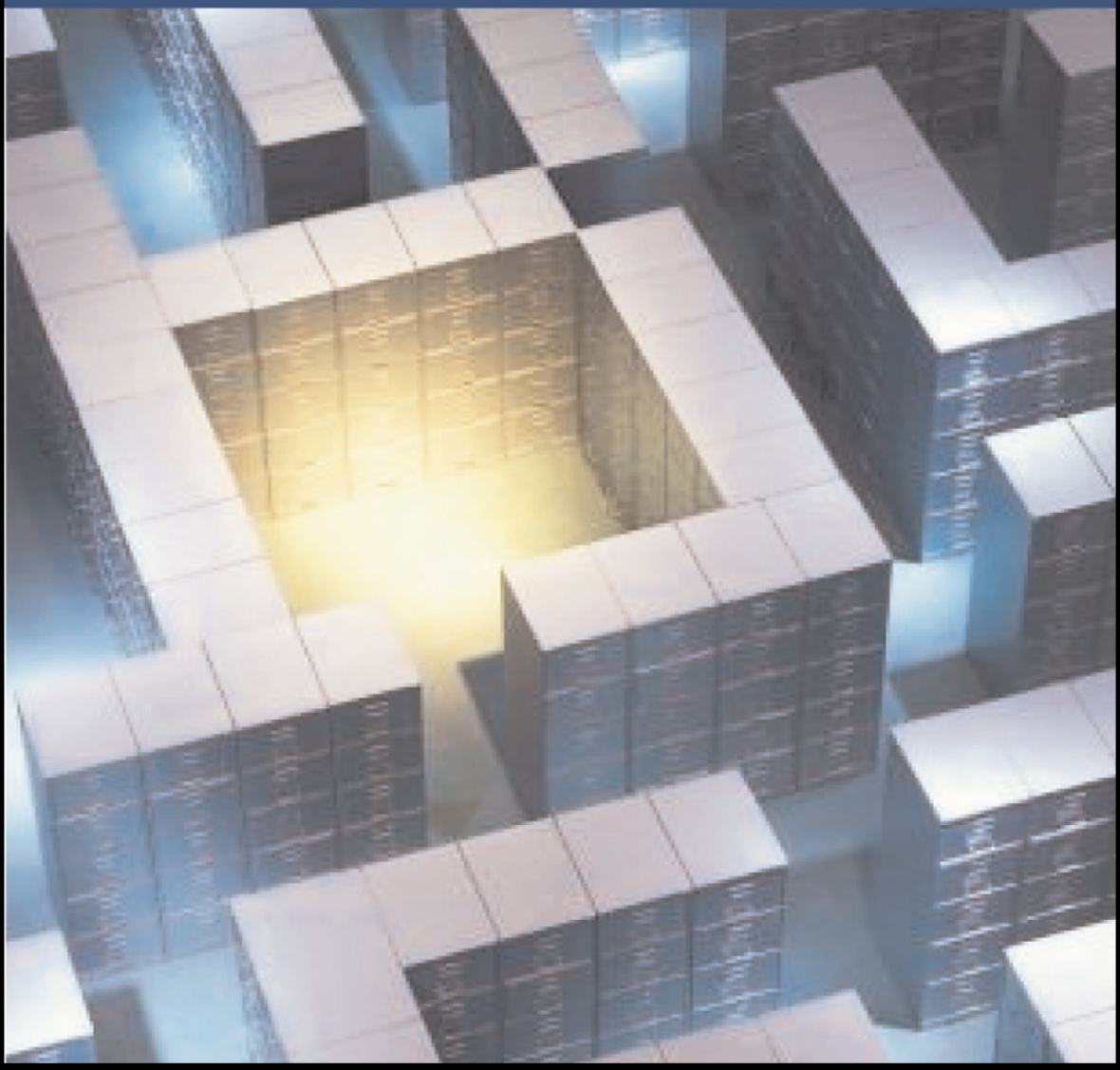
NANDISH V. PATEL

CRITICAL SYSTEMS ANALYSIS AND DESIGN

A PERSONAL FRAMEWORK APPROACH



Critical Systems Analysis and Design

As systems analysis and design is becoming increasingly concerned with the organization as a whole, systems analysts need to concern themselves with organization design as well as systems design.

This book takes a unique look at systems analysis and design by using an approach that provides learners with a critical personal framework. This enables the reader to develop a personal method for critically considering and developing a knowledge and practice of systems analysis and design by contrasting the real world with the systems world, thus differentiating it from existing systems analysis books.

Each chapter of this book begins by highlighting what can be learned by completion of the chapter and ends with a critical skills development section that contains activities, tasks and discussion questions. Chapters include:

- systems analysis and design in concept and action;
- structured data modelling;
- making systems analysis and design inclusive.

Although the discussion and examples in this text are drawn primarily from business information systems, the lessons apply to both government and healthcare information systems and to systems development in general.

Critical Systems Analysis and Design makes a complex area of study accessible and relevant and as such is an indispensable textbook for both advanced students and professionals concerned with the innovation of information systems.

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A personal framework approach

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My darling daughter Risha
(which means knowledgeable)
for a brighter future

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Preface

The purpose of this book is to redress the gap of criticality in systems analysis and design. The development of criticality in learners is the rationale that underpins programme specifications at universities, and increasingly it is the preferred attribute of professional employees in companies. Criticality is important in systems analysis because its scope has vastly increased since the 1960s. Then, it was concerned with the design of Information Systems (IS) for local or departmental functions. It now covers the whole organization in system projects involving business process redesign, eCommerce, eBusiness, and knowledge management systems. Systems analysts are now not just systems designers, they are part of a team involved in organization design too.

IS is an important subject in academic curricula in undergraduate and postgraduate programmes at universities. Learners are exposed to how technical analysis is conducted, how to use formal notations to develop systems models and designs, and how developed systems models and designs are implemented using Information Technology (IT). The emphasis is on providing comprehensive knowledge and the development of necessary problem-solving skills for learners to become practitioners. This emphasis has resulted in an absence of criticality in the subject, which for university degree programmes in business schools and computing departments is probably a significant weakness. Learners and practitioners need to reflect critically on the problem of IS development encompassing organization design, in particular systems analysis and design. Such criticality is necessary in postgraduate programmes and in workplaces where critical thinking is often the impetus for innovation.

