Routledge
Taylor & Francis Group

Construction Management & Economics

ISSN: 0144-6193 (Print) 1466-433X (Online) Journal homepage: https://www.tandfonline.com/loi/rcme20

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To cite this article: Davide Nicolini (2002) In search of 'project chemistry', Construction Management & Economics, 20:2, 167-177, DOI: 10.1080/01446190110101217

To link to this article: https://doi.org/10.1080/01446190110101217

Construction Management and Economics (2002) **20**, 167–177

In search of 'project chemistry'

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Received 10 May 2001; accepted 1 October 2001

The paper aims to provide a language and a conceptual toolkit to deepen our understanding of the impact of relational and social issues on the success of construction projects. Building on several streams of literature, as well as on individual and group interviews with construction practitioners, the paper develops the notion of 'project chemistry' as a way of capturing some of the relational and behavioural dimensions and factors that may affect project success and effectiveness in construction. The paper introduces a provisional theoretical framework that (a) identifies a number of external and project level determinants of 'project chemistry', (b) suggests ways of measuring *how* and *how well* people interact, perceive, and work together in a project, and (c) relates these issues to broader economic and technical factors. The paper concludes with some reflections on the implications and challenges for future research and management practices raised by the notion of 'project chemistry'.

Keywords: Project management, project success factors, human resource management, behavioural aspects

Introduction

The importance of interpersonal relations, team spirit and collaboration is a recurring theme in construction management. The take up of innovative procurement and business practices such as partnering, lean construction and supply chain management require the adoption of non-confrontational attitudes, a collaborative spirit, and trust that, in turn, highlight the importance of social, human and cultural factors in the management of construction organizations and projects (Akintoye *et al.*, 2000). However, in spite of the increased recognition of the importance of 'soft' management factors in construction management, practitioners (and sometimes researchers as well) often lack the necessary language and conceptual tools to make sense of and effectively address these issues.

The present paper constitutes an attempt to fill such a gap. It proposes the use of the notion of 'project chemistry' as a way of deepening our understanding of the relational dimensions and factors that may lead to successful project performance.

Historically the notion of 'good chemistry' between people has a very ancient and prestigious pedigree. The images of chemistry and affinity were in fact in common use before the advent of scientific psychology in the early 1800s to explain sympathies and aversions between people and groups, and they have been used ever since with this meaning.

The term 'good project chemistry' is particularly attractive in our context for it seems to capture a quality of the interaction between people on a project, based on an affinity of intents and dispositions, i.e. an intangible characteristic of interaction that many have posited as the basis of, for example, successful partnering.

Although the notion of 'project chemistry' may be useful as a metaphor to highlight a particular aspect of business and work practices, there are some inherent risks as well, in that the notion may quickly become a sort of black box term (like 'culture') that hampers our comprehension of project processes instead of making

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Construction Management and Economics
ISSN 0144–6193 print/ISSN 1466-433X online © 2002 Taylor & Francis Ltd
http://www.tandf.co.uk/journals
DOI: 10.1080/01446190110101217

them more comprehensible. Thus in order to exploit the heuristic potential of the term we need to investigate what sorts of things may be encapsulated by the expression 'project chemistry', how it relates to other aspects of work life and work practices, and what role it plays in project success. The paper aims to take a first step in this direction. Building on the existing literature on organizational climate, cross-functional team effectiveness and behavioural aspects of project management, as well as on a series of focus groups and interviews with construction practitioners, the paper develops a provisional theoretical framework of what 'project chemistry' as metaphor or expression may refer to, its antecedents and the ways in which it affects project outcomes.

It is important to emphasize that the main purpose of this work is *not* to provide definitive answers or to propose prescriptive models, as much as (a) to raise awareness in the construction management research community about the impact of human issues on projects and how these issues interact with broader economical and technical factors; and (b) to develop a language and a conceptual toolkit for thinking through these complex phenomena. It should not come as a surprise, then, that the paper raises at least as many issues as it solves, and that the proposed model captures only some of the issues at stake.

The contribution of the literature to our understanding of 'project chemistry'

Three bodies of literature appear particularly useful to help articulate the notion of 'project chemistry': on organizational and team climate, on success factors in cross-functional teamwork in new product development, and the project management literature on social determinants of project effectiveness.

