# Planning for physical performance: the individual perspective

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## Planning, periodization, prediction, and why the future ain't what it used to be!

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CHAPTER CONTENTS



## Introduction

The aim of this chapter is to provide an appreciation of critical factors that influence physical preparation planning within performance environments. Surprisingly, perhaps, a meaningful analysis of this topic requires much more than simply a review of the existing training science literature. It also goes without saying that it is beyond the scope of a single chapter to delve into every crack and corner of such an expansive topic. Nevertheless, we will cover a lot of ground, much of which is previously uncharted within performance science domains, in an attempt to understand the origins and veracity of the methods in common use and, perhaps, how things may be improved.

The objective of the physical preparation plan is to guide the performer towards a state of optimal performance readiness at a specified future date. As such, the preparation plan may essentially be considered an exercise in stress management. As noted by Canadian endocrinologist Hans Selye, the pre-eminent early researcher on the biological effects of stress: 'The goal is certainly not to avoid stress; stress is a part of life. But in order to express yourself fully you must find your optimum stress level and then use your adaptation energy at a rate and in a direction adjusted to the innate structure of your mind and body' (Selye 1956).

In such terms, the planner's quest is to ascertain the *optimum stress level* and impose training stress in both the *magnitude* and *direction* that maximally benefits target performance.


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The principle of progressive overload has long been regarded as a fundamental principle of physical preparation planning. From the fable of Milo of Crete's daily squatting of the growing bull calf (lifting the calf every day as it grew heavier gradually made him stronger!), to modern undulating load designs, the critical challenge of preparation planning has been to impose a manageable, progressively challenging stress that elicits optimum positive adaptation. Should imposed training stress be insufficient, optimum adaptation will not occur; alternatively, if stress is excessive then some form of negative adaptation will result. Error within the physical preparation process may be costly. Injury, burnout, disillusionment and failure to realize potential are the likely consequences of an incorrect blending of the various preparation ingredients. Accordingly, preparation plans are a key factor in shaping the destinies and future successes of performers, from the competitive sportsperson to the aspiring ballerina, to the adventurer negotiating a hostile terrain. Reflecting this importance, planners within the realm of physical performance pursuits bear a significant, and at times onerous, responsibility.

Each performance pursuit responds to its own unique set of physical demands, challenges and peculiarities with a tailored set of planning solutions. However, it is also true that there are many aspects of planning custom that are common across the spectrum of physical performance activities: universally shared philosophies, beliefs, traditions and practices. It is these all-pervasive planning commonalities, these collectively shared aspects of planning practice that will be scrutinized and reviewed within this chapter.

We will show evidence that conventional planning approaches owe as much to innate aspects of human psychology and societal planning convention as to physiological training science. Accordingly, this chapter is as relevant to the performance psychologist seeking insight into the biological underpinnings of training planning as it is to the coach, exercise physiologist, conditioning specialist or support team member seeking to understand the psychological forces that have helped shape cultural preparation planning conventions.

The structure of our discussion progresses through four logically consecutive steps:

- A status check on current theory and practice; where we are and how we got here?
- Is there a planning problem? How do we know?
- Why is preparation planning so difficult?
- What can we do?

## A status check on current theory and practice: where we are and how we got here?

The published training planning literature emanates predominantly from sport and strength training domains where the universally pervasive planning template is referred to as the periodization of training. As periodization is the only documented, formalized training planning approach, it is worth taking some time to explore both its origins and its basic tenets.

In a series of scholarly works in the 1960s and 1970s, the Soviet training theorist Matveyev described a method of training planning based upon the experiential and scientific knowledge of the time. Matveyev's landmark Russian publication, *Fundamentals of Sports Training*, published in 1977, followed by an English translation in 1981, became the first extensive encapsulation of training planning theory. Matveyev's original work was not widely read in the West. In fact, the cumbersome nature of the English translation makes it quite difficult to discern precisely what is being discussed. What consequently emerged was a collection of various interpretations, based around a couple of core concepts.

### What is periodization?

The periodization approach organizes all training in terms of several basic structural units. These are the training session, the microcycle, the mesocycle, the macrocycle, the Olympic (or quadrennial) cycle and the multiyear cycle (Siff 2000). The training plan is consequently represented as the sum of the microcycles aligned in a sequential chain. A specified number of microcycles form a mesocycle, and in turn a specified number of mesocycles form the macrocycle. This structure is described in Box 10.1. Prior to key events there is commonly a planned reduction in training, termed the taper, intended to allow for dissipation of residual fatigue and optimization of performance readiness. So, for example, track and field athletes will attempt to peak for Olympics, team players for important phases of a season, climbers for specific routes, adventurers for expeditions and dancers for an audition or tour.

## Box 10.1

### Periodization definitions

- **Microcycle**: Shortest sequence of training and recovery days before unit is repeated. Typically between 4 and 10 days.
- **Mesocycle**: A sequence of similarly focused repeated microcycles. Typically 3–8 weeks in duration.
- **Macrocycle**: The overall training period. Typically 6 months to 4 years, dependent on the time-frame of long-term training objectives.

The cornerstones of the traditional periodization model are essentially twofold:

1. Training periods are arranged in a predetermined sequential order so that capacities (e.g. strength or aerobic capacity) developed in preceding periods will enable the development of capacities (e.g. power or anaerobic capacity) in future periods.
2. The preplanned manipulation of training volumes and intensities to realize specific, phasic conditioning goals (e.g. build strength in this phase, develop muscular power in the next).

Classically, this planning template was envisioned as a reduction in training volume accompanied by an associated increase in training intensity as the competitive peak approached. In recent years, however, novel and inventive derivations of the original high-volume/low-intensity to low-volume/high-intensity model have been proposed: more on this later.

Periodization principles have received widespread support in the literature. To illustrate, consider the following sampled snippets from respected planning theorists. Periodization is perceived as 'a logical and phasic method of manipulating training variables to increase the potential for achieving specific performance goals' (Stone 1996), and to provide training planners with a 'methodical, scientific procedure to help athletes achieve high levels of training and performance' (Bompa 1999). Furthermore, 'the development of a precisely controlled training programme is necessary in order to assure that the maximal sports performance is attained at the right moment of the season' (Mujika 1998). Consider the phraseology employed: logical, precisely controlled, productive manipulation, methodical scientific procedure. This is what periodization offers; a rational, scientifically justified planning model that meticulously guides and controls the preparation process. There is an enticing intuitive appeal to such reasoning. The perceived worth of the periodization concept was further promoted by the contemporary success of Eastern Bloc athletes, (periodization frequently being referred to as a Soviet training secret). As a consequence, and in the absence of any significant competing theories, periodization entered the lore of physical performance cultures as the pre-eminent training planning model for physical performance.

It must be noted here that Matveyev was certainly not solely responsible for formulating the periodized training approach. Within the general sports training literature there have been a number of influential, predominantly ex-Soviet, theorists who have published widely, and frequently argued widely, on the topic. Furthermore, most performance pursuits have influential practitioners who have shaped philosophies within that domain. So for example, endurance running culture has been heavily influenced by planning methodologies employed by legendary coaches such as Jack Daniels and Arthur Lydiard. However, regardless of the individual twists and quirks advocated by individual practitioners, the underpinning planning rationale is remarkable consistent. Why? Essentially because they share a common planning ancestor.

## The historical context

So, what is this common heritage? Consider the similarities between periodization philosophy and the industrial and political planning approaches of the early-to-mid 20th century; for example, the stylized mechanistic planning approach typified by the works of industrial theorists such as Henry Gantt and Frederick Winslow Taylor. In particular, Taylor's influential work *The Principles of Scientific Management* applied strict scientific principle to the management of the production industry. Taylor combined the scientific knowledge of the day, his pioneering 'time and motion' studies and what is best termed contemporary management's prejudice towards workers ('all we want of them is to obey the orders we give them') to construct the first great planning paradigm of the modern era.