Teachers are concerned about the divergence between textbook knowledge of IS and systems analysis and design and its practice in organizations. The formal approaches that constitute knowledge seem at odds with the domains in which they are applied, namely organizations and people. Organizations, and the people who work in them, make it difficult for practitioners to deploy formal IS methodologies or systems analysis and design techniques and tools as intended by their authors and inventors. Often practitioners resign themselves to the fact and stop using formal methodologies, techniques and tools. This is regrettable because formalism and ontological knowledge of systems can make real contributions to practice. Teachers are aware that what they teach their learners in the classroom seems to lack relevance to actual practice in software development companies and in business organizations that develop and use IS. Yet the problem remains. Teaching knowledge

is fundamental to understand the vitally revolutionary phenomenon that IS and IT constitutes in the twenty-first-century organization.

To bridge the relevance gap between knowledge and practice it is possible to present knowledge to learners in a stimulating and interesting manner. A Personal Critical Framework (**PCF**) approach will incite learners, and practitioners, to think critically about how they internalize the taught knowledge and how they would put it into practice. The author's ten years of reflective teaching practice and innovations in pedagogy has resulted in an exciting way of teaching that appeals to learners. Taking a Holistic Approach to Learning and Teaching Interaction (Patel, 2003) can make the subject material interesting and relevant to learners' personal and professional development, and most importantly to their notions of the self and their appreciation of the role of knowledge in personal and working lives. The Holistic Approach has been shared with colleagues and nationally at conferences on learning and teaching. Learners and colleagues have applauded it, and learners are satisfied with their levels of performance and knowledge insights achieved.

In the Holistic Approach, learning and teaching interaction is defined as the social context in which a learner, who is seeking to improve the self, is taught specific discipline knowledge by a knowledgeable teacher whose aim is to disseminate discipline knowledge and improve the quality of life of the learner by developing him or her into a critical learner. The Holistic Approach seeks to develop critical, confident, and independent learners capable of action in their professions, and in society generally. The task of the holistic teacher is to enable critical learners to direct themselves and to devise ways of enabling learners to do that.

The purpose of the Holistic Approach is to develop critical thinking skills in learners and practitioners. Cognitive critical thinking skills are difficult to develop in a practical subject like systems analysis and design. The Holistic Approach makes use of PCF to enable learners to *relate* taught material to the actions they perform or would perform. The Holistic Approach, PCF and a **Critical Framework** for studying and analysing the taught material are combined to provide a set of cognitive tools for learners and teachers that engender critical thinking.

The pedagogy of this textbook is termed *critical learning* in which the learner is regarded as a *critical learner*. The traits of a critical learner are criticality, confidence, and independence. The critical learner is an individual who has to act eventually in real situations. Such purposeful *action* requires critical faculties that enable individuals to make decisions about the action, based on knowledge that they learn to assess for its validity in practice. Confidence is required to act. The holistic teacher's task is to provide such confidence by developing independent learners. This independent trait of the critical learner reflects that the individual is responsible for their action. A critical learner can only be independent if they are confident, and confidence only develops if learners are taught to be reflexive. This textbook introduces the development of a PCF as a device to structure knowledge and purposeful action that is based on critical *thought*. The development of a PCF and its critical evaluation can lead to confidence and independence in action.

As Barnett argues:

> The challenges facing the university in developing critique-in-action are, in part, concerned with the ontological questions of what it means to be a self in the world, and about the relationship of the self to the world of work.
>
> (Barnett, 1997: 129)

Barnett's comments have a resonance with the notion of *praxis*. Praxis is the art of acting in

given conditions in order to change them. It is precisely this kind of situation that systems analysts and developers of IS encounter. Action in existing situations with given conditions requires critical thinking. The Holistic Approach is intended to develop critical learners who will be capable of such critical praxis. It has been conceptualized as a result of the success of the author's teaching of IS with this approach and appreciative learners' favourable comments.

This textbook is aimed at postgraduate learners undertaking a Master of Science or Master of Business Administration degree. Its purpose is to develop critical learners capable of making judgements on how to use the existing knowledge on IS development in practical work. It can also be used at level three of undergraduate programmes. The traits of criticality, confidence, and independence of a critical learner enable an individual to act in real situations in relation to the discipline knowledge taught. The basis of the teaching approach is praxis – our body of knowledge arises from the very problems that we need to solve to make progress. Knowledge that arises from practice is in turn used to improve personal effectiveness. The discussion and examples in the text are from business IS, though the lessons apply to both government and healthcare IS and to systems development in general.

I am grateful to all my learners who have been exposed to my pedagogical approach to learning critically about IS and practice. They have been, and continue to be, learners on postgraduate programmes in IS and Systems Project Management. Many masters and MBA candidates have taken my modules on IS development. They encouraged me to continue using the Holistic Approach because of the benefits they have derived as practitioners. In particular, graduate trainees on a day-release company-based programme in Information Management have encouraged me to continue developing the approach. All my learners have contributed to my learning on how to teach an essentially problem-solving subject from a critical perspective, and I am pleased and gratified that I have been able to contribute to even highly experienced practitioners too:

> Nandish,
>
> May I just say that I enjoyed your lectures a great deal, having worked in IT for 30 years, I understood and appreciated what you were saying and also learned a lot, it was a lecture that I always looked forward to attending!
>
> Best regards

Acknowledgements

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Abbreviations

ASD	Agile Software Development
BPR	Business Process Re-engineering
CASE	Computer-Aided Software Engineering
CMM	Capability Maturity Model for software development
CoCoMo	Constructive Cost Model
COTS	Commercial-Off-The-Shelf Software
DBMS	Database Management System
ETHICS	Ethical and Technical Implementation of Computer Systems
IS	Information System
IT	Information Technology
JAD	Joint Application Development
JSD	Jackson Systems Development
JSP	Jackson Structured Programming
NCC	National Computing Centre
NIMSAD	Normative Information Model-Based Systems analysis and Design
OSS	Open Source Software
PCF	Personal Critical Framework
RAD	Rapid Application Development
SDLC	Systems Development Life Cycle
SPICE	Software Process Improvement and Capability Determinations
SSADM	Structured Systems Analysis and Design Methodology
SSM	Soft Systems Methodology
STRADIS	Structured Analysis, Design and Implementation of Information System
UML	Unified Modelling Language
XP	eXtreme Programming

Introduction

How to use the book

The aim of this book is to admit learners and practitioners into systems analysis and design. Admission into a subject is called *vishay prevasha* in the Indian Sanskrit language. It means to provide learners themselves with critical faculties for acquiring and developing knowledge in a discipline. The book is not a technically complete text on how to undertake systems analysis and design. Rather, only material sufficient to form the basis for developing criticality is introduced.

