relations of people, tasks and supervisors defined by the two design principles. The basic module for DP1 is a supervisor of several one person-one shift units reporting upwards while for DP2, it is the self managing group. These modules flow from two sources, different forms of redundancy and different locations of responsibility for coordination and control which are the two fundamental dimensions of organizational structure. Coordination is the horizontal axis and control the vertical axis in Fig. 1.

For organizations to behave flexibly and adaptively, they must contain a degree of redundancy. There are two basic ways that redundancy can be built in:

- By adding redundant parts to the system where each part is replaceable, and
- By adding redundant functions to the parts so that at any one time, some of the functions of a part will be redundant to the role it is playing at that time. If a part fails in the function it is performing, other parts can assume the function.

In organizations, the parts are people.

In the first design principle (DP1), responsibility for coordination and control is located at least one level above where the work, learning or planning is being done, in this case



**Fig. 1** Genotypical organizational design principles. *Note:* S<sub>1</sub> = first-line supervisor

with S<sub>1</sub>. DP1 yields a supervisory or dominant hierarchy in which individuals have fragmented tasks and goals. DP1 is called ‘redundancy of parts’ because there are more people than are required to do the productive work as typically, supervisors do not participate fully in the productive work of the section.

In structures based on the second principle (DP2), responsibility for coordination and control is located with the people performing the task. DP2 is called ‘redundancy of functions’ because more skills and knowledge are built into every person than that person can use at any one given point in time. The people in DP2 work to a comprehensive set of agreed and measurable goals and they manage themselves, all their previously individual tasks and all the interdependencies between them, i.e. the whole group task. They are a self managing group. There is no supervisor, team leader, coach or any other designated person in the role of S<sub>1</sub> in DP1. There are no individual jobs, roles or positions in a DP2 structure.

DP1 structures are hierarchies of personal dominance as S<sub>1</sub> has the right and the responsibility to tell those below what to do and how to do it. DP2 structures are non-dominant hierarchies of function where group members have equal rights to make decisions and all change is negotiated between peers.

As people are purposeful systems (Ackoff and Emery 1972), they do not appreciate being treated as children and denied responsibility for decision making about their own work. Over time DP1 actively demotivates and deskills while DP2 motivates and skills (Emery and Emery 1974). DP1 also induces competition while DP2 induces cooperation with all the flow-on effects of these behavioural modes. The design principles, therefore, affect common organizational phenomena such as communication problems and personality conflicts (Emery and Emery 1976; Emery 2004) and Bion’s (1952, 1961) group assumptions of dependency, fight/flight, pairing and the creative working mode (Emery 1999). Seemingly every dimension of organizational life is affected by them.

Laissez-faire (Lippitt 1940) is defined as the absence of a design principle and, therefore, the absence of structural relations between the people. Laissez-faire today commonly takes the form of an organization where the structure on paper is DP1 but the controls have been loosened to the point that there is widespread confusion about where responsibility for control and coordination are located. Supervisors are commonly called ‘team leaders’ but retain their legal rights as supervisors. These forms of organization are increasing in North America and have mistakenly been designated as empowered workplaces (de Guerre

2000). The design principles along with laissez-faire form a complete and mutually exclusive set of structural alternatives.

These design principles have been discovered independently by Eisler (1995, p. 105) who calls the systems flowing from them androcracy and gylany. She also recognizes they are extremely powerful and comprehensively affect organizational behaviour. These genotypical organizational design principles also appear to operate across the animal, biological or cellular and mechanical realms (Emery 2003).

DP2 is correlated with the psychological requirements for productive work, called the '6 criteria' for short (Emery and Thorsrud 1969) while DP1 is inversely correlated with them.

The 6 criteria are

1. Elbow Room, optimal autonomy in decision making
2. Continual Learning for which there must be
  - (a) some room to set goals
  - (b) receipt of accurate and timely feedback
3. Variety
4. Mutual Support and Respect, helping out and being helped out by others without request, respect for contribution rather than IQ for example
5. Meaningfulness which consists of
  - (a) doing something with social value
  - (b) seeing the whole product or service to which the individual contributes
6. A desirable Future, not having a dead end job.

These 6 criteria have been routinely measured in countless Participative Design Workshops (PDWs) (Emery 1993) as well as in surveys. They are the intrinsic motivators.

Jointly optimized sociotechnical systems are now known as participative democratic structures based on the second genotypical design principle or DP2 structures (Emery 1967; Emery and Emery 1974). Structures based on the first genotypical design principle (non-jointly optimized sociotechnical systems) are known as bureaucratic or DP1 structures.

### The Participative Design Workshop (PDW)

The PDW was designed in 1971, specifically to create jointly optimized sociotechnical or DP2 systems by changing the design principle of existing organizations that are predominantly DP1 (Emery and Emery 1974; Emery 1993). The PDW, therefore, replaces the old method known as STS.