'Project chemistry' and the study of organizational and team climates

Interest in social and affective atmospheres in organizations and their link to performance has been pursued for several decades under the heading of organizational climate, which has been defined as 'a relatively enduring characteristic of an organization that distinguishes it from other organizations and: (a) embodies members' collective perceptions about their organizations with respect to such dimensions as autonomy, trust, cohesiveness, support, recognition innovation, and fairness; (b) is produced by members' interaction; (c) serves as a basis for interpreting the situation; (d) reflects the prevalent norms, values and attitudes of the organization's culture; and (e) acts as a source of influence for shaping behaviour (Moran and Volkwein, 1992, p. 20).

Following the pioneering work of the social psychologist Kurt Lewin, who in the 1940s started to investigate the effects of what he called 'social climate' on the behaviour of individuals in groups and organizations, the topic has been at the centre of the interest of the organizational studies community for several decades (Lewin, 1948, 1951; Littwin and Stringer, 1968; Tagiuri *et al.*, 1968; Schneider, 1975; Schneider and Snyder, 1975; Joyce and Slocum, 1982; Glick, 1985; Reichers and Schneider, 1990; Moran and Volkwein, 1992).

Scholars studying the phenomenon of organizational climate have proposed three alternative notions of its nature and origin: as an attribute of an organization, as the shared perceptions of members, and as the perception managers have of their organization.

A first group of scholars argues that the organizational climate is a characteristic or an attribute belonging to an organization. It forms because members are exposed to common structural characteristics, such as the size of organization, the degree of centralization of decision-making, the number of levels of hierarchy, the nature of the technology employed, and the extent to which formal rules and policies proscribe individual behaviour (Littwin and Stringer, 1968; Tagiuri *et al.*, 1968).

Another group of scholars takes a different view, and focuses more on the individuals and their perceptions. These scholars take the climate as a result of people interacting with each other in response to the organizational situations; more precisely, climate is the shared implications of organizational policies, practices and procedure (Reichers and Schneider, 1990, p.22).

Finally, a further group of scholars describes climate as the perception managers have of the characteristic and the way of functioning of their organization. They emphasize the role of the leadership in shaping the organizational climate through the organizational structure they set up, the way they reward people, and how they recruit and promote members. Thus there are several possible climates conducive to success, and the task of managers is to ensure that the organizational ethos is communicated properly, so that the organizational climate is aligned with the strategic direction set by the top management.

In recent years authors have taken a more sceptical view of the concept of organizational climate and pointed out, for example, that speaking about climate does not really make sense unless one specifies a referent for the notion (e.g. climate for change, etc.). If we do not know what the climate is for, it is almost impossible to test the correlation between climate and organizational performance (Schneider and Reichers,

1983). As a consequence, researchers have started to direct their attention to investigating the conditions conducive to particular climates, especially those for innovation and for safety, focusing especially on small group and team levels.

For example, Anderson and West (1996, 1998) developed a useful model of team climate and a related tool named 'team climate inventory'. The model applies at work group level, understood as 'the permanent or semi-permanent team to which individuals are assigned, with whom they identify, and with whom they interact regularly in order to perform work related tasks' (Anderson and West, 1998, p. 236). It describes and measures the climate for innovation in work groups along the following five main dimensions: (1) level of shared vision and clarity of goals; (2) perception of a safety and non-threatening environment that encourages participation in decision-making; (3) presence of a task orientation and a commitment to excellence coupled with continuous improvement procedures and practices; (4) support and reward for innovation; and (5) level of communication and interaction between team members.

In summary, the long lasting interest in organizational and group climate provides some valuable insights into understanding 'project chemistry'. In the first place, 'project chemistry' is likely to be an outcome of a number of factors of diverse nature, some specific to the project level, and others deriving from the organizations involved in the project and the broader business environment. One should resist the temptation to focus on HR practices only, and the effects of 'hard' technological processes or commercial practices should also be taken into consideration. Second, project management styles, practices and procedures are likely to have a considerable impact. Finally, the notion of 'project chemistry' overlaps, at least in part, with that of climate and in particular with that of team climate. Some of the factors identified by Anderson and West could therefore be usefully extended to capture aspects of what we call here 'project chemistry'.

Project chemistry and the study of cross-functional teamwork in new product development

Cross-functional teams are defined in management studies as teams in which members of different departments and disciplines are brought together under one manager and charged with making development decisions and enlisting support for them throughout the organization in order to ensure the effective delivery of a common organizational objective (Ancona and Caldwell, 1992; Holland *et al.*, 2000).

Unlike in construction, where cross-functional project teams have been the norm for a long time (Cherns and Bryant, 1984), in manufacturing the use of cross-functional teams in product development constitutes a relatively recent innovation. It was not until the beginning of the 1980s that cross-functional teams became common practice in innovative product development, although in recent years their diffusion has become widespread and they are currently used by over 84% of US firms (Griffin, 1997).