Criticality is explored in this textbook through: transformatory critique, refashioning of traditions, reflexive criticality and critical skills, after Barnett (1997). It is to be distinguished from the notion of simply being taught knowledge. The central theme of the textbook is the development of a PCF, either for learners or practitioners. Learners and practitioners can think critically about knowledge and personal action and develop personal constructs based on critical thought. The PCF is to be developed on the basis of critical understanding of knowledge and practice. It should form a set of related cognitive constructs derived through reflective study or reflective practical experience, or both. The value of a PCF is to anticipate or determine future action and, based on personal experience, it is to be continually revised. It serves to enable learners to develop individually methods for critical reflection on knowledge and practice.

The PCF and the Critical Knowledge and Practice Framework provide the lenses for critically studying systems analysis and design. They provide the critical focus. These frameworks serve to encourage learners and practitioners to reflect critically on the notion of systems, methods, techniques and tools and engender reflective and critical discussion aimed at the development of a PCF.

To develop a PCF each chapter serves three purposes. It presents sufficient material to begin thinking on a specific topic. The material is then related to the Critical Knowledge and Practice Framework designed to enable reflection. The PCF is then developed through questions, exercises, and activities on the basis of the reflective study of the material presented and other readings. This section in each chapter is on how the Critical Knowledge and Practice Framework can be used to develop the conceptual and praxis elements of a PCF. Systems analysis and design concepts and analysts' practice based on conceptual and technical knowledge need to be subjected to criticality. The section enables critical evaluation and development of professionalism. Analysts can assess its

value in individual and professional terms. In particular, they can consider the impact of knowledge on practice.

Student-centred learning

This textbook can be used in conjunction with the student-centred approach to learning and teaching. As with criticality, student-centred learning requires learners to take responsibility for learning, but it also requires them to be involved in its delivery. It reinforces the transfer of ownership of knowledge from the teacher to learners. It is particularly relevant to postgraduate learning and teaching, where it can draw on learners' experiential knowledge.

The Systems Development Life Cycle (SDLC) is introduced. Learners should be encouraged to do simple, uncomplicated exercises to familiarize themselves with the techniques, tools and methods. Readings of relevant research papers and cases then lead learners to recognize and question premises and assumptions made by the various approaches, SDLC, methodologies, techniques and tools. Questioning leads to the development of a critical perspective on the various problems in structured and object-oriented analyses. Learners can then be encouraged to think how improvements in knowledge and practice can be made in the light of the critical reflection.

Teachers' own seminar exercises, cases, research papers, and seminar discussions can be used to involve learners in the delivery. The teacher can introduce topics via a short interactive lecture and then facilitate seminar discussion. The discussion can be based on cases and research papers. Learners should be encouraged to lead discussions in small groups, which then report to the plenary. The plenary discussion itself will result in a synthesis of learners' contribution to the delivery.

After reading the Delphi Report's definition of critical thinking, self-examination and self-correction, learners should attempt the PCF development section in each chapter. Its purpose is to encourage critical reflection. It contains questions encouraging critical reflection, individual and group discussion exercises, and activities that lead to the development, and subsequent enhancement, of personal constructs. The PCF is thus progressively developed in each chapter.

As there are no right or wrong answers for a particular systems analysis problem no solutions are provided. The teacher can determine when to make use of the student-centred material and provide guidelines to learners on acceptable resolutions. References to research publications in the textbook are not reproduced but a full reference is provided in the further reading sections.

The teacher is encouraged to think of similar activities to those presented in the PCF development sections. Given the interpretive nature of many of the questions and activities in the PCF development sections no model answers are provided. Teachers should use their discretion to judge what constitutes an appropriate response by learners. The author is available to discuss the development of teachers' initiatives and learners' responses via the textbook's associated website.

Supporting web resources

Additional material on the holistic approach to teaching and learning is available at www.routledge.com/textbooks/0415332168. Teachers' activities in developing PCF are:

- Introduce concepts of systems analysis and design and present methods, techniques and tools.
- Use the Critical Framework to develop critical thinking. Relate real and practical

problems in applying systems analysis and design in the real world, and seek pragmatic resolution of the problems.
- Encourage learners to develop a PCF consisting of personal constructs. Personal constructs may be derived from practice or taught material, or from both sources. A PCF should include a list of problems and issues in systems analysis and design, compiled by individuals, groups or the teacher.
- Formulate questions designed to make learners think about clients, systemic problems, social factors, organizational problems, communications problems, knowledge gaps, and other problems and issues. Relate these to learners' PCF by using exercises, discussions and activities in the PCF development sections, thus progressively enhancing PCF.
- Develop their own activities for learners that encourage them to think of how to resolve practical problems in systems analysis and design, ranging from assumptions about organizations, people, IT and IS, covering conceptual deficiencies, difficulties with implementing techniques, and using tools in real contexts.
- Develop activities that encourage learners to relate their resolutions of practical problems to PCF development and to question the effectiveness of their resolutions in terms of the PCF.

Selective chapter readings

A chapter map is given in Figure 0.1. Excepting Part I, the remainder of the book is organized to reflect the phases of the SDLC. This does not justify the SDLC but recognizes the clear conceptual distinctions prevalent in research and practice.

