The Troubles of Time Management with Applications for Astronauts

Justin Ruiz

The Academy for Science and Design

Abstract: *The troubles of daily life call for any multitude of skills. However, one skill often goes overlooked and underappreciated: Time Management. It is essential for almost any profession and for many tasks, including the profession of Astronauts. Countless events have to happen on time and just right for Astronauts to just survive, making time management crucial. Thankfully as Christine P. Bartholomew and others have stated, time management can be taught. This paper demonstrates the intricacies associated with time management as well as provides a potentially effective solution to teaching time management in the form of a scheduler program.*

Keywords: Astronaut Astronomy Time Management Scheduler

1. Introduction

> How did it get so late so soon?
> It's night before it's afternoon.
> December is here before it's June.
> My goodness how the time has flewn.
> How did it get so late so soon? (Geisel)

This poem by Dr. Seuss highlights a key problem that many have today: lack of good time management. Time passes by and what is done in that time is done; time can never be reclaimed. Time management seeks to fill this time with productive work. The lack of effective management of time has always been a problem for humans. Before gas lights, humans were limited to doing most activities in daylight ("Life before Artificial Light"). This motivated humans to figure out how to get as much done in a day as possible. The advent of gas lights and artificial light then generated new problems as employers would have people work the night ("Life before Artificial Light").

One modern example of a time management crisis is one that can be experienced by astronauts. The former astronaut, Rick Searfoss, shares the nature of this crisis well. "He used the phrase "too bad" when someone asked for permission to add another task to the already overloaded schedule. As a supervisor, if your folks have too many priorities competing for their time, you must cut things out at the bottom and look to optimize, not maximize, what you get out of your people" (Stack). Another instance of this overworking and over scheduling comes from astronauts in NASA's Skylab back in 1973. Mission control overscheduled the astronauts so much that they did a sit-down protest in order to get a proper schedule (Hiltzik).

2. Subscales of Time Management

Before time management can be improved it must be quantified. It is generally measured in "dimensions" with various people identifying various and different dimensions (Misra and McKean 42). Three major models of time management exist: Britton and Glynn's, Macan's, and Huang and Zhan's models (Yi 4; Macan et al.). Britton and Glynn's model has three subscales: choice and goals

prioritizing, creating tasks from goals and subgoals, and planning and implementing tasks (Yi 4-5). Macan's model of time management provides four dimensions: perceived control of time, setting goals and priorities, mechanics of time management, and preference of organization (Macan et al. 765; Yi 5). Huang and Zhan's model has three dimensions with multiple "levels" to them. The first dimension is the individual's sense of time value, which includes social and individual oriented time value. The second dimension is the sense of time control, whose various levels include setting goals, planning, priorities, time allocation, and feedback. The third dimension is the sense of time efficacy which contains the levels of efficacy of time management and efficacy of time management behaviors (Yi 5-6).

Time management is complex and psychologists do not agree on the number or kinds of dimensions. Even with disagreement, all of the proposed models for time management can be generally filtered out into a model containing nine dimensions, called subscales. Psychologists find that distinguishing between each subscale is essential to understanding the whole (Bartholomew 915; Macan 765-767). Scores in different subscales correlate with different skills in time management (Bartholomew 915). The nine overarching subscales are Sense of Purpose, Structured Routine, Present Orientation, Effective Organization, Persistence, Setting Goals and Priorities, Mechanics, Perceived Control of Time, and Preference for Organization (914-915). People with higher subscale scores are less prone to anxiety and depression and have lower stress. They also have greater optimism and satisfaction with school, work, and life. Finally, they also have better grades and study methods (916).