Given their wide diffusion and critical importance, in recent years cross-functional teams, and the factors affecting their performance, have attracted increasing attention from organizational and management researchers (Stein, 1982; Pinto *et al.*, 1993; Ancona and Caldwell, 1992; Holland *et al.*, 2000). Extensive research on the topic has found that five factors are critical for the success and superior performance of cross-functional teams: task design, group composition, organizational context, internal processes and boundary management, and group psychosocial traits (Holland *et al.*, 2000). These results are summarized in Table 1.

The body of research on success factors in cross-functional teamwork in new product development confirms and expands the insights derived from the study of organizational and team climate. In particular: (a) cross-functional teams are more likely to succeed where there is strategic alignment between functions, a culture that prizes participative teamwork and an organizational focus on supporting team and project needs as well as rewarding team level efforts and achievements; (b) in order for teams to obtain a high level of trust and cohesiveness, appropriate action needs to be taken so that the design, group selection and formation processes, management style and practices, reward and recognition principles, communication mechanism and systems are all aligned. In short, successful cross-functional teams thrive in organizations that value them, recognize their importance and provide the necessary support and assistance.

Project chemistry and the study of social determinants of project effectiveness in project management literature

Contrary to the substantial attention devoted by organization theory and occupational psychology to the study of human, cultural and psychological factors, these issues still attract relatively little attention in the construction literature. As a consequence, in spite of the burgeoning literature on project success (how to measure it, how to achieve it), we still know very little about the relations between human factors and project outcome.

Furthermore, as noted by Bleout (1998), even in the broader project management community, often the impact of 'human factors' is addressed at a very high

Table 1 A summary of critical success factors in cross-functional teams

Factors	Teams are more successful when
Task design (Holland *et al.*, 2000)	The task is challenging, meaningful, well communicated and achievable Members are accorded high level of autonomy and empowerment Formalized yet flexible integrative processes are in use (e.g. disciplined problem-solving process, stage-gate processes)
Group composition (Stein, 1982)	Right mix of expertise Led by a leader selected in view of the specific job Roles and responsibilities openly negotiated and formalized has been undertaken Same composition and leadership throughout the project or several projects
Organizational context (Pinto *et al.*, 1993; Holland *et al.*, 2000)	Clear mission from senior managers Practical support from the parent organization (e.g. provision of time, senior manager access, services, training for team managers and members) Team based rewards and accountability are co-located
Internal processes and boundary management (Ancona and Caldwell, 1992; Holland *et al.*, 2000)	Goals defined by the group and regular feedback on performance provided Team leader as a facilitator (e.g. draws upon work challenges and expertise rather than formal authority to lead) Moderate level of conflict is accepted and openly addressed Leader trained in team process skills Leader invests enough time in networking and influencing behaviour towards superiors and other parts of the organization
Group psychosocial traits (Pinto *et al.*, 1993)	Presence of mutual trust, respect between members, willingness to change and team cohesiveness (please note that team trust and cohesiveness have been found to be an outcome of good communication, good task design and effective organizational context, while at the same time predicting team performance, quality, schedule and budget performance over time.

level, e.g. utilizing traditional human resource management categories (e.g. staffing and recruitment at the organization level, employee assistance and information, legal requirement compliance, industrial relations, equal pay policy, sanctions, administrative services, etc.) that fail to capture the critical success factors of different project management practices.

Among the few studies explicitly addressing the social and psychological aspects of project management is the work of Boddy and Buchanan (1992). These authors take an unusual approach in that they address project management as an instance of management of change, assuming that most 'projects' will have as a major aim the production of significant modifications in the task, structure, and technology of people in an organization. Although their work is not always based on rigorous research (the data are derived from eight diaries kept by project managers, and no details on the treatment are provided), and the results are presented in a prescriptive manner, their tenets are not too dissimilar to those emerging from the literature on organizational climates and cross-functional teams in manufacturing. According to Boddy and Buchanan (1992, Chapters 5–8), project managers are mainly in the business of influencing *all* the stakeholders that have an interest in the project. In particular, they state that project managers need to influence their project team and staff by providing a focus, choosing the right people, negotiating time, making the most of diversity, building relationships and sustaining momentum during difficult times; also they need to manage across other departments and organizations, negotiating the necessary resources and support and creating a sense of collective ownership; and PMs need to manage up, that is, influence senior executives or founders by creating and selling the vision, communicating results and recognizing danger signals.