Chapters in Part I are essential reading because they provide the foundation for developing skills in critical thinking and the development of a PCF. Once the notions of a PCF and the Critical Framework are understood, other chapters may be read as required. The selective reading of other chapters can then lead to the development of certain elements of a PCF. Teachers are encouraged to read the supplementary account of the Holistic Approach, available at www.routledge.com/textbooks/0415332168 because it explains the pedagogy underpinning the approach to learning and teaching adopted in this book.

Chapter 1 explains the PAC cycle. Teachers and learners should read it. It details the components of a PCF and discusses how it should be developed. It relates a PCF to action and discusses the development of critical selves through action.

Chapter 2 explains the Critical Framework. Teachers and learners should read it. It details the components of the Critical Framework and explains how to apply them to study critically topics in systems analysis and design. The Critical Framework is a set of constructs to enable criticality.

Part II covers conceptual foundations, project management and systems analysts. A reading of the chapters will develop the intellectual and conceptual elements of a PCF. This coverage is required because criticality assumes conceptual understanding and argument.

Chapter 3 introduces fundamental concepts and discusses their effect on analysts' actions. The SDLC, structured and object-oriented systems analysis and design, and methodologies are covered. A reading of this chapter will lead to the development of fundamental and essential personal constructs in analysis and design for a PCF.

Chapter 4 examines systems project management. It covers how an IS is selected for development, formulating a business case for its development, and project management

issues and techniques. Project management as planned action is elaborated. A reading of this chapter will provide the basis for developing reflexive critical thinking and critical skills, and enhancement of the elements in a PCF.

Chapter 5 discusses the role of systems analysts. The qualities and skills required, their tasks, and the techniques and tools available to them are covered. The working relationship between systems analysts and stakeholders and developers is discussed. A reading of this chapter will enable systems analysts to think critically of 'the self', and contribute to considering all the elements in a PCF.

Part III focuses on systems analysis. A reading of the chapters will enable a critical consideration of the instrument elements of PCF. These chapters are included because the development of reflexive criticality and critical skills assumes familiarity with the instruments of practice.

Chapter 6 explains the importance of understanding and developing knowledge of what a new IS is required to do, or system requirements. Structured and object-oriented techniques and alternatives are presented and critically discussed. Chapter 7 introduces structured data modelling techniques. It focuses on logical data modelling, entities, relationships, normalization and documentation. Chapter 8 introduces structured process modelling, covering data flow diagrams and business logic modelling techniques. It also details SSADM technical products. Chapter 9 introduces object-oriented analysis, covering object modelling and UML diagrams.

Part IV focuses on systems design. A reading of the chapters in this part will enable a critical consideration of the design instrumental elements of a PCF. Similar to the previous part, the chapters in this part contribute to reflexive criticality and critical skills.

Chapter 10 examines user interface, input and output design. Chapter 11 considers system and data design, and covers change management because of its importance in introducing IS in an organization. A reading of these chapters will enable an appreciation of the system level design issues and contribute to the personal constructs and instrument elements of PCF.

Part V relates the social context of systems analysis and design. It develops a critical perspective through critical reflection of the previous chapters and paradigmatic analysis. A reading of the chapters in this part will enable critical consideration of the intellectual and conceptual elements of PCF. The development of transformatory critique and the possibility of refashioning traditions assume knowledge of what constitutes knowledge and how it is acquired.

Chapter 12 considers social theory, organizational and political factors that are not covered in structured and object-oriented analyses. Chapter 13 is a critical reflection of the previous chapters in terms of human and organizational factors. A reading of these chapters will contribute significantly to the ethics, assumptions of reality, personal constructs and instrument elements of PCF.

Chapter 14 synthesizes knowledge and action to deepen the knowledge element and enable reflection on praxis in PCF. It considers criticality in terms of refashioning traditions. It provides a paradigmatic analysis of alternative and emerging knowledge on systems analysis and design. A reading of this chapter will contribute to acquiring knowledge of assumptions of reality, personal constructs and instrument elements of PCF.

Chapter 15 takes a future-oriented perspective. A reading of this chapter will provide knowledge of how emerging approaches are making paradigmatic shifts to make systems analysis and design inclusive of social and organizational factors. It gives brief accounts of new