The different subscales show many different attributes. Sense of Purpose is one's feeling that what he is doing is important. Structured Routine is the measure of using routine actions and good planning to lay out one's time. Present Orientation evaluates if an individual focuses more on the present rather than the future or past (Bartholomew 924). It helps the formation of goals, the feeling of satisfaction, and the formation of solutions (924). Low scores on Present Orientation are linked to depression, anxiety, and the inability to do actions in a given period of

time (924). Effective Organization is how effectively organized a person can be. People with higher scores in this subscale spring into action more easily (915). Persistence is how much someone is inclined to stay on a task. Setting Goals and Priorities is setting and weighing goals and their respective deadlines (Macan et al. 765-767; Bartholomew 919, 928). A higher Goal Setting score is an indicator of higher GPA, satisfaction, and even health. People with low scores usually procrastinate. Setting daily goals has been shown to be a better practice than setting weekly ones. The ability to set goals also helps with prioritizing (Bartholomew 928). Mechanics of Time Management is planning and scheduling skills (Bartholomew 930). Preference for Organization is how inclined a person is to be organized in his execution of a task and in the space in which he works (Macan 765-767; Bartholomew 919).

The final and most important subscale is Perceived Control of Time. Perceived Control of Time is someone's view on whether he has sufficient time to meet a deadline (Bartholomew 918). The subscale seems to mediate over Setting Goals and Priorities, Mechanics, and Preference for Organization (Yi 5). An increase in Perceived Control of Time also seems to increase all other subscale scores (Bartholomew 918, 926). It is for this reason that Perceived Control of Time is the most important subscale. A low score on this subscale makes it less likely that an assignment is completed on time. An increased score increases satisfaction and decreases tension and anxiety (926-927). Understanding the effects of these subscales on the whole of time management and each other helps fix time management deficiencies.

3. Flow

Closely related to many of the aforementioned subscales of time management is flow. Flow is a state of mind where a task can be worked on without investing much processing power on other tasks (Rodríguez-Sánchez and Schaufeli 75-77). Greater flow means greater focus on an activity. The study of one's absorption and enjoyment can be used to measure flow in an individual. Absorption is how much information about the task is being currently "absorbed" while enjoyment is how much one enjoys the task (76-77). One study by Alma M. Rodríguez-Sánchez and Wilmar B. Schaufeli found that enjoyment was higher when in non-working conditions and that absorption was higher when in working conditions (84-89). They also found that people experienced more absorption on weekdays and that enjoyment was a lot more prevalent on weekends (84-89). The study looked at two groups of people: one with a lack of sleep ("burned up") and the other perfectly healthy. The "burned up" group experienced less flow than the healthy group. People were also found to be more likely to experience flow at the start or end of the day (84-89). Enjoyment was found to have more of an effect than absorption at these ends (87). The U.S. Department of Education showed that the more one enjoys school the more successful he is in it (Vasagar). Interestingly, the pattern of how flow fluctuated between times and days did not differ between the "burned up" and healthy groups (Rodríguez-Sánchez and Schaufeli 87).

It appears that flow is similar or related to Present Orientation, Persistence, and Sense of Purpose. Present Orientation is very similar because it is the focus on the present task rather than the past or future. Persistence appears to be related because flow allows for and encourages greater persistence on an action as the individual is absorbed by the action. It stands to reason that Sense of Purpose would be related to flow because the more absorbed someone is into a task, the more he would feel a Sense of Purpose in doing it. All of these points show that flow is most likely related to effective time management and that greater levels of flow would be indicators of greater time management. Even if flow does not directly affect one's level of time management, it will affect time management in so far as it affects the execution of a schedule. It will negatively impact this execution because less flow means less concentration. If the execution of a schedule is compromised, time management itself will be affected. Execution of the plan, or any other action, would be easier and faster with higher levels of flow.

4. Deadlines

Like flow, deadlines can also help time management. Dan Ariely and Klaus Wertenbroch of the Massachusetts Institute of Technology studied the effectiveness of self-imposed deadlines. Their paper found that people are willing to make self-imposed deadlines, self-imposed deadlines are effective in improving task performance, and people do not usually set deadlines optimally (Ariely and Wertenbroch 219). His paper also found that self-imposed deadlines do not have as much of an effect as externally imposed deadlines. Much of the loss of effectiveness stems from the timing of the deadlines (222). Self-imposed deadlines do not have lesser effectiveness from a loss of perceived effectiveness (222). The paper also found that when constraints on deadlines increase, the performance of and time spent by people on a task increases (223). Constraints on deadlines are the strictness of the dates and the punishments associated with missing the dates.