The project management literature offers some interesting insights into the mechanisms through which a 'project chemistry' can contribute to project success or failure especially in construction. Loosemore (1998), for example, studied the reaction of construction teams during project crises. He found that serious project crises affect the pattern of relationships between

members and generate three ironies: at a time when effective communication is important, it is less likely; at a time when mutual sensitivity between team members is important, it is less likely; and at a time when collective responsibility and teamwork are important, they are less likely. He concludes that crises put serious strains on projects, and they can represent either opportunities for increased team cohesion and collaboration or a potential cause of division and conflict. From our perspective, a good 'project chemistry', supported by the necessary organizational processes, can at this juncture make the difference between a gleaming success and a serious failure.

In conclusion, the project management literature on social determinants of projects indicates primarily that there is a need for more research focusing on micro-level social and human processes and their relations to organization-wide HR practices. It also suggests that 'project chemistry' may have different effects at different stages of a project and, by extension, that the same type of chemistry, i.e. the same combination of factors, may not always deliver superior project team performance and project success.

Building theory from the bottom up: what practitioners say

As already noted, most of the literature on team climate and critical success factors for cross-functional teams and even project management derives from sectors other than construction. Such literature is therefore extremely helpful in pinpointing a range of general factors, but by its nature it cannot help us identify specific conditions and factors that affect the success of projects in construction. Although the similarities between the task of cross-functional teams in new product development and construction project teams suggest that some of the findings could be transferred between the two areas of study, this may not be enough to develop a meaningful and usable framework for construction.

Accordingly, in order to produce a model of 'project chemistry' suited to the conditions and domain specificity of the construction industry, I decided to support the theory-building effort with some qualitative field work aimed at eliciting practitioners' views of 'project chemistry' and the factors affecting it. I wanted to integrate my traditional 'top down' strategy of theory building based on the literature review and personal reflection with a 'bottom up' effort based on the distillation of practitioners' experience. The purpose was to establish how practitioners make sense of these phenomena so that their grounded categorization could be taken into account during the theory-building effort to create a model that would speak not only to the research community (as would be one built on only the results of previous research) but also to 'reflective' practitioners as well.

To achieve this aim, during the project I conducted two focus group interviews and a number of individual semi-structured interviews with members of demonstration projects of the Movement for Innovation Initiative (M4I).

The focus group method is an established rigorous technique for collective interviews aimed at eliciting and exploring in-depth opinions, judgements and evaluations expressed by professionals, experts or users/clients about specific topics (Morgan, 1997). The two focus groups in the present research were facilitated by the author and lasted about 90 minutes each. Prospective participants were sent a brief description of the project together with a short note explaining the mechanics of the focus groups. Overall, 17 people accepted the invitation and participated in the two groups. Interviewees belonged to different professional groups (architects and other designers, project managers, human resource managers, corporate managers, client project sponsors), and came from a variety of industry segments (public sector, private sector owner-occupier building, private sector building for a developer). The two collective interviews were conducted separately using the same schedule. Questions discussed included how to describe and recognize project chemistry, what factors affect it, and concrete ways in which chemistry could affect the outcome of a project.

It is important to note that the focus groups were not intended as a survey, and their results should not be construed as such. In our context they were used to enrich the comprehension of what may count as 'project chemistry', how it is achieved and how it may affect project outcome. Therefore they cannot be construed as a reliable sample of the view of the UK construction industry. By the same token, the two group interviews helped us identify initiatives currently being carried out or planned in the industry, but they do not tell us how common they are or how they affect projects.

The two focus groups were integrated by seven individual interviews with expert project managers and construction practitioners. The semi-structured interviews were carried out face-to-face or by telephone, and used the same schedule as the focus groups.

Data from the focus groups and the other interviews were transcribed verbatim and their content was analysed with the (limited, given the small amount of transcribed material) support of 'Nudist', a computerized qualitative data analysis tool.

In the following section, I summarize the findings of all interviews. The indented text in smaller type has been taken from the verbatim transcription of the interviews.

What is captured by the idea of 'project chemistry'?

In the first place, participants indicated that at the simplest level the expression simply captures the idea that people in the team get along.

Upon closer scrutiny, however, the term appears to have several dimensions. According to participants, 'project chemistry' can be used to capture two different aspects: specific behaviour and perceptions of the team by members. Participants tended to associate good project chemistry with good and open communication, collaboration between members and integration:

> . . . a team where you can really fire ideas that bounce around

Others associated the term more with members' perceptions of the group climate, especially in terms of shared goals, psychological safety and care:

> . . . there are no territories and I think nobody is precious about it, and so it is all expansive: everybody can tread wherever they like including the client, and I think that's an essential component . . . people care about how other people fit . . .