There is a comprehensive, educative and preparation phase for PDWs so that by the time they are held, everyone is well informed of the consequences of relocating responsibility for the control and coordination of work to those doing the work. In the workshop, employees get a final briefing about the 6 criteria and design principles. They use the 6 criteria and a skills and knowledge matrix to analyse what DP1 has been doing to them and their skills. They then redesign their own section of the workplace to give the best quality of work for everybody in it. Once the designs are agreed, a set of measurable goals is drafted, a program of training essential for the changeover is drawn up, career paths based on skills and knowledge held are considered and anything else required to make the DP2 design work well in practice, e.g. equipment or layout changes, is designed in.

A change of design principle is so fundamental that virtually every facet of worklife is affected in some way. For example, a DP1 organization is designed by top management who determines its structural shape and what is required to accomplish all its tasks. When innovation is required, it normally involves disruption with jobs lost and new people hired. People are seen as replaceable parts.

In DP2 and in the PDW, people throughout the organization design their own part of that organization. No design is imposed. The process induces psychological ownership. The PDW equips employees with the knowledge and skills they need to continuously evolve their DP2 structures to meet external and internal change. Innovation is a continuous process in DP2 structures.

PDWs were the intervention used in the research described below. As the PDW does not attempt to change the people nor any other organization feature apart from the design principle, it provides a pure test of the hypotheses.

### Partial Models

There have been several attempts to extract particular dimensions from the concept of the design principles to test their relationship to health and mental health. Karasek extracted the *control* variable and discovered that high work *demand* combined with low personal control of work reliably predicted job strain and negative health effects (Karasek 1979; Karasek et al. 1981). Closely related to the demand/control model is the “effort/reward imbalance” model (Siegrist 1996).

These two most popular models of low control/high demand (Karasek 1979) and effort/reward imbalance (Siegrist 1996) have generated a huge literature (see de Guerre et al. 2007). However, Kristensen et al. (2002) found positive associations between cognitive demands and good health and this together with many previous inconsistent findings led them to conclude that “demands cannot be regarded as ‘harmful’ in themselves” (p. 45).

Other studies have extracted *equality of relationships* as well as responsibility for and control of work (Gardell 1977; Hayes and Glouberman 1999; Wilkinson 1996, de Guerre and Hornstein 2004). Inequality is a feature of DP1 structures and has proven a major factor in ill health and premature mortality (Wilkinson 1996; Marmot 1999; Marmot et al. 1999; Marmot and Wilkinson 1999). The fight/flight response that flows from unequal relationships is particularly dangerous when it becomes frequent and/or chronic (Brunner and Marmot 1999).

Changing the design principle of organizations from DP1 to DP2 is an obvious and effective starting point to overcome inequality of relationships, particularly as there are transfer effects from healthy democratic organizations to community (Gardell 1977; Gardell and Gustavsen 1980). Pavett (1986) in contrast found transfer effects from professionals in poor quality, high stress jobs to their spouses showing that work, family, community are all coimplicative. The effects of work and workplaces are partial determinants of the health of community and family.

We note here that over time, more and more factors have been added into these various partial models, to the point where they almost cover all dimensions of the design principles and the 6 criteria. For example, social support was later added in as a third dimension to demand/control (Johnson 1986; Kristensen 1995), acknowledging that social support and trust between workers and supervisors may buffer the effects of psychological strain (Karasek and Theorell 1990; Johnson and Hall 1988, 1994). Position in the hierarchy particularly when jobs are precarious or job insecurity high, was an additional factor for Bosma et al. (1997) and Tsutsumi et al. (2001). North et al. (1996) and Melchior et al.

(2003) included lack of latitude and social support, both instrumental and emotional, where 'decision latitude' is a synonym for 'elbow room'.

Veziina et al. (2004) and Sanderson and Andrews (2006) disagree on the relative efforts put into investigating the success of the job demand-control-support and the effort/reward imbalance models. On the basis of their assessment, Sanderson and Andrews (2006) suggest that interventions could include encouraging employee control over timing of work tasks, redesigning jobs to reduce time pressures, and clarifying expected duties and outcomes. These types of debates and the actions arising from them will always be inadequate when partial models are extracted from the whole concepts of the design principles which systematically affect all these factors in a workplace.

The other problem with these partial models is that there are multiple interrelated factors (Health Canada 1996) reinforcing the sociotechnical idea that something else more fundamental is probably influencing all of them.