Imposing deadlines seems to fall under the Setting Goals and Priorities, Structured Routine, Effective Organization, and Preference for Organization subscales of time management. Setting Goals and Priorities is clearly the most similar. The aforementioned perceived effectiveness is also similar to both Perceived Control of Time and Sense of Purpose. Optimizing deadlines should help optimize time management since deadlines are so closely related to the time management subscales.

5. Stress and Anxiety

Like Ariely and Wertenbroch studied deadlines, Ranjita Misra, and Michelle McKean looked at stress and time management. They found females were more prone to stress and anxiety (44). Effective time management and the presence of leisure seem to reduce stress in an academic environment (44, 47). Males seem to get less stress from leisure than females (44). They also found that females have better time management than males (44). People who have greater Perceived Control of Time scores experience less

stress and greater satisfaction with their work (Macan et al.; Bartholomew 916). Mechanics of Time Management is negatively related to stress meaning that the more stress, the lower the Mechanics of Time Management score (Yi 16). This in turn means that time management would be negatively affected by stress. Therefore decreasing stress should be a pivotal detail in bettering time management.

6. Leisure

It is good to take breaks when possible to experience less stress. Olin Business School researched leisure activities and their enjoyment. The findings suggest that scheduled leisure activities are less enjoyable than unscheduled ones ("Scheduling Takes the Fun out of Free Time"). The mere fact they are scheduled can make them feel like a chore or obligation. They also suggest that by broadening the time window for the leisure to start, the individual will get more enjoyment from it ("Scheduling Takes the Fun out of Free Time"). The aforementioned study on stress by RanjitaMisra and Michelle McKean shows that leisure reduces stress (44, 47). It also shows that males and females both benefit from leisure activities with males benefiting more (44). It stands to reason that the more enjoyable the leisure, the less stress somebody would feel. In relation to the aforementioned lack of time management in lawyers and law students, lawyers get little free time and vacation time and law students also get little free time (Bartholomew 911). This lack of free time gives rise to more and more lawyers and law students saying they are worn out and experiencing time famine, which in turn gives rise to sloppier work (911). It is for these reasons that a good amount of quality leisure would improve time management.

Relating back to overworked astronauts, it is clear that leisure is essential for them. Former astronaut Rick Searfoss says to, "'Take a second to wind the clock.' Old aviation clocks had to be wound, which gave the brain a few minutes to look around. It's important to step back and recognize your human limitations. You can't work non-stop without a break to refuel, or your machine will die on you" (Stack). He is clearly stating the importance of leisure in not only the ability to get experiments done, but also in survival as evidenced by "your machine will die on you".

7. Sleep and Time Management

Sleep is an even more important factor to address than leisure. Poor sleep quality is associated with worse academic achievement. This is due to a decrease in cognitive function and an increase in anxiety (Yi 15). The decrease in cognitive function would mean the individual has less flow and therefore worse time management. Poor sleep quality can also decrease mental health and cause depression (Yi 15). Time management is a significant predictor of sleep quality, where better time management equates to better sleep quality (Yi 36). Sleep also affects time management in so far as it eats up time.

Defining sleep and understanding why it happens is just as important as its effects and what affects it. Dr. Jerome Siegel proposes that sleep is a natural time management device. Sleep duration varies for each species and seems adapted to their particular role in the animal kingdom (747). The way dolphins and whales sleep allow for them to keep moving while resting parts of their brain (749). The big brown bat eats mosquitoes and moths and has a twenty hour sleep period. This sleep period is well suited because its waking hours are optimal for catching its prey (751). An increase in the amount of sleep after sleep deprivation is called sleep rebound. Amazingly studies have shown that humans and rats only need to recover about 30% or less of the sleep time lost (750). All of these points show sleep is a period of "adaptive inactivity". This means that sleep was adapted for specific species to suit their needs, be they eating or saving energy (751). Using this definition and the amazing power of sleep rebound, better time management, and therefore better sleep, can be attained.