In general, participants agreed that the term captures an important dimension of the work environment and that 'project chemistry' should not be confused with friendship or 'cosiness', for the latter may in fact be detrimental to project success.

> If the relationship is to live beyond the immediate then there have to be also some long term goals, business rewards or others, rather than just friendship, because I can go to the cricket club for friendship, or I can seek that deeper spiritual thing from other sources.

How do you achieve good 'project chemistry'?

An issue raised at the beginning of the interview was 'who's chemistry are we talking about'? There was recognition that a climate of collaboration should be achieved throughout the entire project community. However, there was also a consensus that the initial focus should be on the small core project group. If the core project group establishes a good chemistry, then it is much easier to cascade it to others and to those coming on board at later stages:

> We should focus on project teams and then . . . I don't mean it in a hierarchical sense but then it filters down to the troops

Such a 'core team first' approach, of course, renders the selection process all the more important:

> . . . the same selection process should run right the way through . . . and I think you have to select everybody, wherever they are in the chain, on very similar criteria, and particularly that key objective to work together as a team and make a contribution as a team member

Reflecting on their experience, participants also identified a number of conditions and initiatives that are conducive to good project chemistry for both the core team and the rest of the project community.

These conditions and initiatives fall within five main categories: commercial and business practices and task design, team selection and composition, management of team development processes, quality of leadership, and initiatives to sustain involvement,

Commercial and business practices and task design.

Participants generally agreed that the quality of 'project chemistry' was enhanced when the commercial relationship established between the organizations involved in the project enabled collaboration within the project community. This included obtaining client support and involvement and adopting the appropriate contractual relations (partnering of some kind), and possibly configuring the project as a sort of virtual organization with which all members of the community can identify. Participants also noted that the way in which the design and construction process is organized constitutes a condition that affects the emergence of 'good project chemistry'. For example, the early involvement of suppliers in the design process, the use of gateways, periodic project reviews both at the whole community level and on a daily basis (e.g. site level short meetings to review work and plan next steps) and co-location were all mentioned as factors affecting 'project chemistry'. Finally, participants noted that the roots of 'bad project chemistry' might at times be deeply ingrained in the ways people are trained to behave. In many a way, participants recognize that the reluctance shown by certain persons in construction to work as a team goes back to the way they were trained in their professional trades.

Team selection and composition

A factor often mentioned as critical is selecting the right people for the job, for example using psychological profiling methods to try to select team members on the basis of compatibility of personalities. Several participants also noted that retaining the same team throughout a project and allowing for repeat collaboration of the same team across several projects helps to capitalize on the time, effort and resources invested. It was also emphasized that accuracy of selection should not be limited to the selection of the core project team but should be carried out for all key project actors coming on board later. In particular, they suggested that the extension of the original project team should be based on proved compatibility, and that all newcomers to the project community should be systematically and thoroughly induced.

Quality of leadership

Several participants recognized quality of leadership as a critical factor in achieving good 'project chemistry':

> Project chemistry almost is dictated by the way the project is led

It was noted that it would be extremely helpful if construction team leaders and project managers received some form of training and mentoring on how to develop and manage good group relationships.

Management of team development processes

Many of the respondents agreed that once the team has been selected and the leader chosen it is important to put in place formalized team building activities and workshops:

> Set up a core team and send them away for a couple of days in a hotel so that they can bond between themselves

Many participants reported that holding an initial professionally facilitated workshop gives a team the right start, and enhances the likelihood of developing good 'project chemistry'. The workshop constitutes an opportunity to refine, so to speak, the composition of the group by testing their capacity to work together in practice; it also allows the team to develop another fundamental ingredient of 'project chemistry', i.e. clear explicit rules and goals. It also facilitates the planning, deployment and review of good communication practices at all levels and all of the time.

A key aspect of the team development process is the establishment of measurement and feedback process, focused on both goals and relations.

Initiatives to sustain involvement and well being of all staff

Observing the impact of this kind on activity on 'project chemistry', participants mentioned whole project and whole supply chain social events, establishing and maintaining high professional standards on site (security, access, health and safety), and providing good facilities (WC, shower, canteen). Clear communication right through the levels, using boards, project gadgets and logos, internal bulletins, short meeting and presentations, was also mentioned as an important way to involve all members of the project community.