Taylor believed that there was a 'one best way' to organize, manage and plan: that optimal practices were deterministic in nature. In other words, once optimal practices were uncovered, they remained stable and did not change. Hence, once the 'best' plan is formulated, all that's required is for it to be repeatedly implemented. Taylor therefore believed in the strict segregation of plan and process. Step one, formulate the plan; step two, execute the plan. Henry Ford readily embraced the principles of this classical perspective, to the extent that this approach was frequently referred to as Fordism. Scientific management precepts were famously endorsed by Lenin and Stalin and are considered by historians to have been a formative influence on the Soviet Five-Year Plans of the 1920s and 1930s.

A concern with this approach is that it is based on a number of simplifying assumptions:

- Control of a limited number of factors controls the behaviour of the system
- Progress is determined through measurement and quantification
- Factors that are measurable are of greater importance than those that are not readily measurable.

Now, the problem with this set of assumptions is that 'what can be measured' and 'what's important' become confused (see the Introduction to this book). Peripheral factors that are easily measured can assume ill-deservedly elevated hierarchical positions. Conversely, critical factors that are not readily quantifiable tend to occupy a planning blind spot and may be largely ignored. This presents a significant theoretical weakness. For example, consider the gross inefficiencies of the Soviet Five-Year Plans and China's Great Leap Forwards – all the hyperbole of strong leadership, a firm direction, a motivated population, simple, straightforward objectives. True, some objectives were achieved, but not at an acceptable cost considering the human collateral damage. Is this an example of good planning with laudable firm resolve or a grossly oversimplified interpretation of reality bordering on criminal negligence?

The purpose of this diversion is to highlight the fact that the early training planners were heavily influenced by this historical planning template. So in essence, when the Soviet training theorists sought to construct training planning templates, they combined the cultural planning blueprint (as per Taylor and the philosophy of the Five-Year Plans) with training records and contemporary scientific knowledge. For example, the historically influential Matveyev collated training data from the 1950s and 1960s, in swimming, running and weightlifting, and applied these records to the pervasive mechanistic planning blueprint. Thus the original periodized concept was a reincarnation of the industrial planning template, with the same strengths, weaknesses and assumptions.

In industrial and political planning domains, the inefficiencies of such regimented approaches gradually became apparent. Today, the Ford Motor Company no longer manufactures cars in the strictly segregated production-line fashion of Henry Ford's day. Similarly, modern governmental agencies realize the dangers that assumptions and generalizations present to project planning. In areas where many factors interact to influence outcome, planning approaches that ignore both minor and unmeasurable system components are excessively vulnerable to error. Consequently modern governments, policy makers and industries, no longer employ rigid 'reduce and resolve' planning solutions. Unfortunately, physical training principles may not have been examined with equal rigour and, in consequence, may not have evolved to quite the same extent.

## Scientific support for periodization planning

The next step in our investigation is to briefly review the empirical evidence supporting the periodization approach. Again, the published peer-reviewed literature emanates exclusively from sporting and strength-training domains.

Stone and colleagues (1999a) reviewed 15 studies of mesocycle length (7–24 weeks). 13 of these studies suggested that periodized models produced statistically superior results in performance measures when compared with models that consisted solely of linear increases in training loads. However, in the majority of these studies (11), there were no controls in place to equalize measures of total work performed. Consequently, intergroup differences in derived training benefits may have resulted from the differing training volumes performed. The authors concluded that the review strongly suggested that a periodized approach, even over a short term, produced superior results, especially in previously trained subjects, compared with constant-repetition programmes (Stone et al 1999b).

In a similar review, Graham (2002) cites 10 studies demonstrating that periodized strength-training models provided statistically significant improvements in one or more of a variety of performance standards when compared with linear non-periodized models (Graham 2002). A more recent meta-analysis comparing the effectiveness of periodized and non-periodized strength training programmes concluded that periodized training structures were more effective for both males and females, for individuals of varying training backgrounds and for a range of age groups (Rhea & Alderman 2004).

In one of the few studies that did not support the efficacy of periodized training regimes, Baker et al (1994) found no differences between an undulating periodized group and a non-periodized control group when volume and relative intensity were equated over a short-term training period (Baker et al 1994). Similarly, DeBeliso and colleagues (2005) concluded that a fixed repetition strength training protocol was as effective in promoting strength gains as a periodized programme in elderly, untrained subjects.

In a rare training study of extended duration (9 months), Kraemer and colleagues (2003) compared the effectiveness of two equitable volume training schemes, demonstrating that the strength and motor performance of female collegiate tennis players was preferentially enhanced in the periodized, as compared to the non-periodized, training group. The authors concluded that the superiority of the periodized training protocol was a consequence of (1) the greater variation of training variables and (2) the periodic exposure to higher training loads afforded by the periodized nature of the programme (Kraemer et al 2003).

In recent years published articles have suggested novel and creative derivations of the original periodized scheme (e.g. non-linear (Brown 2001, Rhea et al 2002), conjugate sequence (Plisk & Stone 2003), block (Issurin 2008), and fractal (Brown & Greenwood 2005)). Furthermore, Plisk and Stone (2003) have inventively equated preparation planning to concepts of game theory and advocated the need for planned unpredictability within the training programme (Plisk & Stone 2003).

In summary, the vast bulk of the published literature concludes that periodized is more effective than non-periodized training. There have been studies that have failed to demonstrate a significant benefit of periodized over non-periodized structures. However, these investigations typically have two design characteristics in common: first, subject groups of low initial fitness and second, a short time-frame of investigation.

## Scientific validity

Based on the reviewed evidence it seems reasonable to conclude that periodized planning models are effective. However, there is an interesting point to note here. Studies such as these are commonly presented as evidence of the efficacy of periodization principles. However, this may be a somewhat over-elaborate conclusion. What is strongly supported is that training variation is a beneficial factor in programme design, but the question of how this variation is best achieved remains largely unexplored.

This is worth noting, as the term 'science of periodization' is one that frequently crops up in the sports science and coaching literature. Unfortunately, the use of such language portrays an illusion of scientific propriety. It generates a sense that more is known about training planning than is actually the case; in short, that periodization principles have been empirically validated. On the basis of the evidence so far, the only valid conclusion to be drawn is that variation is an essential component of good training design.

A further point to note is the group-based nature of both the training records upon which periodization is justified and the empirical investigations offered as proof. These group-based conclusions discount the possibility that an individual's response to any given training input and/or method of organization may vary widely from the average group response. As we will see later, this assumption is called into question by contemporary evidence. Other obvious but often by necessity unavoidable limitations of such studies are the use of subelite populations as subject cohorts, the habitually short duration of training studies and the lack of sensitive fitness assessment measures.

A final point before moving on: the term 'periodization' has become so ubiquitous in sporting parlance that many now commonly neglect its original meaning and use the term interchangeably with 'training plan'. Thus the term has the potential to conjure up different interpretations for different practitioners. This chapter will consider the term in its originally intended context as representing training schemes that are segregated into sequential, distinct, pre-planned training blocks.

## Summary

So before we proceed, a quick summary of the key points so far:

- Preparation planning throughout the physical performance domains has been heavily influenced by the historical culturally pervasive planning paradigm
- The planning process is essentially an exercise in stress management

- The nature of the conducted periodization studies means that current training philosophies for individuals are heavily based on averaged, group-based empirical data
- Regular variation of training parameters over the course of the training programme is broadly supported as a prerequisite of good planning
- Differing planning structures have been proposed as means to providing appropriate training variation. However, there is little empirical evidence to aid discrimination between the worth of the various schemes
- The principle of gradual progressive overload appears an eminently sensible guideline. However, the issue of whether or not progress can be adequately modulated solely through manipulation of training 'numbers' (sets, reps, intensities, etc.) will be addressed later in this chapter.