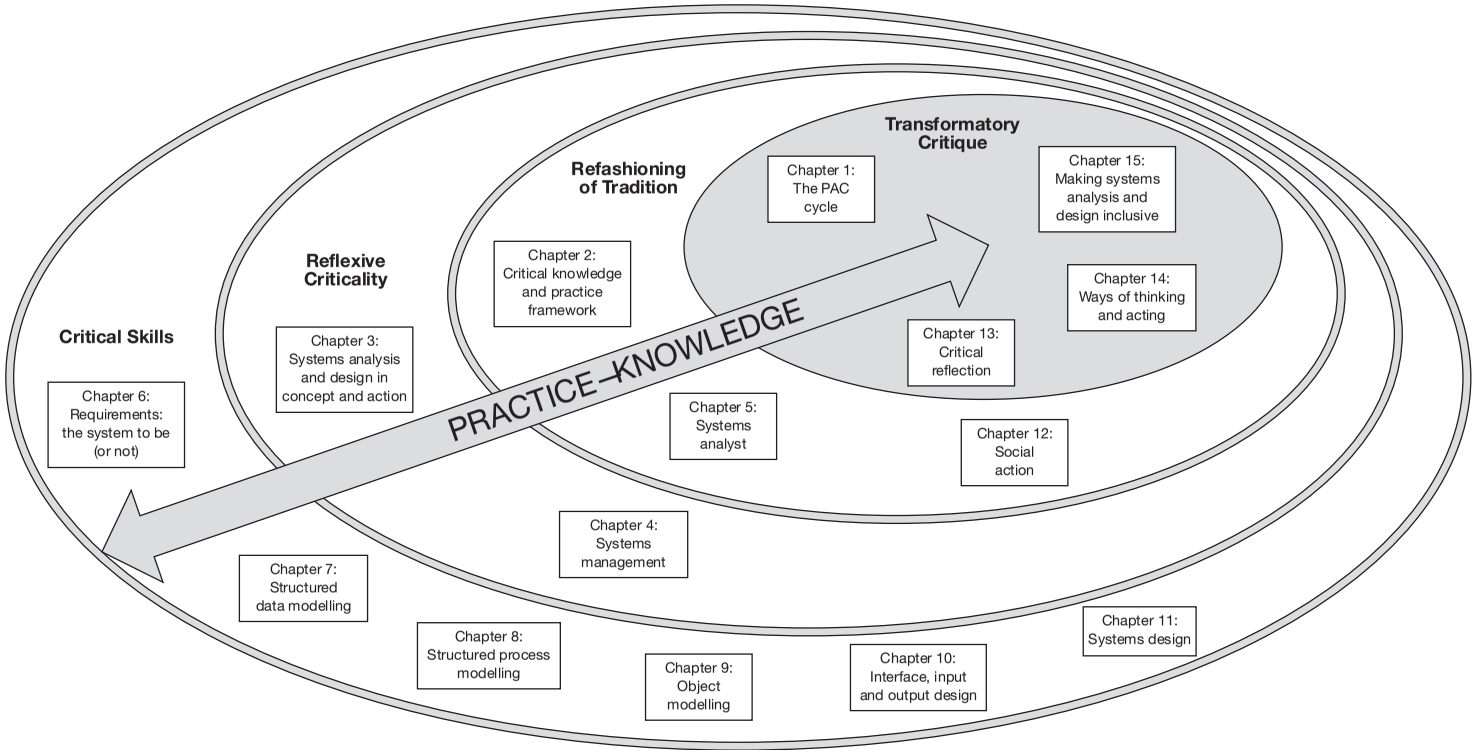

Figure 0.1 Chapter map in the context of criticality

and emerging approaches. Since a PCF is designed to facilitate how learners and practitioners anticipate action, this chapter is important for anticipating future developments in knowledge and practice of systems analysis and design.

Each chapter has a section for the development of a PCF. It contains activities, questions, and tasks that will help to objectify and define personal constructs related to the three major themes and six sub-themes of the Critical Framework. They will help start thinking on a PCF. It can be used to evaluate personal constructs related to knowledge and practice for inclusion into a PCF. Where the questions or activities require reference to an organization, it may be the university where you study or the company where you work. Some activities are alternatives and so do not need to be repeated, though using alternative methods to objectify a PCF can lead to more clarity. For all the activities in the PCF development in each chapter refer to the illustrative PCF in section 1.7 and use the Delphi Report cognitive skills given in Table 1.4 in section 1.8.1.

The Critical Framework figures in each chapter contain much critical information. It is not all discussed or commented upon but selectively addressed. Teachers, learners, and practitioners should study each figure and investigate and critically discuss the points relevant to their interests. The pragmatic resolution component is left with question marks in some chapters to prompt learners to think about their own solutions to the problems depicted.

The chapters are mapped in Figure 0.1 in the context of the critical themes explored. Each concentric circle names the type of criticality covered in the relevant chapters placed in the relevant concentric circle. In accordance with the purpose of this textbook, the chapters are evenly distributed around the themes of transformatory critique and refashioning of traditions for critiques of knowledge, and reflexivity and critical skills for critiques of praxis.

The placing of the chapters within the critical themes is not exact. For instance, all the chapters contain a PCF development section that spans all the critical themes. Chapter 5 on systems analysts should actually be rooted in the core transformatory critique and stretch out through refashioning of traditions and reflexivity to the development of critical skills in the discipline knowledge.

The 'practice–knowledge' bi-directional arrow indicates that praxis is informed by knowledge and that knowledge is informed by praxis. Deep transformatory critique, the inner concentric circle, can have radical effects on practice, the outer concentric circle. Deep critical skills, the outer concentric circle, can have radical effects on knowledge, the inner concentric circle. In the outward direction, transformatory critique and refashioning of traditions in knowledge inform practice, and in the inward direction critical skills and reflexivity in practice inform knowledge.

Learning outcomes

The outcomes of working through the chapters should be critically aware learners and reflexive practitioners. They will be able to:

- Appreciate transformatory critique, refashioning of traditions, reflexive criticality and critical skills as kinds of criticality of knowledge and practice.
- Develop cognitive critical skills in interpretation, analysis, evaluation, inference, explanation and self-regulation.
- Deploy the Critical Framework to identify, question, and critically think of premises and assumptions in systems ontology – structured and object-oriented analyses and design, and other approaches.

- Apply cognitive critical skills to develop, amend and revise continually a PCF.
- Deploy the Critical Framework to consider critically the application of methods, techniques, and tools in real situations and develop pragmatic resolution for practical application problems.

These learning outcomes will lead to the development of a PCF underpinned by critical thinking and criticality of knowledge and practice. They specify the prerequisite cognitive skills required to develop critical thinking and seek to develop deeper and different kinds of criticality.

Part I

Foundations for critical learning and teaching

Part I provides the foundational development for a PCF perspective. It is the pedagogical basis for developing criticality. The contents of a PCF determine how it is used to anticipate action, and how critical thinking is applied to studied and experiential knowledge. This is called the PAC cycle and it is elaborated in Chapters 1 and 2. The PAC cycle enables the structuring of critical thought.

Criticality is only possible if a suitable framework for analysis and evaluation is devised. Criticality requires a critical lens through which systems analysis and design can be examined. Chapter 2 sets out such a Critical Framework used throughout the textbook. In it systems analysis and design is interpreted as human action that can be improved through critical thought. The framework suggests cognitive processes for acquiring, understanding, and assimilating knowledge and its application. It is the requisite lens for developing critical thought and also the basis for insights into how to develop and sustain a PCF for personal effectiveness.

The value of a PCF is its criticality. It is the critical consideration of systems analysis and design and subsequent inclusion in PCF that provides substance. Chapter 2 also explains what a PCF is, how to develop one, and why a PCF is necessary for improving understanding and practice. The question of how to understand something, and assimilate it into a PCF, is addressed in terms of personal cognition and personal constructs.

Chapter 1

The PAC cycle

1.1 Learning outcomes

To engage in the PAC cycle, after completing this chapter you should be able to:

- Develop, revise and amend a PCF based on criticality.
- Apply critical cognitive skills to a PCF.
- Relate a PCF to personal action and effectiveness.
- Interpret formal and practical knowledge in terms of transformatory critique, refashioning of traditions, reflexive practice and critical skills.