### More Complete Studies

A comprehensive study of the Australian workplace measuring some of the components of the design principles and 6 criteria noted "...that when a person has been in a low quality job for a long time the spark in him tends to go out, and not just in the workplace" (Emery and Phillips 1976, p. 74). Many studies linked various others of the 6 criteria and job satisfaction to structures and health (Walsh et al. 1985; Jamal 1986; Lee and Mitchell 1994; Lee et al. 1996; Everson et al. 1997; Kawachi et al. 1999; Glouberman et al. 2000). *However, this is the first study that uses all the components of the design principles, all the 6 criteria and the other major hypothesized contributors to mental health and productivity found in the literature.*

Since the discovery of the genotypical design principles and the invention of the PDW which makes the change quick and effective, there have been countless organizations that have moved to DP2 in many parts of the world. For example, Karadoc wineries reported improvements in efficiencies and waste reduction at around 28% and 38% respectively, and customer complaints about packaging fell by about 14%. There was no direct measure of health but there was a reduction of lost time injuries down from 2,000 to 3,000 h per year to 20–30 h per year over a 10 year period (Aughton et al. 1997).

Synchrude Canada Ltd used PDWs to secure its future by reducing the cost of a barrel of its light sweet synthetic crude to a cost competitive with the traditional product. During the 1980s, they had tried sociotechnical analysis and design as practised in the United States. Management felt it took too long, was too expensive and too difficult to implement as workers rejected the design and remained negative despite extensive human relations training. An internal action research team of 5 fulltime members and 3 part time associates began work with PDWs in 1992. Between 1989 and 1995, production increased by 37%, productivity per person increased 76% and revenue increased 50%. At the same time, operating costs dropped 20% and the workforce of originally over 4000 dropped by 22% (Purser and Cabana 1998, p. 272). There were no major technical changes during this period with only minimal sustaining capital injection. By 1997 productivity and revenue had increased even more while costs and workforce had further reduced convincing owners and new investors to commit over \$2.5billion in new capital (de Guerre 2000, p. 657).

More recently, J. Robins & Sons, a 100-year old fashion shoe manufacturer, changed its design principle from DP1 to DP2 using PDWs. Over 5 years, total stock has reduced by 50% resulting in increased investment in new technology, lead time has reduced from 15 days to 2

h, customer returns have reduced by 45%, downtime has reduced by 65% and pairs produced per person has increased by 30%. While they have faced challenges over the 5 years, they are the sole remaining large footwear manufacturer left in Australia. They compete with India and China and have not shifted jobs offshore. There was no direct measure of health effects but absenteeism has reduced from 4% to 1.5% (Aughton and Butt 2007).

They are only recent examples of many organizations that have recorded profound positive changes after moving from DP1 to DP2. However, many of these organizations report their success only informally if at all.

### In Summary

It is clear that partial models and studies that use only some of the components of the design principles and the 6 criteria cannot hope to get to grips with the fundamental factors in mental health at work. Well-structured *and systemic organizational approaches* are most effective (Vezina et al. 2004).

## Design and Methodology of Current Study

Several years ago, we began work on a comprehensive instrument to measure the effects of the design principles on health and organizational performance. Data from the first two organizations showed that the DP2, not DP1, leads through various enabling conditions to motivation, productivity and low number of sick days (Emery and Aughton 2006). This is exactly what we would expect from the literature and from numerous examples of action research projects involving a shift from DP1 to DP2. Accelerating worries in the community about mental health and productivity led us to add measurements of mental health and its hypothesized determinants to the existing instrument.

This study uses the full sociotechnical model, measures all major dimensions of the design principles; i.e. coordination, control, supervision, type of team and location of accountability (Appendix A), the 6 criteria and other critical determinants such as demand and reward identified in the literature. Scales were developed for the major variables such as the design principles, the 6 criteria as a set, intellectual satisfaction, trust etc (Appendix A). All questions and scales have been previously piloted with some used extensively. Further details can be found in de Guerre et al. 2007.

To test the theory that a shift from DP1 to DP2 will improve mental health, it is necessary to have a 'before and after' the PDW design.

The *major hypothesis* to be tested, therefore, is that individuals will record better mental health after the intervention than before. Sub-hypotheses include that:

- relationships will be better and trust will be higher as the shift is from relatively unequal and asymmetric power relations to more equal and symmetric ones
- people will experience higher levels of intrinsic motivation
- people will experience more positive and less negative affects

Two organizations to date have completed the 'before' version of the mental health questionnaire and one of these has proceeded to change its design principle so that we also have changes in business results over the first year of operation as a DP2 structure. These results complement the questionnaire data. In this paper we report on the relationship between the design principles, the mediating or enabling factors and mental health from the

first stage of the study, plus business results. As the enterprise bargaining agreement covering the legal DP2 structure and its associated pay for skill system has now been negotiated, it is expected that the follow-up instrument will be administered in July 2008, providing a rigorous statistical test of changes in mental health as well as other organizational behaviours and performance.