How does good 'project chemistry' affects the outcome of a project?

The results of the analysis of the focus group and individual interviews indicated an emerging pattern of relations between 'project chemistry' and project outcomes.

In the first place, good 'project chemistry' enhances the quality of the final product by harvesting expertise and creativity from all team members. It also reduces time, for it allows the early detection of potential problems and an improved problem-solving process. Second, good 'project chemistry' constitutes a motivator and helps people working in the same direction:

> . . . you work more cooperatively and easily together . . . no need to struggle with external influences affecting the project

Also it allows more productive use of resources, less defensive bureaucracy and use of time, and less paperwork.

Overall, participants in the two focus groups and individual interviews agreed that 'project chemistry' is something special that happens when the right people and the right conditions apply:

> I think good chemistry actually binds together . . . we're talking about a chemical reaction where elements bind together, fuse together and in that process then . . . people feel so secure and able to contribute.

However, 'chemistry' is not only being friends. Although friendliness is an important aspect of 'good project chemistry', it does not imply respect, or capacity to listen and to disagree while working towards a common goal.

A provisional theoretical framework for understanding 'project chemistry' and its implications for project performance

The results of our two focus groups are very much aligned with the available literature. Together they provide support for the idea that 'project chemistry' may be a useful term to embrace how and how well people interact, perceive each other and work together in the project. On the basis of the literature and the 'grounded' categories emerging from the focus groups analysis, it is possible to hypothesize both the antecedents, process and immediate outcomes of such processes of interaction and perception, as well as to advance some hypotheses on the mechanisms through which this may impact the outcome of a project. These hypotheses are summarized in the model presented in Figure 1.

The model suggests first that 'project chemistry' depends on two types of antecedent factor: factors deriving from the organizations involved in the project (and from the broader business environment through them) and factors specific to the project and its individual members.

The antecedent factors deriving from the organizations involved in the project and from the broader