1.2 Introduction

Critical systems ontology is the interpretation, analysis, evaluation, inference, explanation, questioning and critical study of systems. It is the notion that current ontological knowledge of systems can be improved, and that it can be 'other than it is' to be practically effective. It is enabled through a **P**ersonal Critical Framework, **A**ction, and **C**riticality or the PAC cycle. The PAC cycle is proposed as a method for systems analysts to develop criticality and critical thought. It is termed a 'cycle' because criticality is a continuous activity. Practitioners need to develop the habit of reflecting on what they do, how they do it, and crucially, why they do it in order to improve practice. These are the preconditions for developing criticality, and require cognitive skills in interpretation, analysis, evaluation, inference, explanation and self-regulation. Learners too need to develop these cognitive skills. They can benefit from learning to reflect on knowledge and develop deeper understanding of systems analysis, systems design, its techniques, **tools** and methods.

The PAC cycle is illustrated in Figure 1.1. Readers are encouraged to develop a PCF marked as (1) in the figure, enactment of the PCF (2), and reflect critically on the effect of the enactment on achieving desired aims (3). A PCF is a qualitative approach to knowledge formation in which **personal constructs** are unique to an individual. The cycle is completed when criticality leads to the revision or amendment of personal constructs and the PCF.

An initial PCF can be formed either through critical study or reflective practice. It is composed of personal constructs on systems analysis and design and the relations between them that

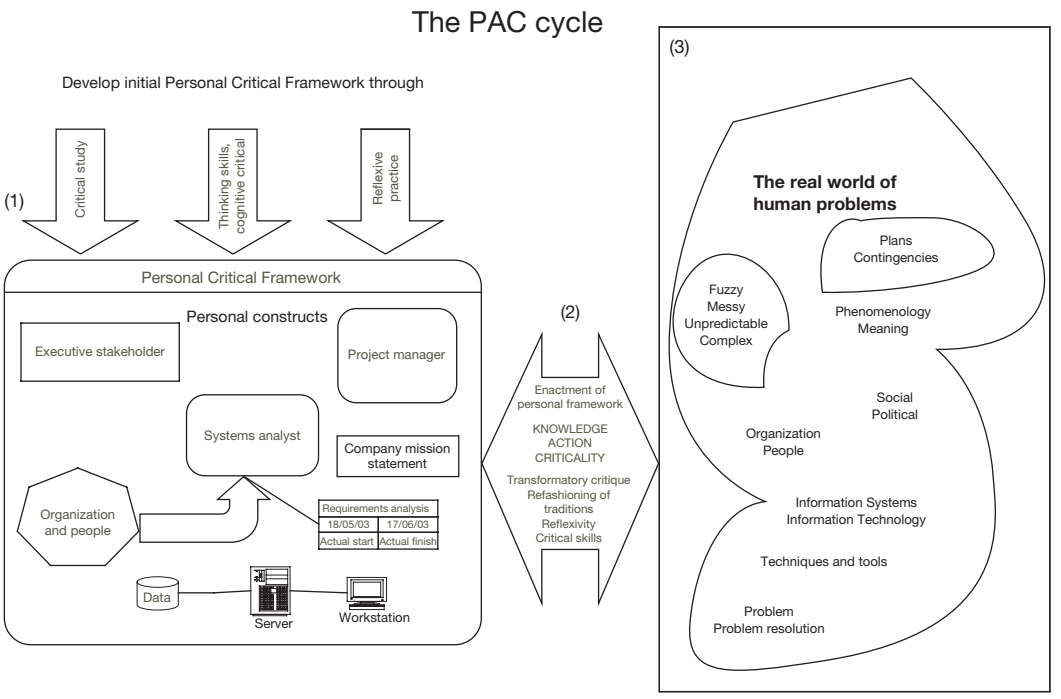

Figure 1.1 The PAC cycle

a systems analyst deems relevant to *anticipate reality*. It is this focus on anticipating reality that makes a PCF relevant for analysts because the development of an IS is such an anticipation of reality. Systems analysis and design is practical and the analysts' actions shape actual IS. The PCF is then enacted in actual IS development situations. The analyst critically considers the effects of the actions in the actual situation to enhance or revise the PCF. The process of forming personal constructs, using them to anticipate events, and revising them is continuous.

The PAC cycle is a cognitive device to assess and improve personal effectiveness and success. Personal effectiveness is the basis for developing professionalism. Assessing personal effectiveness itself requires an objectified process. Objectification is the basis for improving knowledge and understanding practice. Objectified experiential and learnt knowledge is an important part of the PAC cycle. It is necessary for the development of personal constructs and a PCF, reflection on ones actions to develop knowledge further, and the application of criticality to a PCF.

1.3 Personal Critical Framework

A PCF is a significant element of knowledge and professional development. It brings training and education in systems analysis and design together on the basis of the self and the self's need for knowledge to anticipate experience. A framework is: 'typically a mixture of pre-suppositions of correctness, of what is valuable, and of validity. The framework is not purely cognitive; it is not even mainly cognitive. It is invested with values, emotion, commitment, and professional and social identity' (Barnett, 1997).

A PCF is an objectified tool for critical reflection on the self, knowledge, and practice, and it is open to revision, amendment and update. While training in systems analysis and design leads to specific and prescribed behaviour, education results in an awareness of the processes that lead to acquiring knowledge, and cognitive and practical skills. Education engenders personal reflection on these processes.

The practice-orientation of systems analysis and design requires learners themselves to discover ownership of knowledge. Generating ownership is the major aim of a PCF. As individuals have selves, the self is central in the development of a PCF. It is vital for making learning and knowledge relevant and meaningful. Knowledge is gathered and interpreted by the self. Learning that is divorced from the self usually lacks relevance when action is required.

A PCF enables criticality in systems analysis and design. An analyst develops a PCF to improve understanding of knowledge and practice. Its purpose is to improve the self through knowledge and individual action. Knowledge that is devoid of the self creates a vacuity. The self provides ownership and responsibility. In the absence of the self, learnt or experiential knowledge lacks meaning. Such insipid knowledge then bares no relation to actual practice.