## Is there a planning problem? If so, how do we know?

That preparation planning models are in need of refinement may be a contentious assertion. A standard defence against such an accusation is to point to celebrated performers who have reached the heights of their profession using conventional, periodized preparation plans. Such reasoning is a very understandable human reaction to visible facts. However, despite its instinctive appeal, such rationale does unquestionably present a damaging logical inconsistency. Employing isolated examples to support any stance, as is frequently the norm in performance environments, is a one-sided and ultimately irrational argument. A valid assessment of the worth of any training scheme necessitates that both the scheme's successes and 'failures' be factored into analysis. This peculiar aspect of human cognition is pervasive throughout domains and has been extensively documented elsewhere (e.g. Taleb 2005). Accordingly, great care must be taken to avoid the temptation to employ isolated individual examples to confirm the worth of any planning scheme while neglecting to consider all those who adhered to a similar planning framework yet 'failed'.

That a performer achieved previous success does not provide evidence that this was the most efficient preparation scheme. How can we know whether or not following a different plan would have led to still greater achievement? To less injury or illness? To a longer, healthier, more productive career? Our inability to run counterfactual, alternative reality strategies that originate from the same starting point means that we cannot answer such questions.

Accordingly, in the absence of any direct 'proof' of preparation planning problems, further exploration of the topic requires consideration of two distinct lines of indirect evidence. To shed light on the question of whether or not training planning conceptions would benefit from refinement, let's consider the problem from two perspectives. First, we will briefly review evidence of planning problems in other domains of human endeavour and second, we will consider circumstantial evidence emerging from within physical performance environments.

## Evidence of a general planning problem?

The pervasiveness of human planning inadequacies has been extensively documented. High-profile examples include the construction of Denver International Airport (16 months late, costs 300% greater than forecast), the development of the Eurofighter jet (5 years late, $25 billion above predicted cost), the Scottish Parliament building (3 years late, with projected cost of £35million escalating to £414 million) and, most famously, the Sydney Opera House (a scaled-down version completed 10 years late, with estimated costs of $7 million eventually amounting to $102 million). What is startling about such examples is that these projects were not entered into lightly and were not planned by inexperienced amateurs short on resources, yet all still floundered spectacularly. Military planners have often been the butt of ridicule, yet planning in this domain has typically been conducted by intelligent, highly trained, highly experienced groups of individuals. However, factual evidence indicates that, despite high levels of resource, planning in such environments habitually goes awry. Exempting combat examples, consider that the US General Accounting Office estimated that only 1% of major military high-tech purchases were delivered on budget and on-time (Buehler et al 2002).

As far back as the 1950s, psychologist Paul Meehl investigated discrepancies between expert clinical prediction and prediction based solely on simple mathematical formulas. His research revealed that such basic methods of prediction almost always outperformed those of clinicians. Meehl's conclusion, that statistical prediction consistently outperforms clinical judgment, has stood up extremely well for over half a century. Surprisingly, Meehl also discovered a sharp discrepancy between clinicians' rating of their personal performance and their actual record of success (Meehl 1954).

Subsequent evidence of planning and predictive inadequacies has been gathered across a spectrum of domains, from large-scale governmental projects to personal tasks such as completing Christmas shopping. For example, when asked to predict how long it would take to finish their honours thesis 'if everything went as poorly as it possibly could', psychology students significantly underestimated completion time (Buehler et al 1994). Buehler and colleagues (2002, p. 252), commenting on this and other work, wrote: 'Even when asked to make a highly conservative forecast, a prediction that they felt virtually certain that they would fulfil, students' confidence in their time estimates far exceeded their accomplishments'. In similar fashion, Newby-Clark and colleagues (2000) found that asking subjects for predictions based on realistic 'best guess' scenarios and for their hoped-for 'best case' scenarios, produced indistinguishable results. This neatly illustrates that when people think of their 'most probable' outcome they typically envision everything going exactly to plan! Ironically however, the empirical evidence suggests that what actually happens is typically worse than the predicted 'worst case' scenario. In fact, there is a mismatch between our illusion of capability in planning tasks and the reality of our documented performance. This is commonly termed the planning fallacy (Newby-Kahneman & Tversky 1979) and is pervasive across domains and cultures.

In the most extensive examination of human predictive ability to date, Philip Tetlock of the University of California at Berkeley collated the precisely specified predictions of a large cohort of experts. This 20-year study involved 284 professionals, all of whom made their livelihood through the prediction and analysis of political and economic trends. All experts were given regular lists of questions and asked to forecast future outcomes. All had access to extensive information, had extensive experience, had high levels of relevant education and were considered leaders in their respective fields. Yet, when the results of the many thousands of predictions were collated, it became blatantly obvious that their ability to predict was universally poor. No single expert came remotely close to being consistently right. In fact, only in certain cases were expert predictions better than what researchers termed 'dart-throwing chimps' – in other words, randomly generated guesses (Tetlock 2005).

Finally, in closing this quick review it is worth noting that researchers have previously concluded that it is impossible to find any domain in which humans can outperform even crude predictive algorithms, far less sophisticated ones (Grove & Meehl 1996).

## Evidence of a specific performance planning problem?

A line of circumstantial evidence that is suggestive of potential planning inadequacies within performance environments relates to the widespread proliferation of the various 'stress mismanagement' syndromes that plague performance domains.

Overuse injury has been defined as an imbalance caused by overintensive training and inadequate recovery leading to a breakdown in tissue reparative mechanisms (Cosca & Navazio 2007). Overuse has been identified as a major mechanism for injury in a wide diversity of physical pursuits, e.g. multisport athletes (Villavicencio et al 2007), cross-country skiing (Smith et al 1996), elite Olympic weightlifting (Calhoon & Fry 1999), professional soccer (Waldén et al 2007), various dance disciplines (Bronner et al 2003, Brown and Micheli 2004, Garrick & Lewis 2001, Quirk 1994, Shan 2005) and professional ballet (Nilsson et al 2001). Some examples are shown in Box 10.2.

Further evidence of potential programming deficiencies comes from the variously labelled manifestations of chronic imbalance between psychophysiological stress and recovery, such as staleness,

### Box 10.2

#### Sample findings illustrating the extent of overuse within physical performance contexts

- Overuse accounted for 37% of all injuries to Swedish professional football teams (Waldén et al 2007)
- Half of over 500 elite junior figure skaters surveyed reported repeat occurrence of overuse syndrome (Dubravcic-Simunjak et al 2003)
- 64% of professional dancers need to stop performing for extended periods due to overuse syndrome (Shan 2005)
- In a retrospective study of a Swedish professional ballet company, most injuries were considered overuse in nature, and 95% of dancers suffered injuries over the 5-year study period (Nilsson et al 2001)

burnout and overtraining syndrome. Previously, burnout has been described as a 'psychological syndrome' (Maslach & Jackson 1984) but it may be more appropriately considered a clinically complex stress-imbalance condition of indeterminate cause with a range of physical, psychological and social symptoms. Overtraining syndrome has been defined as long-lasting performance incompetence due to an imbalance of training load, competition, non-training stressors and recovery (Smith 2003). In ballet, manifestations of burnout and overtraining phenomena have been described (Koutedakis et al 1999, Koutedakis & Jamurtas 2004), and staleness, burnout and overtraining syndrome have all been identified as widespread problems among athletes and sportspeople (e.g. Junge et al 2002).

The proliferation of stress mismanagement syndromes throughout the physical performance domains is certainly, in and of itself, suggestive of cultural planning inefficiencies. The counterpoint to this argument is that, in high-performance settings, when both body and mind are consistently being stretched to their absolute limits, some form of physical or psychophysiological damage is inevitable. There is surely an element of truth in this perspective: an inevitable byproduct of negotiating fine margins of error is that, occasionally, thresholds will be exceeded.

However, stress mismanagement need not be an inevitable byproduct of high-performance preparation. This is effectively illustrated by a number of studies that have successfully reduced the incidence of 'stress syndromes' through the introduction of simple, easy-to-implement management strategies (Box 10.3).