### Definition and Measurement of Mental Health

Our definition of mental health adapts the USA's Surgeon General's (1999) definition to acknowledge people as open, purposeful systems (Ackoff and Emery 1972) with needs for both autonomy and interdependence with others (Angyal, 1965). Specifically, a mentally healthy person is *one who purposefully engages in productive activities and enjoys fulfilling relationships with other people, with the ability to adapt to and change their environments.*

Research that integrates social and clinical dimensions depends on the voluntary agreement of everyday, sceptical participants but the standard tests of mental health/illness based on behavioural indicators of illness (e.g. Beck et al. 1961; Cummins 1991) and designed for captive ill populations can incite derision in workplaces or be ignored. We resorted to the self report question used by Statistics Canada in its community surveys although we suspected this could produce an overestimate of quality of mental health. This is because people believe that mental health problems lead to job loss.

Given this sensitivity, we also used a comprehensive list of affects, eighteen in all, as all definitions of mental health, well being or mental illness put a heavy emphasis on the affectual or emotional component of these phenomena (e.g. Stewart-Brown 1998; Surgeon General 1999; VicHealth 1999). Use of the affect scales allows us to judge the accuracy of the self report of mental health and will eventually lead to a more powerful test.

### The Organization

Org3, part of a multinational with 68 employees in outback Australia, manufactures mining industry components. Management had tried a variety of methods to improve productivity and lower costs in order to get to the desired cost per unit produced. Extensive effort had been expended on streamlining the technical system and while there were marginal improvements, nothing got the operation close to the unit cost goal.

There had also been experiments with the social system and at the time of the first measurement, there was a mixture of sections with supervisors, with 'team leaders' and one section which consisted of a self managing group, all operating informally within a legal DP1 structure. Employees, particularly those with team leaders, were confused about where responsibility really lay.

The questionnaires were administered to shifts in a group setting. There were no problems with understanding and almost no missing data. We have a total sample of the organization.

The PDWs were single day events for management and operations personnel (production, maintenance and distribution by day, afternoon and night shifts) starting in August, 2006. An integration workshop was held on 19–20 December. The third part of the PDW consisting of agreed and negotiated goals, training requirements and other requirements was finalized on 15–17 January. This workshop also finalized the program for implementation. An implementation manual documenting the process and all decisions was produced in February 2007.

As there were no major training requirements that would necessitate a long delay in start up, self management began almost immediately after completion of the January workshop.

### Causal Path Analysis

Causal path analysis (Emery 1976; Alvarez and Emery 2000) is an alternative to factor analysis with several major advantages. It makes no a priori assumptions and yields a unique systemic solution that cannot be influenced by the researcher. Subjectivity enters only in the last stage of the analysis where causality is assigned to the graph that emerges from the correlation matrix. It was developed from hierarchical linkage analysis where clusters emerge from success iterations of the matrix and is a simple transparent method that can be checked by anybody who can do basic arithmetic. There is no limit to the number of variables in the analysis.

## Results

The analysis of results falls into two parts. The first part examines the relationship of the self report of mental health and the affects in an attempt to determine the accuracy of the self report. The second part is a systemic overview of all the major variables to gauge support for the hypotheses, the consistencies between early findings and the current study, and to examine the role of other factors in mental health at work found in the literature.

### Analysis of Affect and Mental Health

Estimates of mental illness in the population range from about 3–5% with about 15% of people considered to be at some degree of risk of mental disorder. On the self rating of mental health, nobody rated their mental health as poor, 4.4% rated it as fair, 32.4% as good, 42.6% as very good and 20.6% as excellent.

In order to estimate the accuracy of the self report, the 18 affects were analysed by causal path analysis as above. There were three independent clusters which were converted to scales (Appendix A). The *Positive affect* scale ( $\alpha = .74$ ) included boredom reversed. The *Negative-angry* scale ( $\alpha = .82$ ) contains those affects normally associated with a bad day at work such as tired and frustrated while the *Negative-trapped* scale ( $\alpha = .80$ ) contains the more psychiatric indicators. Table 1 summarizes the affect scales, the percentage 'at risk of mental disorder' on each affect as determined by extreme scores and the set of variables contributing to each affect scale.

Table 1 shows that more people had high scores on the *Negative-angry* scale than on the *Negative-trapped* scale. Both the numbers and the affects contained in the scales indicate that the *Negative-trapped* scale may be a measure of more serious mental health problems. This is particularly so with the inclusion of mental demand which for the total sample is part of intellectual satisfaction, correlated with other positive features of the organization and mental health. We also note that education is a contributor to the *Negative-trapped* scale and this also indicates that these people are not coping well at work despite having a higher level of education than their peers. This is a typical profile of 'lost potential' (Druss et al. 2000), a higher than average education and family background combined with current low status job or income, i.e. they could not live up to their original potential. It would appear that the *Negative-trapped* scale could become a useful psychiatric indicator.