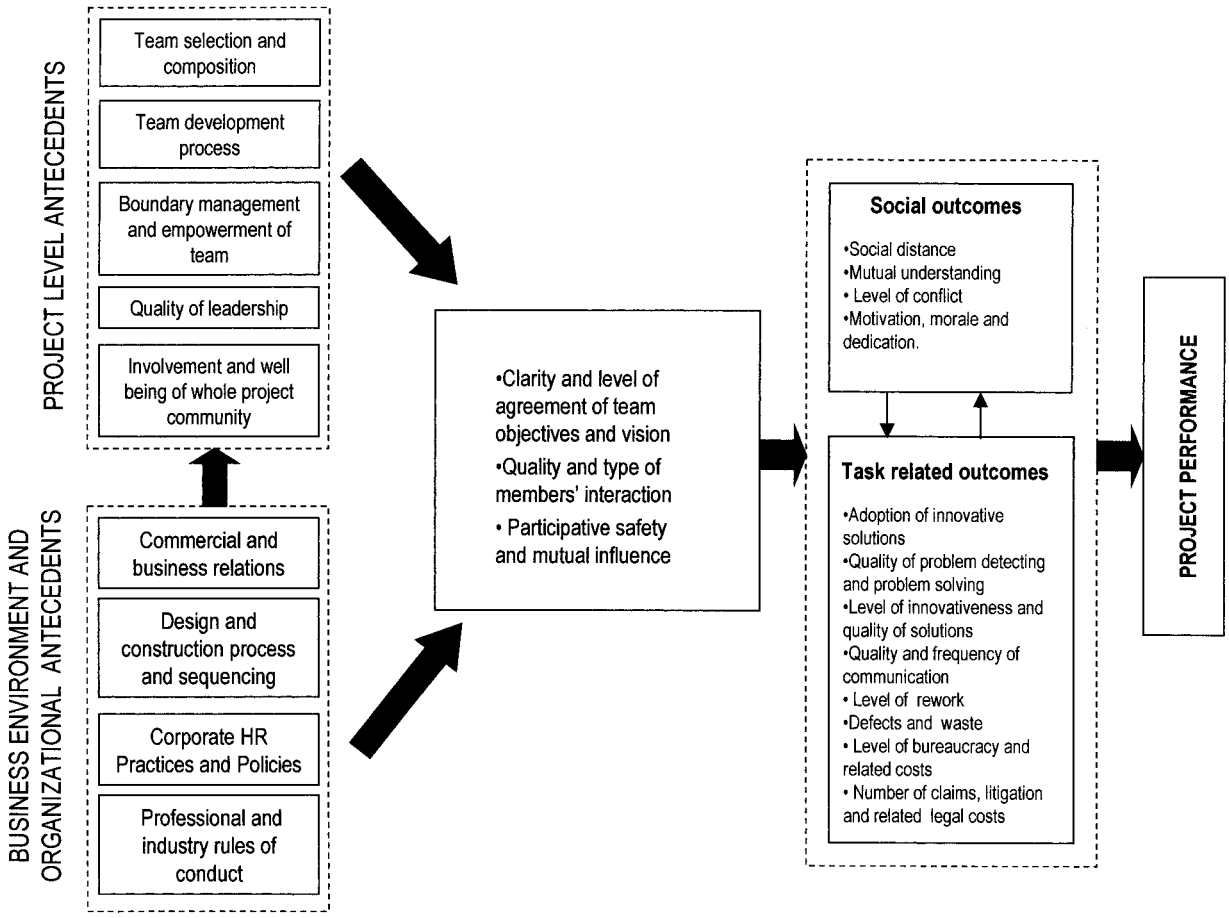

Figure 1 Provisional model of 'project chemistry' and its effects on project performance

business environment through them include: (1) commercial and business relations, e.g. client support and involvement and collaborative contractual relations; (2) the design and construction process, i.e. structured early involvement of suppliers in the design and planning process, use of a formalized gateway-based project process, use of participative decision-making techniques such as value and risk management, and periodic project reviews both at the whole community and site level; (3) human resource management policies of the organizations involved in the project, included here because of their effect on selections, reward structure and training at project level; and (4) wider industry rules of appropriateness on how to relate at project level learned during instruction and professional training and to be taken into consideration as they are carried into the project by individual 'carriers', to borrow an expression from Max Weber.

It is worth noting here that, by pointing to these factors as antecedent of 'project chemistry, I am in fact suggesting that although 'project chemistry' refers to the emotional, perceptual and psychological consequences of communication and interaction, its emergence is likely to be affected by 'hard' aspects such as the existing technological processes and commercial practices that lie mainly beyond the reach of the project team members.

The emergence of 'project chemistry' is also likely to depend on the establishment of a number of conditions and identifiable project level practices. Probably these will fall within the following categories: team selection and composition, team development process, quality of leadership, boundary management and empowerment of team, and involvement and well being of whole project community. They constitute project level determinants of 'project chemistry'. Table 2 summarizes a way of operationalizing these five factors along a number of dimensions.

Because the notion of project chemistry as described here overlaps, at least in part, with that of team climate for innovation, some of its features could be provisionally colllected and measured along three of the four dimensions of the Anderson and West TCI model (Anderson and West, 1996, 1998), e.g. clarity and level

Table 2 Project level determinants of 'project chemistry'

Direct determinant of 'project chemistry'	Dimensions
Team selection and composition	Quality based selection using profiling techniques Right mix of expertise Team established by assembling initial 'core group' tested for capacity to work together and then enlarged by inducing newcomers tested for compatibility with existing rules and group culture Same team throughout the project or, possible, across several projects
Team development process	Clear mission from top management and client Facilitated team building workshop Clarity of roles and responsibilities Establishment of communication practices and facilities Periodic feedback on achievement of goals and quality of team climate
Quality of leadership	Leader selected in view of the specific job and team Leader trained in managing group processes Professional coaching to Team leader available to address crisis
Boundary management and empowerment of team	Clear remit from top managers and 'no meddling' by parent firm managers Structured interaction with Client and client's team Co-location of team Provision of assistance and support by parent organization Team-based rewards and accountability
Involvement and well being of whole project community	Communication right through the levels, using boards, project gadgets and logos, internal bulletins, short meeting and presentations Social events High professional standards good facilities on site Induction for all newcomers

of agreement of team objectives and vision, participative safety and mutual influence, and quality and type of members' interaction.

Finally, my model hypothesizes that 'project chemistry' affects overall project performance in two ways: by generating specific social outcomes and by affecting the way in which the task is performed. In other words, 'project chemistry' is likely to produce some intermediate social and task-related outcomes that are in fact the medium through which 'project chemistry' affects overall project success. A project with good chemistry is likely to have close social relations between team members, a friendly and open environment, a low level of conflict, high motivation, a focused team, and high morale and team dedication. Some or all these features are likely to be found lacking in a project with 'poor project chemistry'. Social outcomes constitute a significant project result on their own merit, given that, as noted by participants in the focus groups, a project in which good technical or financial outcomes are obtained at the expense of human and professional relations is a false success.