### Box 10.3

#### Impact of programme management interventions in reducing incidence of overuse injuries

- Case management and an early intervention programme reduced the annual number of compensation cases from 81% to 17%, and decreased the number of days lost by 60%, over a 3 year time span in a professional corps de ballet (Bronner et al 2003)
- A significant decrease (21%) in sports injury incidence following an intervention based solely on education and increased supervision (Junge et al 2002)
- Monitoring of ratings of perceived exertion has previously been associated with avoidance of under-recovery, e.g. in rowing (Maestu et al 2005) and sprinting (Suzuki et al 2006)

## Why is preparation planning so difficult?

Two strands of evidence have been presented thus far, serving to question our current planning capabilities and paradigms: specifically, the clear demonstrations of the planning fallacy that have emerged from studies within social, behavioural and cognitive psychology, and also the provocative circumstantial evidence of a proliferation of stress mismanagement syndromes emerging from within performance environments.

In order to evolve strategies to redress the observed planning deficiencies, we will first need to unravel the psychological and biological considerations that interact to predispose to planning error.

### Innate psychological considerations

An extensive literature has provided illustrations demonstrating that, as a species, we universally struggle with planning and prediction tasks (Fig. 10.1). Paradoxically, in both the seminal work of Meehl and the extensive study of Tetlock, experts with the lowest rates of forecasting accuracy were simultaneously the very ones with the greatest confidence in their predictive abilities. It would appear that this misplaced overconfidence made experts increasingly vulnerable to decision-making error. In contrast, their less dogmatic peers, who resisted the temptation to employ the cognitive shortcut of predicting the future exclusively on the basis of past observations and who refined their perspectives against the emerging evidence, consistently outperformed their more confident peers.

The key factors driving such behaviours are innate, instinctive ego-protective mechanisms, which habitually rationalize our successes as resulting from our superior intuition but failure as being consequent to events outside our control (for more on this, see Tetlock 2005).

A direct implication of this is that we commonly fail to update our beliefs even when confronted with contradictory evidence. An immediate implication of such reflexive tendencies is that we frequently fail to learn from past mistakes, because we fail to self-critique dispassionately and in an unbiased manner. As previously noted, 'when faced with the choice between changing one's mind and proving that there is no need to do so, almost everyone

**Fig. 10.1** • Kristan Bromley at the top of a skeleton bobsleigh run – always a 'hard to predict' challenge. With thanks to Kristan Bronley.

gets busy on the proof' (Gilovich & Griffin 2002). However, research has also revealed that such irrational tendencies can be overridden and consequent decision-making ability enhanced. For example, chess masters actively seek to falsify potential next-move decisions. In contrast, experienced novices primarily seek evidence that confirms the perceived worth of their next move (Cowley & Byrne 2004). In other words, masters sought to objectively pick holes in their own theories, whereas novices sought evidence that positively supported their initial opinions.

Within the literature, our planning and prediction limitations are commonly attributed to a number of innate psychological traits. Tetlock (2005) has described four key contributing factors:

- A strong preference for simplicity
- An aversion to ambiguity and dissonance
- A deep-rooted need to believe we live in an orderly world
- A lack of appreciation of the laws of chance.

These cognitive characteristics are most commonly explained as a consequence of our evolutionary past. Simple, rule- based decision making is highly functional in environments where survival is dependent on quick, instinctive, fight-or-flight-based choices. Accordingly, there is a discrepancy between the nature of the problems that now confront us and those that evolution equipped us to solve. Our performance suffers when faced with convoluted, multifactorial problems, as we are fundamentally deterministic thinkers with a demonstrated aversion to probabilistic reasoning (Tetlock 2005). The significance of this problem is illustrated by a report by the US Institute of Medicine estimating that between 44 000 and 94 000 patients die each year in US hospitals as a result of medical error (Institute of Medicine of the National Academies 1999), and major causes of error in medical decision making have been identified as physicians' lack of competency in probabilistic reasoning and a faulty conceptual knowledge (Patel 2000). Accordingly it would seem that, as previously noted, 'our brains are made for fitness, not for truth' (Pinker 1997). We actively seek out simple, straightforward answers. Such a habitual preference for simplistic, rule-based decision-making is a predisposition that is especially exposed when we attempt to plan in unpredictable, complex environments.

## Biological complexity – a further complication

An essential requirement for any efficient planner is a conceptual model that is optimally reflective of the true nature of the system under consideration. Put more plainly, in order to plan effectively there must be an incisive understanding of how the system works. If the conceptual model, or paradigm, for understanding the system is flawed, then all subsequent decision making will be compromised. In relation to performance planning, the most obvious system to consider is the performer's biological system.

The predominant historical model for conceptualizing biological function has been the mechanistic paradigm. This mechanistic conception of 'human being as machine' is widespread and deeply ingrained in our conceptual system (Karaliute 2007). This classical perspective depicts the biological system as analogous to a well maintained, well oiled machine. Accordingly, the covert conceptual lens through which we have historically rationalized human functioning envisions our biology as a highly intricate, advanced but ultimately mechanical system.

If the biological system is indeed characterized by machine-like functioning, then enhancing performance is a relatively straightforward process. Mechanical systems are predictable, with stable functioning in which a known intervention results in a predictable output. When dealing with mechanistic systems we can use linear, deterministic logic to derive appropriate plans. In such circumstances, periodized training schemes would be eminently sensible. Frustratingly, however, reality intervenes to spoil the party.

One of the great tectonic shifts in science over the course of the 20th century was the realization of the explanatory inadequacies of the mechanistic world-view when applied to real-world systems. This shift was not sudden, nor can it be accredited to the work of any single person or scientific discipline. In a slow, meandering journey that started in physics and mathematics in the late 19th century and progressed through various scientific disciplines, mechanistic concepts have gradually been supplanted by a more reflective paradigm that has only recently been embraced by biologists and the medical professions.

The term 'complex adaptive system' was coined to describe systems that are composed of multiple component subsystems that interact in non-linear, non-periodic and non-proportional ways. These systems are adaptive, as they undergo temporary or permanent modification in response to imposed stress. The global behaviour of such systems is impossible to track in terms of its elements and so, unlike the simple 'billiard-ball' systems of classical mechanics, complex adaptive systems cannot be decomposed to a series of proportionate cause and effect reactions. Chaotic properties are a fundamental component of complex systems. Many have encountered chaos theory primarily through the butterfly metaphor. However, chaotic systems are not necessarily chaotic, and the butterfly metaphor is not very good at explaining how such systems work. Much of the time, chaotic systems remain relatively stable. In fact, it is a hallmark of such systems that imposed shocks reverberate through the component subsystems and are dissipated throughout the network. Accordingly, such systems are typically robust to perturbation.

However, this is not the case if the system is sufficiently delicately poised. In this condition, a single minute occurrence may be all that is necessary to push the system past its tipping point. Alternatively, the ripples of a number of seemingly innocuous occurrences may interact, being exponentially amplified as they propagate through the system, eventually resulting in large-scale disruption. There is a bifurcation (a dramatic and sudden change) in behaviour. Minor episodes can rapidly mushroom into major events. As we have no means of adequately assessing current states of the component subsystems, of knowing which are the most important subsystems or of unravelling the dynamic relationships between the subsystems, a defining feature of complex adaptive systems is that future behaviour is impossible to predict.

Consider weather systems: despite the meticulous study of meteorology, despite all the technical advances and efforts of scientists and space agencies, we will never have complete predictive capability. Why? Because we cannot measure to a fine enough scale, because infinitesimally small measurement errors can rapidly upset any prediction and because the various component elements of weather systems interact in complex and unpredictable ways.

The current global credit crunch offers an excellent example of how the behaviour of a seemingly stable, 'tamed', complex adaptive system can rapidly and unpredictably diverge from the expected path. Complete control of such systems is ultimately illusory. We can influence, we may nudge in a given direction but we cannot completely regulate and hence need to be aware of the pitfalls and avoid complacency.