**Table 1** Incidence of risk factors and contributors to the affect scales

Scale	Affects	% At risk*	Contributors to scale	Adj. $R^2$	Total. d.f.	$F$	$p$
Positive affects	Excited	47.1	Sense of achievement	.669	67	17.94	.000
	Not bored	30.9	Reward for bright ideas				
	Joyful	29.4	Motivation				
	Creative	23.5	Low having to jog work along				
	Interested	17.6	Low dependency				
Negative-angry	Energetic	14.7	Productivity	.613	67	18.69	.000
			Relationships with peers				
			Social meetings				
	Frustrated	27.9	Low intrinsic motivators				
	Powerless	26.5	Dissatisfied with pay				
	Tired	22.1	Low cooperative relationships				
	Angry	16.2	Supervision				
	Disgusted	11.8	Low trust in peers				
	Humiliated	10.3	Looking outwards (personality factor)				
			Low trust in superiors				
		Knowledge wasted					
Negative-trapped	Trapped	16.2	Low motivation	.531	67	13.65	.000
	Despairing	7.4	Poor relationship with peers				
	Anxious	7.4	Dissatisfied with pay & conditions (external motivators)				
	Depressed	4.4	Education				
	Lonely	4.4	Low control				
	Afraid	1.5	Mental demand				

\* These are the percentages of people who scored 4–5 on the negative affects and 1–2 on the positive affects. In other words, there were 47.1% of people who never or rarely felt excited at work, 30.9% who were frequently or almost constantly bored at work, and 27.9% of people who felt frustrated frequently or almost constantly at work

It is clear from Table 1 that many organizational factors are directly contributing to these scales. There is only one personality factor (in *Negative-angry*) and one demographic characteristic (in *Negative-trapped*). In particular, the inclusion of control and supervision (two variables included in the scales for the design principles) tells us that DP1 and DP2 are involved in determining an affect profile.

Stepwise regression of all major variables shows as we would expect that low *Negative-trapped* contributes directly to mental health (see Fig. 3). However, productivity also contributes directly to mental health. In other words, a productive workplace helps produce healthy people. This echoes the famous saying that ‘the product of work is people’.

Partial correlations confirmed that low *Negative-trapped* made the largest contribution to mental health ( $r = -.39$  for *Negative-trapped*,  $p < .001$ ;  $r = .31$  for productivity,  $p = .012$ ). In other words, feeling any of trapped, anxious or the other affects in this cluster, frequently or constantly, contributes to or is an indicator of mental illness. *Therefore, any organization that wishes to prevent mental illness in its workforce needs to avoid producing the conditions that lead to these affects.*

An extensive statistical analysis comparing the degree of risk to mental health as measured by the affects and the self report of mental health led us to conclude that respondents had overestimated their mental health by roughly a third. The overestimate appeared to be mainly amongst those who rated very good or excellent. Our affect measures appear to give a more accurate assessment. We are developing an 'at risk' scale and this preliminary measure showed 10.3% with a high level of risk and 4.4% considered almost certain of having psychiatric problems. Using these admittedly very tentative figures, the mental health in Org3 would appear to be in line with more general ratings of mental health in the population. Until further research can corroborate this finding we use both data sets in the following analyses. We will be reporting on the 'at risk' scale as more data accumulates but it is looking promising that we can develop an appropriate and acceptable test for measuring risk to mental health in workplaces.

### Systemic Overview of Determinants of Mental Health

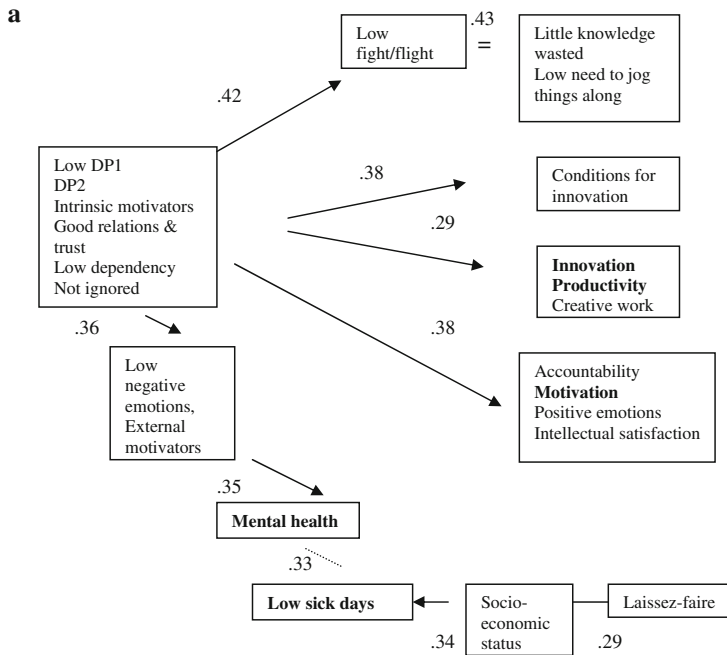
At the time of measurement, Org3 was 56.1% of the way towards a perfect DP1 structure, 64.8% of the way towards a perfect DP2 structure and 53.5% of the way towards a perfect laissez-faire structure. Single variable analyses showed there were particular weaknesses in the intrinsic motivators (6 criteria) and in the factors leading to intellectual satisfaction. Mental demand in particular was low. Relationships and trust were generally average, positively influenced on the one hand by management's openness in discussing how the business was going but suffering from frequent appraisals, the fairness of which was sometimes doubted. There was a reasonable level of tolerance for small mistakes but insufficient opportunities for learning on the job and low reward for innovativeness.