'Project chemistry' is also likely to produce outcomes that are directly related to the performance of the specific tasks at hand, such as adoption of innovative design and building solutions, reduction of waste, improved efficiency and costs of quality or of litigation. Social and task related outcomes of good 'project chemistry' are summarized in Table 3.

Finally, it is an assumption of this study that through these social and task related outcomes good 'project chemistry' will impact positively on the outcome of a project. However, it is worth emphasizing that, as Özçelik *et al.* (2000) recently reiterated, the latter relation is far from established, and should be tested in the context of the overall model.

Conclusion and directions of future research

The present study constituted an exploration of the notion of 'project chemistry' and how it may effect project performance. My research resulted in a provisional theoretical framework to identify a number of dimensions to make sense of 'project chemistry', as well as a host of factors that may affect it and ways in which it, in turn, can affect overall project success. In particular, the framework suggests that 'project chemistry' should not be thought of as a characteristic of the people involved as much as a trait of the relations between people, task and organizational conditions. Thus, 'project chemistry' is a process that needs

Table 3 Social and task related outcomes of 'project chemistry'

Outcomes of good 'project chemistry'	
Social	Reduced social distance Mutual understanding Low conflict level/constructive disagreements High motivation and collective focus Increased morale and dedication
Task related	Improved problem detecting and problem solving capability Increased innovativeness and quality of design and building solutions Improved communication Reduced rework and defects Reduced waste, reduced bureaucracy and related costs Absence of litigation and legal costs

to be nurtured and maintained throughout the project. Appropriate conditions need to be put in place for good 'project chemistry' to happen.

The findings of this research hold significant implications for future research, and provide some provisional indication on how such research could benefit the construction business community.

In the first place, the model needs to be tested to ascertain which of the described relations are significant or which of the factors have more impact on project performance. As mentioned above, the study was aimed at theory building, and the methodology utilized does not permit the drawing of any conclusions. Corroborating the model will therefore necessarily be the aim of a future study. It is worth noting, however, that the hypothesis that good 'project chemistry' has an impact on project performance builds on the extensive research that demonstrated a relation between group effectiveness and group performance (see Cohen and Bailey (1997) for an extensive review).

The model also raises some interesting issues for further research. For example, is 'project chemistry' an enabler or an enhancer of project success? In other words, is 'project chemistry' a necessary basic condition without which project success cannot be obtained, but that in itself cannot guarantee project success? Or is it a characteristic that relates directly to project performance? Are degrees of 'project chemistry' correlated with degrees of success or is there a threshold below which outstanding project results will not be achieved? Are all the factors of equal importance? Can one aspect compensate for another 'poorer' one? Are the three dimensions of the TCI model good enough to capture the critical aspects of team level interaction and perception?

It is clear that any future attempts to test the validity of the model will have to wrestle with the challenge of measuring project success in order to measure the relationships between the variables. Although this issue is quite complex and has proved highly elusive, several studies in construction and in other sectors have proposed promising models and metrics (Freeman and Beale, 1992; Shenhar, 1997; Liu, 1998).

Although a lot of work remains to be done, the identification of which of the practices and factors in the framework bear what consequence on project performance would provide invaluable information to construction organizations and project managers. Certainly, the model indicates specific areas of skill and competence that could become specific targets of training and development, as well as criteria for selection and performance evaluation.

If corroborated, the model could also help direct the attention and optimize the efforts of construction managers to improve project effectiveness. For example, the model hypothesises that both hard (business, technological and commercial processes) and soft (human relations and HRM) factors are involved in producing 'project chemistry' and especially good 'project chemistry'. This tenet suggests that attempting to improve project effectiveness by focusing on soft issues only, without making any progress on the hard ones, may be fruitless. This is likely to have an impact on the strategies used to increase efficiency and productivity. At the same time, if corroborated, the model would make a case for specific and well thought out 'project level' human resource policies, initiatives and investments to produce consistent high performance at the project level in the construction industry.

Acknowledgements

The research was supported by CRISP (Consultancy Commission – 00/9) and the Movement for Innovation (M4I). Special thanks go to Robin Nicholson, CBE, Peter Runacres and the other M4I research officials for their support. I am in debt to Cyril Tomkins and Rob Briner for their thoughtful comments on previous drafts of this paper and for their suggestions for further research, and to Moira Doherty for her editing work. The expression 'project chemistry' within the context of the present research was initially put forward by Robin Nicholson who, however, bears no responsibility for how it has been dealt with in the paper.

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