One of the hidden implications of the mechanistic perspective of biology is that appropriate plans, and appropriate solutions can be advance-planned through a process of deduction and prediction. However, in the light of complexity theory it is evident that this would require an extensive knowledge of the innumerable causal connections that exist between the components of the system, a knowledge that clearly does not exist (van Regenmortel 2007).

## Evidence of biological complexity?

A defining characteristic of periodized training plans is the implicit assumption of stable, cyclic, underpinning biological processes. For example, consider the rationale supporting the logic of fixed duration planning blocks. The most prevalent scheme, as documented in the published literature, organizes training programmes into phases of 4 weeks' duration. Plisk & Stone (2003) cite the rationales of three noted periodization theorists in advocating 4-week cycles:

- To correspond with natural monthly biocycles (Matveyev 1972)
- To correspond with the half-time of training effect involution (Viru 1995)
- In order to super-impose delayed training effects (Zatsiorsky 1995).

Such rationale was eminently logical given the level of insight provided by the mechanistic model of biological functioning. However, if we consider this rationale through the lens of the complexity paradigm, a very different picture emerges. It is without question that distinct but mutually interactive biological rhythms underpin all aspects of the human life cycle, health and response to applied training stress.

Consider: complex bodily rhythms are ubiquitous in all living organisms (Glass 2001). Organisms have evolved timing mechanisms, commonly referred to as biological clocks, that assimilate cues from multiple sources and modulate oscillations accordingly (Rensing et al 2001). These rhythms interact with eachother through myriad feedback and feedforward linkages while also being subjected to the influence of environmentally generated cues and perturbations. It is the seemingly orderly behaviour emerging from this multiplicity of interactive, fluctuating constraints that characterizes the functioning of complex biological systems (for further review, see Foster & Kreitzman 2005).

The interactive effects of various forms of stress have been shown to affect biological functioning. For example, emotional stress has been observed to downregulate the immune system (Aubert 2008, Rogers et al 2001, Venkatraman et al 2000). Loneliness has been established as a predictor of morbidity and mortality (Cacioppo et al 2002). Sleep disruption has been shown to have substantial negative effects on a range of capacities such as motor and cognitive performance, mood, metabolism, hormonal health, and immune function (Ferrara & De Gennaro 2001, Himashree et al 2002). Academic stress has been noted to have a negative effect on the mood scores of swimmers (Carl et al 2001). Mood has been shown to affect the training performance of cross-country skiers (Mahood et al 2001) and personal, economical, psychological and physical factors have been proposed to increase the stress levels of ballet dancers, resulting in elevated injury risk (Kelman 2000).

As a further illustration, consider the variety of factors that have been demonstrated to affect the release characteristics of the androgenic hormone testosterone. Observed patterns of testosterone release have been variously noted to modulate in males in response to the time of day (Bird & Tarpenning 2004), week, month and female partner's cycle (Hogg 2002), in response to cycles of light and dark (Luboshitzky 2000, Takagi 1986), in accordance to ratings of work satisfaction (Axelsson et al 2003), in response to motivational and assertiveness levels (Schultheiss et al 1999, Schultheiss & Rohde 2002), and in response to training stress (Filaire et al 2003).

In summary, the body of evidence demonstrating the mutual inter-connectivity and inter-activity between psychophysiology, cognition, emotion, brain function, and genetic predisposition continues to grow, emphasizing both the extent of biological complexity and the limitations of mechanistic conceptual frameworks (for review, see Lovallo 2005).

## Biological complexity and physical fitness

Physical fitness is influenced by a variety of environmental and genetic factors. Consider the evidence emerging from the HEIRITAGE Family Studies, a linked series of investigations focused on uncovering the genetic underpinnings of individual responses to exercise and disease risk factors.

Studies have demonstrated a considerable heterogeneity in the responsiveness of individuals to regular physical exercise (Bouchard et al 2000). For example, training induced changes to $VO_2$max were established to vary widely among subjects in response to identical training parameters. High, medium and low responders existed among all age groups, in both sexes, among blacks and whites and at all levels of initial fitness. When $VO_2$max was adjusted for age, sex, body mass and composition; genetic factors explained about 40% of interindividual variation. The average increase in $VO_2$max was 19% but it was the range of training responses that was truly surprising. 5% of subjects had no change in $VO_2$max consequent to training and 5% had an increase of over 50% (Skinner et al 2001). Of course, it must be noted that subjects were previously untrained. Nevertheless, such extremes of outcome in response to identical training parameters serve to illustrate the uncertainty associated with any attempts to forecast the effects of prescribed training interventions.

Elsewhere, an investigation employing a cohort of professional rugby players established that prescribed resistance training sessions produced a range of individually-specific hormonal responses in subjects (Beavan et al 2008a). Individuals with broadly similar training backgrounds responded differently to the same training stress. Individual players were high responders to a certain session but not to another, while team-mates displayed the opposing pattern. In an aligned study, the hormonal responses of players to four differing resistance training sessions were determined. Then, in a 3-week crossover design, players alternated between the sessions that elicited their maximum and their minimum testosterone responses. All players demonstrated significant gains in strength after 3 weeks of training using the protocol that elicited their maximum testosterone response. In contrast, when subjects performed the protocol that occasioned their minimum response, either no change or a significant decline in tested strength measures resulted (Beavan et al 2008b).

When we consider these converging streams of evidence, it seems logical to conclude that adaptation, and consequent retention, rates of differing aspects of fitness are highly individual-specific. Taken as a whole, the presented evidence suggests that any training loading interacts with intrinsic and environmental factors to occasion a unique adaptive response.

The key mutually interactive factors dictating this response are:

- Training loading parameters
- Genetic inheritance
- Transient states of biological functioning
- Habituation to previous stress exposures (i.e. training history)
- Transient psychological states
- Transient social and environmental factors.

Accordingly it can be concluded that:

- Identical training parameters will always elicit a unique adaptive response for each individual
- An individual will respond uniquely each time identical training sessions are repeated
- Generalized conclusions from group-based observations may be seriously misleading in guiding individual training
- It is highly improbable that there are universal 'best' loading schemes for any given pursuits or objectives.

## How should we cope? what can we do?

### Design and management of dynamic adaptive preparation planning systems

To err is very definitely an unavoidable aspect of the human condition. However, it is also within the compass of human ingenuity to create solutions, find alternative ways of working and devise strategies serving to offset human planning and decision-making errors. An understanding of the factors at the root of our habitual planning inadequacies permits the formulation of such pre-emptive strategies. Training theorists whose work contributed to the formulation and popularization of periodization concepts were certainly intelligent, experienced and insightful. Their conclusions were eminently sensible when contextualized against the pervasive conceptual frameworks and knowledge base of the past. However, our exploration and synthesis of relevant emerging evidence thus far highlights a number of conflicts between current scientific knowledge and traditional practice.

Specifically; three critical assumptions of the traditional periodization planning model are challenged:

- It is possible to predict the effects of any given training intervention and/or training organizational structure
- It is feasible to optimally advance plan preparation programmes
- Prescribing training in empirical terms is an adequate means of controlling imposed stress.

In the discussion thus far we have shown the mismatch between our innate predisposition for rule-directed, pre-formed planning solutions and the complex reality of the planning problem. Evidence from other planning pursuits, as well as circumstantial evidence from within performance domains, has been offered to illustrate the potential consequences of this mismatch. Accordingly, the challenge of appropriate planning has shifted from a process of mathematically manipulating and segregating future training into preformed schemes to the design of dynamically adaptive training systems.

Consequent refinements to convention can be categorized under the following four headings:

- Paradigm
- Process
- Planning structure
- Prescription.

## Paradigm

The planning paradigm is the conceptual model, the implicit set of assumptions and core beliefs that defines our framework for understanding the planning task. A clearly defined conceptual knowledge is an essential aspect of appropriate planning decision making.

Within this chapter, strands of evidence questioning habitual planning perspectives have been examined. The key conceptual sources of error may be broadly summarized into two sections; human cognitive limitations and the underlying task complexity.