All scales were entered into a correlation matrix which was subjected to causal path analysis. Figure 2 presents the overall pattern of results, from the full solution where the correlation matrix has been iterated 5 times, and from the breakout cluster taken from the zero order matrix. Please note that these graphs are not models, they are the actual patterns of links within the data. In Fig. 2a and b, the arrows depict causal relationships and this is the sole subjective judgement of the researchers.

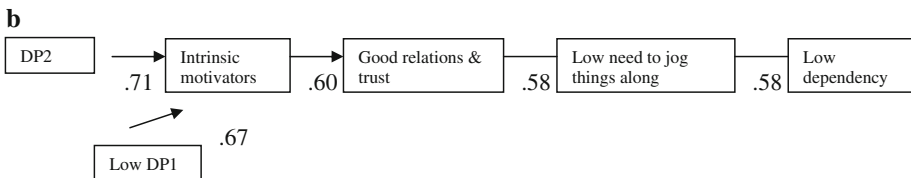
Reading Fig. 2a like a road map and starting from the left shows that the cluster containing DP2 and DP1 reversed, along with the intrinsic motivators, good relationships and trust, low dependency and people's bright ideas not being ignored, leads to most of the enabling conditions and then to the outcomes of mental health and low sick days. The same cluster also leads directly to the outcomes of innovativeness and productivity. The breakout of the determining cluster in Fig. 2b shows that DP2, not DP1, is the primary cause of the intrinsic motivators from which the other factors flow.

Mental health and low sick days have two primary determinants, DP2 as above and also laissez-faire which was particularly evident at the top of the hierarchy (SES). This suggests that, at least as it was practiced in Org3, laissez-faire is less damaging than DP1. However, laissez-faire is intrinsically unstable and can revert quite unpredictably to strict DP1.

This causal path answers the question raised from the literature survey, namely, 'what lies behind the variability in apparent causal factors in mental health in organizations?' Factors such as low self confidence, dependency, inequality, poor relationships and trust at work amongst many, have all been found to be precursors of, or associated with, mental health problems. Figure 2 explains the variability mystery: each of these factors is a consequence of the first genotypical organizational design principle, DP1. It would appear that denying people their purposefulness and right to decision making has long term



There are also strong secondary links between the clusters on the right meaning that there are also causal relations between the conditions for innovation and innovation and between motivation and innovation and productivity etc



N=68;  $r = .24 @ p < .05$ ;  $r = .31 @ p < .01$ ;  $r = .39 @ p < .001$ ;

**Fig. 2** (a) Causal path for Org3 (from M5). (b) Breakout of determining cluster (from M0)

consequences. Suffering hierarchical dominance affects different people in different ways to produce the range of factors implicated in mental health disorders.

The causal path also provides support for the hypotheses. As DP2 increases, relationships are improved and trust is higher, levels of intrinsic motivation rise as do levels of positive affect while levels of negative affect fall.

It also confirms the promise of sociotechnical theory and illustrates how DP2 produces the jointly optimized system that then produces its effects. DP2 which locates responsibility for coordination, control and meeting group goals with those doing the work, increases the objective quality of working life as measured by the 6 criteria (intrinsic motivators) and, therefore, motivation or engagement.

Working together in self managing groups rather than in supervised, individual jobs equalizes relationships, improving their quality and reducing the probability of the destructive dynamics of dependency, fight/flight and pairing (Emery 1999). Once people are motivated and enjoying the challenges of learning, managing themselves and meeting

their goals, they innovate. They use their intrinsic potential for creativity to fix their technical system or find ways to improve it. In other words, the joint optimization of social and technical systems is the result of DP2 transforming human purposefulness and the potential for ideal seeking and creativity into everyday creative behaviour. Having challenges and meeting them in self managing groups creates intellectual satisfaction. Little existing knowledge is wasted and if a group needs new skills or knowledge, it works to obtain it. All this adds up to a quantum increase in productivity and accountability. As we have seen above, productivity further contributes to mental health so a virtuous spiral is initiated. DP2 is the bedrock on which the positive individual and organizational outcomes are anchored.