8. Measuring Time Management and Related Factors

Since focusing on lacking subscales of time management is a great way to help time management, it is necessary to be able to measure them and related factors (Bartholomew 918). Misra's study used four self-report questionnaires: Gadzella's Student Life Stress Inventory (SLSI), Beard and Ragheb's Leisure Satisfaction Management (LSM), Time Management Behaviors (TMB) of Macan et al., and Spielburger's State-Trait Anxiety Inventory Form (STAI-Y) (42-43). SLSI assesses student's academic stress level and how they react to such stress and produces a score where a greater number indicates more stress (42). LSM gauges leisure satisfaction and its benefits producing a score where a greater number indicates more benefits (43). TMB assesses time management behaviors where a higher score indicates better time management (Macan et al.; Misra and McKean 43; Yi 5). STAI-Y asses state anxiety and trait anxiety where higher scores indicate more anxiety. State anxiety is the subject's current emotional state while trait anxiety is the subject's proneness to anxiety in their personality (Misra and McKean 43). Yi mentions a few relevant ways to measure related factors as well. Time Management Disposition Inventory (TMDI) by Huang & Zhan is used to measure time management based off of 3 factors (Yi 5-6). Perceived Stress Scale (PSS) by Cohen, Kamarch, and Mermelstein, is a standardized stress test used for many college populations. Yi also presents a good indicator of academic achievement to be cGPA (24). A good way to measure flow is through the Experience Sampling Method (ESM) which entails timed journal entries to measure flow's components (Rodríguez-Sánchez and Schaufeli. 80-81). The Pittsburgh Sleep Quality Index (PSQI) by Buysse, Reynolds, Monk, Berman, and Kupfer, is a standardized way to measure subjective sleep quality (Yi 14). All of these methods of quantifying subscales and related factors should help in understanding how to achieve better time management.

9. Time Management Solutions

Even with a way to measure time management, fixing problems with it is difficult. The best solution would be one that is able to reduce stress, increase academic achievement, and increase sleep and general health. As mentioned before, a person with higher subscale scores has less anxiety,

depression, and stress, greater optimism and satisfaction, and better grades and study methods (Bartholomew 916). Sleep will also increase in light of this. Therefore the best solution would be ones to raise subscale scores.

Raising subscale scores can be done through time management training. Most research seems to suggest that time management is teachable (Bartholomew 917-918). There are three key elements to teaching it. The first is to focus on lacking subscales of time management (918). This means that teaching time management would have to be highly personalized. The second is to focus specifically on the subscale of Perceived Control. As mentioned before, Perceived Control may be the most important out of all subscales and an increased score can increase other subscales (918, 926). The third key element is to not use self-directed time management instruction. Supervised practice is better than traditional time management courses with a lack of supervision outside the course (918).

One of the ways of fixing deficiencies people may have is to teach them to break down tasks into smaller chunks. This does not mean just recommending breaking down tasks, but actively encouraging it (Bartholomew 941). Again, supervised practice is better than one instruction without a follow-up. Long-term goals should be broken down into a series of more attainable short-term goals (941-942). Breaking down tasks is very similar to Goal Setting, therefore Goal Setting should be focused on more than most other subscales (942).

Teachers can help students learn to break down tasks in a variety of ways. This can be most easily done with syllabi (Bartholomew 943). The syllabus has to be done well. The main indicator of a good syllabus is that it outlines how smaller concepts tie into bigger concepts (943). Another way teachers can help is by identifying short-term goals at the start of lectures. Students can then see how the larger concepts are broken down (943-944). A third way that teachers can help students is incremental outlines. They are short but difficult to draft since students need to filter information and prioritize it; very much like Goal Setting (944). In regards to astronauts, the syllabus could be a detailed layout of what the astronaut will do in space. Mission control identifying daily goals for astronauts would be a corollary to the short-term goals of lectures.