### Human cognitive limitations

Awareness of our human fallibility in forecasting and predictive realms should foster a healthy planning and decision making paranoia. Recall the evidence. Despite having an extensively documented poor track record in planning and predictive tasks, simultaneously we have a demonstrated tendency to be over-confident in these pursuits.

This over-confidence, our habitual over-commitment to favoured strategies, our ingenuity in rationalizing inconvenient facts in ways that deflect self-critique, are all factors that limit learning from, and predispose towards, repeated error.

These peculiarities lead to an evident paradox. The values we typically admire in 'experts' – assertiveness, undoubting self-belief and an unswerving confidence – are the very characteristics that appear to predispose to decision making error. Yet, ironically, the evidence suggests that our predictive confidence when functioning in complex environments is unjustified and ultimately delusional. There is an evident dissonance in that the values we find laudable in decision makers are not necessarily those that facilitate good management and planning. This presents a conundrum to those responsible for directing physical preparation programmes; an apparent contradiction between cognitive approach and self-presentation style. On one hand there is the cautious, questioning, consultative, consistently checking and re-checking, cognitive style required to enable good planning decision making; on the other, the confident, assertive and self-assured facade necessary to engender performer trust, generate expectation and strengthen commitment to the chosen path.

Understanding our innate reasoning tendencies is an important first step in conquering them. While we cannot re-write our evolutionary programming, we can be aware of our habitual cognitive blind-spots and devise remedial strategies.

### Underlying task complexity

Within this chapter we have uncovered evidence of a mismatch between, on the one hand, our innate desire for parsimony, simplicity and explanatory closure, and on the other, the inherent complexity of the preparation process. When faced with complex reality, the human mind rationalizes the threatening unpredictability of the environment by searching for observable patterns. When patterns are observed, 'rules' are extrapolated. Review of periodization rationale clearly illustrates the covert shaping influence that this mechanistic philosophical legacy has exerted on training planning philosophies. Simplistic questions, eliciting simplistic answers: What is the ideal duration of a training phase? How long is the optimal taper? How frequent, how hard, how many, what percentage of maximum? Broad, generalized, averaged answers offered as solutions to individual-specific and context-specific problems. Much of physical performance science has been absorbed in this quest for 'golden' rules, focused on uncovering idealized solutions, uncovering the 'answer'. If we truly were mechanical systems, this approach would be valid. However, yet again reality fails to cooperate.

The complex, highly sensitive, nature of the biological system will ensure that the progress of physical fitness will not be an orderly, uniformly incremental, predictable process. The adaptive responses to any given training 'input' will not result in a readily predictable fitness ‘output’. An approach that proved successful for one individual will not necessarily work for another, and what worked for an individual in the past may not work for them in the future. Furthermore, and critically, you cannot determine the most appropriate strategy in advance. Consider this: would you buy next year’s shoes for your 9-year-old child based on the average shoe size for 10-year-olds? Of course not! You would be relying on a very broad predictive algorithm based on averaged observations with large sample deviations. What you would do is wait until the child is 10, measure their feet, and buy a pair of shoes that you know will fit. You would also monitor the fit carefully as your child grew, to anticipate and avoid the problems inherent in unforeseen and sudden changes in growth. Responses to training are infinitely more variable, less predictable and more subject to change over short-time scales than a growing child’s foot-size. So why would we assume that we can prescribe future optimal organizational schemes, training modes or loading variables?

The traditional planning model presents sweeping generalizations in relation to the ‘best’ structure, phase duration, sequential order, offering planners idealized training solutions. Although periodization theorists have variously championed and debated the relative worth of differing organizational schemes, the evidence suggests that such arguments are, to a large extent, irrelevant. Rather than searching for notional universal ‘best’ answers that are then cobbled together to formulate plans, a more perceptive approach is the design of processes that facilitate the emergence of context-specific training solutions.

The key take-home message is that automated planning approaches ignore the extreme specificity arising from individual biological systems interacting with ever-changing, dynamic contexts.

## Process

Earlier in the chapter it was suggested that traditional training planning approaches were directly descended from the historically pervasive mechanistic planning paradigm. There are a number of hangovers from this formative philosophy still readily apparent in modern training planning conceptions. Recall that Taylor’s conception of planning was essentially ‘plan’ then ‘execute’. This approach promoted rigid adherence to the plan, and devalued the importance of review and revision. Consequently, sticking to the plan was considered an ideal to be aspired to, and deviating from the plan was ultimately a sign of weakness.

Although classical articles on periodization have frequently made reference to the need for flexibility, it tends to be treated more as a necessary evil than a virtue to be embraced: a sometimes unavoidable, frustrating deviation from the chosen path. However, a main thrust of this chapter is that the correct path cannot be chosen ahead of time. Accordingly, what now takes on added significance is the design of a sensitive and responsive preparation process: sensitive to emerging threats and opportunities; responsive so as to enable swift modification of training in order to alleviate risk and capitalize on unforeseen progression.

The following are offered as hallmarks of a sensitive and responsive training process.

### Information gathering

Information that is relevant to organizing and planning preparation can be collected through both formal and informal means and should include the collation of both objective and subjective data (Fig. 10.2). The worth of performer-generated subjective information has surprisingly been largely ignored within the traditional periodization literature. This should be considered a major oversight, essentially neglecting the primary source of pertinent feedback, i.e. the performer him/herself. The value of subjective feedback as a training modulating factor has been clearly demonstrated elsewhere in the literature. For example, a clinical diagnosis of an athlete’s state of

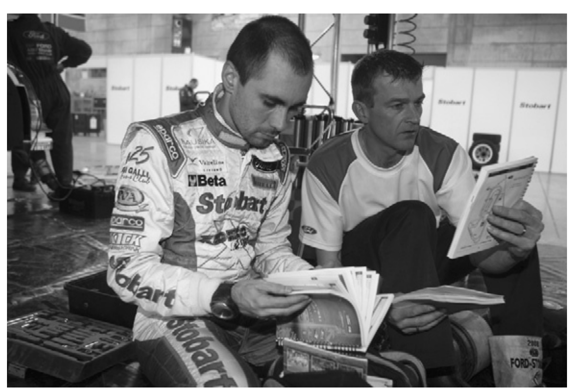

**Fig. 10.2** • Support specialists in action. Rally driver Giovanni Bernacchini making last-minute checks with his engineer. © Stobart Motorport. With thanks to the Royal Automobile Motor Sports Association.

stress and recovery is possible through consideration of relevant subjective parameters (Steinacker & Lehmann 2002). Various tools for eliciting such information have been offered in the literature, e.g. the Profile of Mood States (Armstrong & VanHeest 2002), Recovery-Stress Questionnaire for Athletes (Kellmann & Kallus 2001), Mental States of Readiness and Satisfaction (Hogg 2002) and the Psychobehavioural Overtraining Scale (Collins 1995). In order to optimize the efficacy of such protocols, the performer should be fully aware of the purpose and rationale underpinning subjective data collection. Furthermore, accuracy of subjective ratings is likely to be greatly enhanced by clear definition of rating systems, and consistent application.

## Trend analysis

The belief that effective preplanning is possible, that adherence to preplanned schemes is desirable and that plans may be adequately described in sparing empirical terms creates a system that is particularly insensitive to what may be termed 'weak signals'. Weak signals may be considered low-level background information that may herald future major changes in function. These bifurcations in behaviour may take the form of unexpected favourable shifts in condition that may present unforeseen training opportunities or may provide early indication of elevated risk. For example, muscular strain injuries may be preceded by persistent localized fatigue, which in turn may only be detected through a process of regular information gathering and routine in-training 'readiness' assessments.

Failure to respond accordingly to pertinent low-level information is likely to increase the prospect of unfavourable outcomes such as illness, injury and under- or overloading. Hence system sensitivity to weak signals facilitates the pre-emption and avoidance of potentially unfavourable events and enables the adaptive readiness necessary to respond and capitalize on unforeseen opportunities. An unforeseen training opportunity may take the form of an unprojected improvement in training performance, which in turn may facilitate the positive readjustment of training goals.