1.3.1 Objectifying a Personal Critical Framework

Objectification results in reflection on how knowledge is acquired and used by the self in practice. The process of objectifying knowledge to develop a PCF requires making personal constructs explicit on what constitutes knowledge, how it is acquired, and how it is accepted as valid. Cognitive skills are needed to objectify a PCF and for critically evaluating objectified knowledge. Interpretation, analysis, evaluation, inference, explanation and self-regulation propounded by the Delphi Report (Facione, 1990) serve as requisite cognitive skills to develop a PCF and engage in the PAC cycle.

Objectifying personal knowledge is initially difficult, especially for practitioners immersed in practice. Difficulties in objectifying a PCF arise because of unfamiliarity with reflection. The process of objectifying personal constructs and the relationships between them includes action, reflection, writing, diagramming and discussion. An individual can begin to identify personal constructs through these activities. Objectification may be individual and then discussed with a mentor or trusted colleague, or it may be done in a group. Objectified personal constructs and their relations can then form the foundation for a PCF.

Action Practice is the deployment of knowledge to achieve specific goals. It results in experiential knowledge. Analysts gather and use relevant knowledge for practice. For example, an analyst acquires knowledge of techniques to use to determine system requirements for a new IS. Chosen techniques will be enacted to analyse system requirements.

Reflection Reflection is the process of critical thinking on practice to improve professionalism, and the self. Analysts evaluate and critically assess practice to determine its effectiveness. Practice is scrutinized to understand what was done, how it was done, and whether it achieved predetermined objectives. For example, an analyst reflecting on the effectiveness of interviewing **clients** for functional requirements may assess how the interview was conducted and whether it was suitable for establishing functional requirements.

Writing Making a record or writing is a method for externalizing knowledge and experience. It can be recorded as notes or critical evaluations of practice. For instance, an analyst reflecting on a project to develop a decision support system can record personal activities in

the project. The objectified writing can serve as a record for critical analysis of practice and its effectiveness.

Diagramming Drawing diagrams is a method for making a graphical representation of knowledge, concepts, techniques and activities. A diagram provides an overall perspective on knowledge and action. The objectified diagram can be used to further reflect on practice and how to make it more effective.

Discussion The reflection, written records and diagrams can be discussed with trusted colleagues or teachers. They constitute objectified material for further critical understanding of practice through other peoples' perspectives. Other peoples' perspectives help to critically assess, question and evaluate practice and knowledge.

1.3.2 Knowledge and practice elements

A PCF has knowledge and practice elements. Knowledge and practice is conceptually demarcated in the PCF but in practice they can be accumulated separately or jointly. A learner with no practical experience will initially accumulate only knowledge. A practitioner can accumulate knowledge through practical experience and contribute to the development of practice simultaneously.

The knowledge element is required to understand theory and relate it to practice. Theory is an account or explanation of observed phenomena. A theoretical explanation improves understanding, provides explanatory knowledge and informs practice. It consists of ideas that explain the nature of something, its causes that made it possible and how it functions.

It is difficult to find theory in systems analysis and design, but there are paradigms of thinking and acting that seek to explain systems analysis and design, and how it should be performed. Such knowledge is accumulated through formal learning or from practical experience. Such paradigms can contribute to personal explanations of why and how things work. On a personal level a paradigm consists of objectified ideas, concepts, techniques and methods that form personal understanding of systems analysis and design. Theoretical and paradigmatic understanding can be used to enhance and improve personal constructs or redefine relations between elements in a PCF.

Praxis is the practical side of a discipline or profession and it provides practical knowledge. Practice can be conducted in the absence of clear knowledge or understanding of the reasons for acting in a particular manner. It can benefit from clear explanations for acting in a particular manner. Reflexive praxis or reflexive practice can lead to practical knowledge based on critical thinking. Analysts who reflect critically on practice and knowledge can revise and amend personal constructs accordingly. Reflexive practice can be combined with theoretical or paradigmatic explanations to develop deeper knowledge and understanding.

Professionalism, though, needs to combine the knowledge and practice elements in a PCF. Objectifying knowledge and practice personal constructs can improve understanding of practice. Practice can be developed with clear explanations for acting in a particular manner. Most practitioners are content doing their work and do not attempt to explain or understand what underpins practice. A practitioner may find that object modelling does not work well but be unable to explain why it does not work in practice. Reflexive practice can help to explain the method's shortcomings by understanding **systems ontology**. An analyst may be trained to elicit system requirements using structured techniques and may unquestioningly deploy them. The analyst's understanding of the effectiveness of the techniques would improve with knowledge of assumptions made

about actual situations, explanation for conducting requirements in the first place, and why structured techniques should be used.

Learners especially need to develop the practice element of a PCF. They are best placed to benefit from the knowledge element and use it to consider how they might act in actual situations. They can be encouraged to develop practice personal constructs through scenarios or cases to determine how they would act. A learner's initial PCF can be used as a guide to praxis when they begin practice, which should be revised subsequently on the basis of reflexive practice.

1.4 Personal effectiveness through a Personal Critical Framework

A PCF is useful for determining the success or effectiveness of practice. The achievement of an objective is a practical measure of success. A PCF can be used to improve personal effectiveness and to determine, through critical reflection, which personal constructs and relations lead to effective practice. It enables practitioners to know how to do things better and learners to understand the reasons for particular action. It can be used to:

- decide how to act in actual situations;
- determine knowledge and critical areas for its improvement;
- explore strengths, develop them further, and exploit them;
- identify weaknesses and take action to improve them.

An objectified PCF can improve the effectiveness of practice. It can be used to determine the efficacy of one's action. It can be the basis for critically reflecting on and understanding one's action, resulting in some personal constructs being revised, others replaced, or new ones introduced.

1.4.1 Reinforcing and stopping action

A PCF can be used to explain why certain actions should be repeated and why others should be stopped. Action that leads to success can obviously be repeated. An explanation of why it is successful can be deduced from a PCF. The explanation will enhance knowledge of practice and deepen understanding. For example, when a method or technique works well in practice it is beneficial to know and understand why and how it works. Developing an understanding of how it works in theory can provide deeper knowledge of its value in practice.