The causal path also suggests that the positive and negative affects operate in different ways. DP2 reduces the level of negative affect (and dissatisfaction with the external motivators) and this leads to mental and physical health. DP2 increases positive affect and this is most closely tied to intrinsic motivation. This will be further researched but we can confirm that happy, healthy people are productive people.

As it is not possible for any of the mediating variables to create the design principles, this graph shows clearly that the design principles act to create the intrinsic motivators which in turn create the factors such as motivation and trust which together provide the conditions that enable accountability, innovativeness, productivity and mental health.

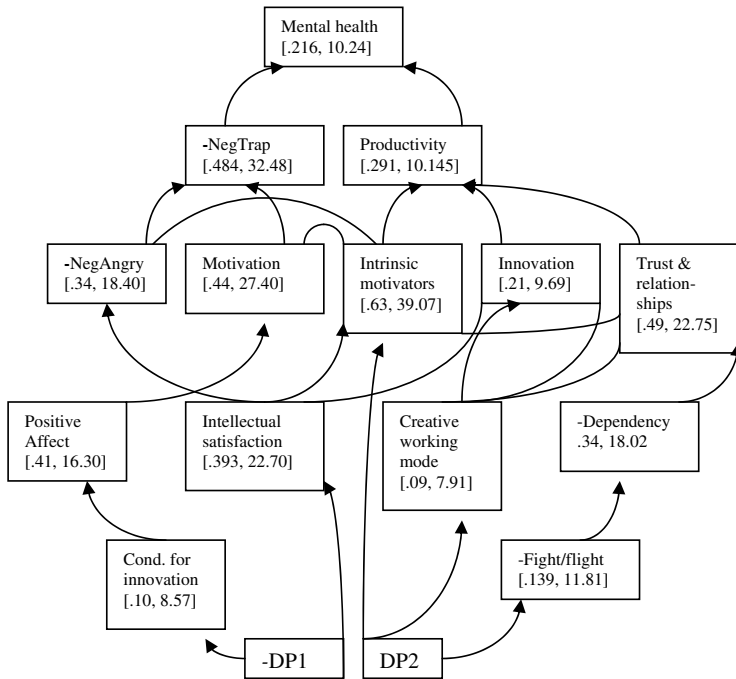
Figure 3 illustrates the results of a cascading series of stepwise regressions confirming that the design principles contribute to the enabling conditions that foster mental health. A couple of minor links have been omitted for reasonable clarity. Following the DP1 (reversed) line we see that the first consequences are good conditions for innovation and intellectual satisfaction. These in turn lead to positive affect, motivation and innovation. Intellectual satisfaction also contributes to low experience of the *Negative-angry* cluster.

Following the DP2 line, we see the first consequences are low fight/flight leading to low dependency, high creative working mode (CWM) and the 6 criteria, the intrinsic motivators. The CWM and low dependency contribute to good relationships and trust and CWM also contributes to innovation as we would expect. The intrinsic motivators contribute to motivation, trust and low *Negative-angry*. Low *Negative-angry* and motivation contribute to low levels of the psychiatric cluster, *Negative-trapped*, while the intrinsic motivators, trust and innovation contribute to productivity. A similar analysis showed the immediate contributors to low sick days are intellectual satisfaction and innovativeness (Adj  $R^2 = .223$ , d.f. = 67,  $F = 10.615$ ,  $p = .000$ ).

As this analysis confirms the pattern from the causal path analysis, we may conclude that the sequence of factors for determining mental health runs from DP2 (not DP1) to enabling conditions to mental health. This means that change management methods that specialize in improving factors such as relationships and trust or overcoming dependency or even increasing awareness of mental illness, may achieve some gains but they will be short lived. Changing one or more enabling conditions for improved productivity and mental health cannot be sustained if the structure is still designed on DP1.

### Business Results for First Year of DP2

Org3 has supplied its business results for the first year of DP2 operation. These constitute another test of our hypotheses. Productivity measures from seven different machines on the assembly floor showed a range from 10% to 22% increase since July 2006. An aggregate of all machines showed an overall increase of 11.8%. There has been no change in quality



Where: [Adjusted  $R^2$ , F] Total d.f. in all cases=67, p ranges between =.000-.006.