Within the sports science literature, much time and energy has been devoted to finding reliable markers of physiological function, variables that may serve as indicators of the performer's readiness to train. The uncovering of such markers would greatly enhance the preparation process.

Although many objective markers have been investigated, none have proved to be universally applicable. When we look at the problem from the perspective of biological complexity it makes sense that such a 'one size fits all' measure would prove elusive. In addition, given the range of both inter- and intraperformer variation, coupled with the diversity of demands of the various performance pursuits, the search for a single definitive marker may ultimately be unrealistic.

However, what does suggest itself as a perceptive and practical way forward is the collation of both objective and subjective information and the periodic trend analysis of such data. The linking of a number of low-level 'weak signals' may pre-empt future biological events more effectively than any single marker. Linked indicators are likely to vary on both a discipline and on an individual basis, and yet again, frustratingly, we are unlikely to be able to predict which trends are most critical until we have longitudinally collated and analysed the data. Hence what is required is an attention to recording detail, regular review of training and performance trends, and an ongoing search for clues. Ultimately, the effectiveness of the training process is likely to be largely dictated by this capacity to readily anticipate positive or negative trends and adapt accordingly (see Table 10.1). A final point of note: when operating in complex environments it is very difficult to learn unless, first, we observe with an open mind as devoid as possible of preconception and, second, we have some definitive means of checking projections against outcomes. In performance training contexts, the collation of a broad range of subjective and objective data and the consequent trend analysis of this information is the best tool available to provide such sorely needed reality checks.

To summarize:

- Data collection and trend analysis should be an integral part of the training process
- It takes time to build a coherent picture. For data collection to be optimally useful it needs to be conducted over prolonged periods so that trends can be identified and tracked
- Introduce data collation from the start of the training process; it is too late when injury, illness or overtraining have already occurred
- Use training data to learn lessons. Check projections against outcomes
- Establishing trends may prove helpful in determining appropriate endpoints for return to exercise programmes following injury or illness.

### Communication, consultation and challenge

Optimized communications are an essential component of any effective management process. Accordingly, due consideration must be given to enhancing networking between the performer, the training director and performer-centred support team. Everyday communication checks should promote clarity throughout the team:

- Is the performer clear on why they're doing what they're doing?
- Does the performer understand exactly how a certain mode of training should feel?
- Is the performer confident of the efficacy of conducted training and on how training modes will positively impact on future event specific performance?
- Is the support team clear on their responsibilities and the expectations placed upon them?
- Is the language used to communicate critical concepts shared, clear, and precise? Are you sure? Check and recheck!

In complex environments there are always innumerable potential perspectives on the best way forward and innumerable ways to justify a preferred course of action. Therefore it is important that, in exploring the worth of a proposed way forward, the training director seeks dissonant, rather than concurring, perspectives. As a protocol, this may take the form of asking support team members to play devil's advocate in critiquing proposed training plans; perhaps reversing roles and arguing opposing positions may prove a useful strategy. External consultants can also offer a new perspective and honest appraisal without the reticence frequently demonstrated by team members. Whatever strategies are employed, it should be borne in mind that the greatest learning opportunities are unlikely to emerge through the vision of a single mind or, indeed, through cosy agreement among group members who share strongly held but similar convictions. Instead, appropriate solutions are more likely to evolve through informed, un-entrenched debate and consideration of differing perspectives. In environments where human learning is severely curtailed by our tendency to seize on the first available perceived pattern and from then on to see only confirming evidence, dissonance is the friend of learning.

These approaches support the use of case conferencing and other methods highlighted in Chapter 24. Directors, managers, coaches and senior staff all need to play a part in developing a performance culture that optimizes benefit from this kind of communication.

### Built-in review and revision

Traditional project planning and management tools can frequently deal with minor uncertainties in relatively stable environments. In more dynamic environments, conditions may rapidly evolve beyond the assumptions made in preplanning, requiring major deviations from the path initially selected. Consequently, rigid planning strategies designed solely on the basis of 'hoped-for' or most likely outcomes, which do not incorporate mechanisms enabling swift modification, are unlikely to yield optimal results. Given the unpredictability and chaotic behaviour of biological systems, contingency-planning processes should be considered an important component of preparation planning.

Performers and team members should be aware that regular review and training redirection is a necessary and planned aspect of effective plan management.

## Planning structure

The implications of biological complexity suggest there is little if any logical rationale supporting the existence of universal 'best' phase duration. However, this does not necessarily imply that programmes should not be planned in segmented blocks. The keypoint is that phase duration should be decided on the basis of logistical constraints and not on any perceived biological imperative. Accordingly, if it suits the specific logistical situation, or a particular performer's preferred approach, or just happens to make the most sense for a specific period, then planning in blocks may be a judicious solution. However, most convenient does not necessarily equal optimal: the longer the time-lag between review and redirection, the greater the uncertainty. Therefore it would appear sensible to review and debrief training progress on a routine and regular basis and to refine training direction accordingly on as frequent a basis as logistically feasible.

Training monotony has been proposed as an important concept in the management of training plans (Bosch & Klomp 2005, Foster 1998, Kreider et al 1998). Monotony has been defined as the variability of practice over the course of a season (Anderson et al 2003) and is suggested as a training error that increases the risk of overtraining syndromes (Kellmann 2002). High training monotony has been linked to poor performance and an increased frequency of banal infections, whereas a reduction in monotony was related to attainment of personal best performances (Foster & Lehmann 1997, Suzuki et al 2003). Accordingly, an index of training monotony, calculated using performer ratings of perceived exertion, has been employed as a useful training-monitoring tool in rowing (Suzuki et al 2003) and sprinting (Suzuki et al 2006).

Long-term physical training schemes that do not provide sufficient diversity of both loading and movement characteristics are likely to expose performers to heightened risks of stress disorders. For example, in ballet, evidence suggests that supplementary (non-ballet) training led to improvements in fitness parameters and reduced injury occurrence without interfering with key artistic and aesthetic requirements (Koutedakis & Jamurtas 2004). Koutedakis & Jamurtas suggest that, even at the height of their professional careers, dancers' aerobic power, muscular strength, muscular balance, and bone and joint integrity are the 'Achilles heel' of the dance-only selection and training system.

Consequently, it would appear sensible to minimize training monotony. However, it is important to recognize that occasionally concentrated phases of replicated training stress may serve to induce rapid development of a particular fitness component. Conversely, it should also be noted that, if training is too widely diverse for extended periods, then gains in fitness parameters are likely to be blunted. Hence there is an evident trade-off that must be negotiated and a delicate balance that must be struck between training monotony, training variation and diminishing training returns resulting from habituation to an unvarying training stressor. The most perceptive solution to this trade-off problem is once again to adopt a sensitive and responsive management approach. The effective training process will monitor, record, gather relevant information, analyse the trends, and can thus facilitate informed training decisions (see Table 10.1).

## Prescription

A hypothetically 'ideal' training load is one that occasions the greatest performance adaptation at the lowest possible cost in terms of energy, residual fatigue and risk of injury. If training load is too low, minimal or suboptimal adaptive response results; conversely, if load is too great then some form of damage will occur. Traditionally, training is prescribed solely using empirical descriptors. How many sets, how many times, at what numerical expression of intensity? Given the extent of biological sensitivity explored earlier, prescribing training in such terms must be considered a crude attempt at providing the precision required in gauging optimal loads. In essence, this approach can be seen as attempting to control the adaptation of a very sensitive system using a technology that is grossly insensitive.

But perhaps the advance planning of 'ideal' training parameters is not always necessary? For many sessions a crude prescription is adequate. Recall that it is the nature of the chaotic biological system to buffer shocks, to self-organize to accommodate stress; our biology is remarkably able to absorb and adapt. So unless the capability of a performer is grossly overestimated then an inappropriate imposition of stress, for a single session, will be accommodated. However, during periods of elevated stress, the capacity of the system to cope is pushed to its limit. The investment of both physiological and psychological resource is substantial and draining. Though the potential gains are high, so too are the potential risks. In such circumstances optimally accurate prescription and management of training takes on an added significance.