Practice that results in lack of desired levels of success or even failure needs to be stopped. The problems with personal constructs can be identified and amended or entire personal constructs replaced. Simply stopping the action will not improve knowledge or practice. It is vital for professional development to know why certain actions should not be repeated. Stopping action without understanding the reasons for failure may lead to future similar failures.

Explaining practice is important for developing a PCF that contains relevant personal constructs. Actual practice consists of implicit or explicit rules, procedures and assumptions of which a practitioner may not be cognizant. Explaining successful practice will objectify them and develop knowledge that will contribute to better understanding of practice.

Practice of systems analysis and design is an important source for developing criticality. Reflecting on learnt knowledge and practice is important, but reflecting critically adds value. The relation between a PCF and practice is processual and interpretive rather than static and prescriptive. An analyst constructs a PCF processually, as they engage in actual situations. Taking action on the basis of a PCF will either lead to success or not. Successful action should reinforce a PCF and unsuccessful action should lead to revisions.

1.4.2 Understanding human action

Analysts' action underpin PCF development. Objectification of personal constructs related to human action in a PCF, and its use to reflect on action, can improve effectiveness. The utility of knowledge for particular action determines the level of success achievable. Effective action is determined by knowledge of how to act. To understand human action and its effectiveness, researchers and practitioners probe questions concerning the combination of knowledge and practice that leads to effective action and how effectiveness can be improved.

There are two significant strands of research that develop knowledge of human action: **planned action** and **situated action**. Planned action is based on human rationality and its capability for achieving desired objectives. It is closely linked to developments in scientific knowledge and the scientific method. A plan epitomizes human action as rational action (Simon, 1957). A plan is an instrument for achieving desired aims and it explicates activities, rules and procedures to achieve objectives. It assumes that it is possible to control events in actual situations.

Planned action is crystallized as 'methodology' in IS development. An IS development methodology is a detailed plan of how to develop IS. It prescribes systems analysis and design activities for analysts, project managers, and software programmers. Systems project management too epitomizes the planned management of IS development. Systems analysis and design methods and techniques are similarly based on planned action. A plan prescribes actions but is incapable of dealing with anomalies not accounted for in the plan in the real situation. Individuals and groups need to respond to the situations they encounter not accounted for in plans. It is proposed here that they do so as situated action in context.

Situated action is human intention and action informed by context and utilizes embodied skills (Suchman, 1994). It is characterized as the setting of objectives and seeking to achieve them. The process of achieving objectives and the actions taken, depend on and are determined by the context and situational factors.

Situated action has had no influence on systems analysis and design, but analysts need to be aware of it when objectifying personal constructs. Situated action raises questions concerning structured and object-oriented systems ontology. If the ontological assumptions underpinning situated action are valid, then action that is informed by context and utilizes embodied skills, logically cannot be extracted from its context, as required in structured and object-oriented systems ontology. Systems ontology needs to account for such action. Analysts need to be aware of situated action when developing personal constructs, and when resolving systems modelling problems pragmatically. Recent developments in Agile Software Development (**ASD**) seem to be taking account of situated action.

1.5 Components of Personal Critical Frameworks

A PCF should include the knowledge and practice elements detailed above, and the five essential components explained in this section. They are required to ensure that a PCF reflects the knowledge and practice elements. The five components are: ethics, assumptions of reality, personal constructs, instruments, and relations between components. Other components specific to individuals or **organizations** may also be included. For example, an analyst working for a charitable organization may want to include morality as a component, or one

working for the government may want to include public service as a component.

1.5.1 Ethics

Ethics is the values component of a PCF. Ethical practice is concerned with making judgements concerning right and wrong behaviour. The purpose of professionalism is to achieve formal objectives, but professionalism that is void of ethical practice often leads to undesirable, illegal, and even immoral practice. Professional bodies in computing and IS provide an ethical code for their members.

IS change the way people work and affect peoples' working lives. Analysts' systems design decisions bind people into working in certain ways, for instance they determine whether people have rewarding working relations. Such design decisions are particularly sensitive in organizations that deal with human healthcare. Researchers have considered the effect of analysts' design decisions on people. The Ethical and Technical Implementation of Computer Systems (**ETHICS**) methodology was developed to encourage ethical behaviour. The British Computing Society have specialist interest groups on ethics. Its Ethics Expert Panel: 'is responsible for providing advice and guidance on ethical issues associated with the development, operation and use of computerised Information Systems (IS).'

The Panel is linked to the International Federation of Information Processing (IFIP) interest group on ethics. IFIP ensures that clients are assured of the professional standard of work of IS professionals. It seeks to provide a code of ethics that: 'acknowledges the professional responsibilities of practitioners to society at large, members of the public, employers, contracting parties and fellow practitioners'.

Analysts need to ethicize personal action and objectify a personal code of ethical behaviour. Analysts' systems design decisions will affect the aims of the organization and the people working in it. Potentially compromised design decisions need to be ethically resolved. They have conflicting demands on them that need to be resolved ethically. These include:

- The tension between thinking in technical terms to comply with the constraints of IT and the needs of the organization and people.
- Potential conflict of interests of paymasters with personal ethics.
- Client contact that may compromise personal ethics and professionalism.
- Behaving as qualified experts who have knowledge of designing IS.

1.5.2 Assumptions of reality

Analysts' assumptions of actual situations they work in constitute the ontological component of a PCF. **Ontology** is knowledge of the nature of a thing, for example organization, people, IS and IT. Such knowledge is based on assumptions, which will be reflected in analysts' personal constructs of these things, and underpin personal practice. As a PCF consists of personal constructs of reality, practitioners and learners need to objectify personal assumptions of reality – which include ideas, notions, concepts and expected behaviours – and relate them to personal constructs.

Analysts make assumptions about organization and people and combine them with actual knowledge to enable practice. As it is not possible for analysts to know the nature of something in its totality, any action will be underpinned by assumptions and the expected effect of the action. Objectifying and understanding these assumptions and expectations results in better knowledge and effective practice. Ironically, assumptions that underpin practice form the practical basis of a PCF.