**Fig. 3** Cascading sequence of contributors to mental health from stepwise regression

measures which is not surprising as faults were already low relative to number of units produced as the product is dangerous. There has been no change in Total Recordable Injuries, 2 in previous year, 2 in the year July 2006 to end of June 2007. Actual sick leave shows a 28% decrease in absenteeism. There has been an 81% increase in employee engagement. These engagement surveys are conducted by an external firm totally independent of the current research reported here.

## Discussion and Conclusions

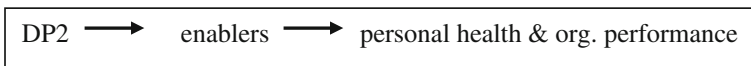
Using the full model of a jointly optimized sociotechnical or DP2 system rather than extracting dimensions such as control from it has several obvious benefits. Not only does it permit the investigation, and change, of the genotypical determinants of the system, it also permits investigation of the partial models included within it.

Doubt has been cast on one of these partial models, Karasek's high demand-low control, and our data supports Kristensen et al.'s (2002) conclusion that demand is not a reliable index of job strain. Neither of our two measures of demand, mental demand and workload had a correlation with mental health while higher mental demand was associated with fewer sick days ( $r = -.25, p = .042$ ). Mental demand and control were also split around the mean and tested with post hocs but there were no difference amongst the four combinations of high and low control and demand for either mental health or sick days. In fact our data as reviewed above support the hypothesis that a negative reaction to reasonable or high

mental demand is a sign of illness rather than a cause of it. In DP2 structures, people continuously increase the demand on themselves with consequent increases in positive affect and productivity.

Clearly mental ill health or the risk of it at work is a result of *a system* of factors, many of which have been previously isolated in the literature. But the point is that such single variables (or various subsets) such as control, demand, effort, reward, trust or equality are not determining factors as each is also the consequence of a much more fundamental factor, the genotypical organizational design principle. Until this is recognized in the literature, we will continue to struggle through masses of studies that present compelling but unnecessarily competing single factor theories of what causes mental health problems in the workplace.

Both the causal path and regression analyses presented here show a clear sequence of causality:



This means that any organization wishing to prevent mental health problems in their workforce will have to bite the bullet and address the genotypical principles involved. Playing around with such phenotypical factors as interpersonal relationships, dynamics and communications will not achieve long term prevention.

It should be noted that demographics and personality have so far, proven not to be particularly significant factors in determining mental health in the workplace. This is not to deny their significance for some or the importance of other individual experiences but in the four organizations for which we have relevant data, the organizational variables have proven the more powerful. This is a reassuring message for managers that wish to change their organizations to prevent mental problems in their workforce, and concomitantly improve their bottom lines. Org3's first year business results again confirm the sheer consistency through nearly 60 years of literature reporting that DP2 will indeed improve the bottom line. It is important to note that there is *no conflict* in improving working conditions or preventing mental illness and improving business results.

Results to date provide early support for our hypotheses, add to the consistency of sociotechnical systems findings over nearly 60 years, and clarify the role of other factors in the determination of mental health at work. Overall, they demonstrate the value of open sociotechnical systems theory and confirm previous findings from Trist and Bamforth (1951) onwards that the genotypical design principles have far reaching effects on all aspects of organizational life, health and performance.

The discovery of sociotechnical systems was recognized from the beginning as a major advance over previous conceptualizations of organization. Its evolution into DP1, DP2 structures and laissez-faire has resulted in further huge advances in our understanding of how structures affect the people who live and work in them. The current study justifies the confidence of the pioneers as we come full circle and confirm the earliest observations that structure is a major causal factor in mental health.

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## Appendix A: Scale Composition

Scale	Components
Intellectual satisfaction	Mental demand + sense of achievement + difficult to replace + learning + workload
Conditions for innovation	Reward innovation + tolerate small mistakes
Relationships + trust	All factors concerning relations & trust + frequency & fairness of appraisal + management openness
External motivators	Satisfaction with pay + conditions
Intrinsic motivators	Sum of all intrinsic motivators (6 criteria)
Level of outside activity	Hours spent volunteering + other community activities
Positive affect	Interest + excited + joyful + energetic + creative +-bored
NegAngry	Angry + tired + frustrated + disgusted + humiliated + powerless
NegTrapped	Trapped + afraid + anxious + lonely + depressed + despairing
<i>Set scales &amp; standard test</i>	
SES	Income + status + position + education
CWM—creative working mode	Creative ideas + celebrate achievements
Fight/flight	Form cliques + play politics
Dependency	Reluctant to participate + giveup easily
IE & SO—internalizing-externalizing & subjectivizing-objectivizing	Eight items as per standard behavioural test
DP1—measure of extent of first design principle	Supervision + -teamtype + -control + -coordination + individual accountability
DP2—measure of extent of second design principle	-Supervision + teamtype + control + coordination + group accountability
LF—laissez-faire-measure of	-Supervision + -teamtype + nobody accountable

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