Similarly, slight but chronic training errors may insidiously creep ever closer to critical threshold levels. Maybe hormonal health is compromised; perhaps immune function is gradually suppressed; muscular biases, imbalances and irritations grow. The pressure of a confluence of negative changes in several factors may gradually mount and, unless this pressure is vented, illness or injury will inevitably result.

A counterclaim to this charge may be that such means of prescription are the only available option and that performers are not expected to stick rigidly to the plan as presented on paper. However, the plan does set the tone. It does serve to constrain the field of possibilities.

A final implication of the traditional numerical means of prescribing training is its surreptitious insinuation that conforming to empirical preplanned variables is important. Such a perspective promotes the fallacy that non-adherence to empirically prescribed, preplanned loading is a form of failure, essentially a sign of weakness. It would appear likely that such a belief structure is at the root of prevalent issues such as overtraining, burnout and staleness.

## What can we do? Simple tools for dynamic adaptive planning

The implications of the evidence presented, and the key thrusts of this chapter, are essentially threefold:

- Each planning task presents a distinct challenge, and hence optimally efficient planning solutions are inevitably unique and cannot be empirically pre-planned
- The unpredictability inherent in the physical preparation process demands that expectations are consistently monitored against the progress data. Hence, information gathering and insightful assessment tools should be considered a fundamental component of appropriate planning
- Traditional periodization concepts founded in deterministic logic can no longer be considered scientifically valid. Instead, training planning is more appropriately perceived as the design of systems that facilitate the evolution of optimal training structures based upon emerging information and challenges (Box 10.4).

As exemplars of ways to meet these challenges, consider Table 10.1, which presents a sample menu of various monitoring tools, many of which have been previously advocated in the literature. These tools are being offered solely as examples of easily applied subjective/objective assessments. To reiterate a previous point, use of any of these tools in isolation is likely to be less effective than the use of monitoring combinations. As with all the key messages in this chapter, indeed in this book, appropriate solutions can only be unravelled after exploration.

The prescription of training variables is an aspect of traditional practice that may also benefit from additional precision. Consider the following: in a previous survey, investigators examined the relationship between the training prescribed by 123 coaches and the self-reported training of their best runners (Hewson & Hopkins 1995). The results illustrated that the association between the coach's prescription and the actual training performed by the runners was generally poor. This was attributed to insufficiently clear communication between coach and athlete. Athletes did adhere to the coach's prescriptions with regard to training volumes but the intensities described by the coaches and performed by the athletes were substantially different. Similar findings have been documented in swimmers (Stewart & Hopkins 2000).

### Box 10.4

**Characteristics of an effective dynamic adaptive planning system**

- Appropriate conceptual model
- Optimized systems functioning
  - Shared objectives and ethos
  - Communications and networking
  - Organizational learning
  - Data collation and trend analysis
- Logistical planning constraints
  - Optimized contact time with training director and access to support team
  - Experience and relevant education of performer
  - Frequent consultation, review, debrief and redirection
  - Minimized planning horizon
- Practical delivery
  - Contingency planning and preparatory strategies
  - Provision of Focused Diversity (Monotony V's Variation trade-off)
  - Subjective/objective monitoring combinations
  - Cross-referenced training prescription
- Optimized system sensitivity and responsiveness to emerging threats and opportunities

A practical means of optimizing clarity in the communication of training intensities is through triangulation of training variables. In other words, for any desired training adaptation, appropriate training descriptors are cross-referenced. For example, this is how much work should be done, this is how the work should feel and this is the necessary quality of execution. (Compare this with the idea of performance criteria described in Ch. 23.)

The triangulation of variables enables a more accurate prescription of training parameters, thus helping to eradicate some of the pitfalls inherent when describing training loadings in solely empirical, unidimensional terms (Table 10.2).

## Summary

The objective of this chapter was to provide an appreciation of both psychological and biological considerations that affect our ability to formulate and manage preparation plans. It is clear from the arguments and

**Table 10.1 Some suggested monitoring methods**

| When | What | Who says |
|---|---|---|
| Pre-pretraining | • *Subjective indicator of 'general' well-being*, e.g.<br>RESTQ, POMS, recovery-cue; abbreviated versions of same<br>• *Objective measure*<br>Morning HR/HR variability | Collins 2000<br>Kellmann 2002 |
| Pretraining | • *Subjective rating (Score 1–10) of key indicators*, e.g.<br>Mood<br>Sleep quality<br>Readiness to train<br>Residual muscle soreness/fatigue<br>Site specific soreness rating<br>Perceived readiness rating<br>• *Objective measure (readiness check)*<br>Psychomotor speed/reaction time<br>Measure system readiness, e.g. countermovement jump (height); drop jump (contact time/height) | Collins 2000<br><br><br><br><br><br><br>Nurmekivi et al 2001<br>Rietjens et al 2005<br>Nederhof et al 2006, 2007 |
| In-training | • *Prescriptive accuracy*<br>Rate desired intensity (how it should feel)<br>Technical execution (required quality)<br>Empirical range (load and repetition limits)<br>• *Recording detail*<br>Empirical descriptors<br>RPE (per effort, set, or session) | |
| Post-training | • *Post-session objective measure*<br>Repeat pre-session readiness check<br>• *Session RPE*. Retrospectively calculate associated measures, e.g.<br>Monotony (weekly average load/standard deviation)<br>Strain (mean weekly load × monotony)<br>Training load (RPE × training time)<br>CPS (category ratio pain scale)<br>TQR (total quality recovery)<br>• *Weekly training 'stress' assessment*<br>Daily and/or individual session RPE = week total | <br><br><br><br><br><br><br><br>Suzuki et al 2003, 2006 |

HR, heart rate; POMS, profile of mood state; RESTQ, recovery-stress questionnaire for athletes; RPE, rating of perceived exertion

evidence presented that many aspects of our customary planning approaches lack both an empirical evidence base and an underpinning conceptual logic.

The illusory security of assumed 'rules' and the associated simplistic vision of the preparation task should be rejected, and the reality of biological complexity and the implications of human cognitive limitations acknowledged. Critically, a dynamic adaptive planning approach demands that the elemental uncertainty and ambiguity inherent in training planning is recognized and appropriate counteractive strategies devised.

Unfortunately, as with so many of the things that are good for us, this approach is also more difficult and more challenging than traditional preformed planning recipes. The management skills required are also not necessarily those historically promoted. Formal, pedagogical planning skills are of limited value within such a dynamic environment. Instead, of more pivotal importance is the organizational ability to create support team networks, to develop communications systems, to implement information gathering processes and to optimize organizational learning. The planning

**Table 10.2 Triangulation of training prescription parameters**

| Construct | Training parameter | How to quantify |
|---|---|---|
| Volume | Recommended range of sets and reps | Numerical prescription |
| Subjective feel | How efforts should feel during execution | Performer rating (e.g. 1–10) |
| Quality of effort | Expected technical quality<br>*or* speed<br>*or* power output/ distance/ height, etc. | Coach rating (e.g. 1–10)<br>Timing system<br>Measurement |

process now becomes centred on facilitating the seamless emergence of training strategy in response to unfolding events, within the boundaries imposed by logistical factors, the stated programme objectives and the time frame imposed by the performance schedule.

## And finally. . .

Mike Tyson once said, 'everyone has a plan, until they get punched in the face', and that's quite an insightful comment. If we plan on the basis of optimistic, 'hoped for' outcomes, neglecting contingencies, our plans become fragile, vulnerable to unexpected events and consequently easily disrupted and derailed. Conversely, a planning paradigm founded on the principles of consistent assessment and rapid adjustment enables the evasion of potential stumbling blocks, facilitating robust and sustainable preparation processes. Effective preparation plans identify and circumnavigate potential pitfalls, are sensitive to emerging threats and respond with considered and timely action.

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