Breaking down tasks into smaller ones does nothing to fight time famine and help time management without time allocation. People need to break down tasks and then learn how to assign how much time it will take them to complete those tasks (Bartholomew 945-946). Teaching time allocation is essentially teaching how to turn goals into to-do lists, and to-do lists into schedules (945). Quantifying time is difficult for humans but essential for scheduling. Use of a timing device helps people quantify time and keep focused (946). This would increase flow within an individual and likely increase time management as well. Time logs would also help people quantify time. They could be put on paper and on electronic devices (Bartholomew 946-947). Teachers can help with quantifying time by requiring a timetable for certain assignments (947). After learning to quantify time people can make schedules. Since people would already

have to-do lists from breaking down tasks it would be relatively easy to make a schedule. Teachers can then help with this by making the formation of a schedule mandatory (947).

Another way to help time management is the formation of good notes. Note taking helps filter out weaker information in favor of information of greater importance but only when done correctly (Bartholomew 949-950). Many people use computers to transcribe a whole lecture rather than prioritize the best information. This is one of the reasons computer notes are not as effective as handwritten notes (949-950). Good note-taking is related to Goal Setting. Teachers should consider requiring students to bring notepads. They can then do oral assignments, collect notes, and provide feedback (950). Teachers should be wary that their oral assignments are more effective when they are interactive lectures, but it should not be so interactive as to be more like a game (Selby 973-974). While there is no difference in academics in the long-term, short-term assignments like notes or quizzes would significantly be hindered by a game-like oral assignment (Selby 973-974).

Making people reflect on their own time management is another way to tackle problems with time management. This helps them focus on their management issues and allows them to improve. It also helps them see the fruit of their good time management encouraging further use of it (Bartholomew 951-952). They can experiment with different time management strategies until they find one that works well (951). These reflections could be required by a teacher.

An important thing to consider when talking about student time management is the way a school structures its day. The National Education Association found many pros and cons to Block Scheduling in a school. When a school has block scheduling students and teachers get more free time to study or plan ("Block Scheduling"). This, of course, would help time management. Teachers would also gain the ability to hold longer cooperative activities which could increase learning in certain subjects ("Block Scheduling"). However, there are cons to block scheduling. Advanced placement and other hard courses have more difficult times covering material and if a student misses a day, they are effectively missing more than one day ("Block Scheduling"). These would harm time management. Block scheduling should be used in a school on a case by case basis.

10. Reaching an Optimal Solution

All of the aforementioned ways to help foster good time management should be considered when reaching an optimal solution. Since self-imposed deadlines are not as effective as externally imposed deadlines, the most effective solution would be one that makes some or all of the deadlines a person needs. Time management should also be personalized to help a person's specific subscale deficits. Breaking down tasks and how to quantify time should also be taught. The formation of good notes and the reflection of practices should also be heavily encouraged.

It is due to all of these preferences that a computer program should be one of, if not the best, solution to teaching and

carrying out time management. A computer program could fulfill the externally imposed deadline requirement and could customize how it presents and teaches time management on a case by case basis. The program could require time logs to not only help teach the user proper time management but also to help the program customize its schedules for the user. The program can also use the aforementioned ways of measuring time management factors to assess how to best help a certain user. Since females generally have better time management than males there can be a weight added for the sex of the individual (Misra and McKean). It can even have an alarm to time users and to tell them how much longer they have until they have to focus on another task. After a task, the actual time spent on a task as well as the results of an ESM test for flow would result in an adjusted time allocated for similar tasks and different tasks at similar times or days. Other tests can also be administered. The program would also function as a supervised practice because the results of how well a user improved or followed his schedule could be made available. This would allow for better reflection on the person's time management skills.

Going back to overworked astronauts, this program could potentially make sure they are not overscheduled. The tests for subscale levels and flow could be packaged with the psychological checks that NASA does on its astronauts in space. Their schedule could possibly interact with the electronic habitat that astronauts stay in as well. It could perhaps lock off certain tasks or leisure activities to an astronaut until previous more important tasks are done. Leisure times could be hidden from astronauts so as to avoid the downsides to scheduled leisure. Astronauts would also probably not have to directly interface with the scheduling program as mission control would schedule for them. This would save time for the astronauts as they would spend less of it logging their activities and planning upcoming ones.

The University of Campinas developed a new system called GRASP (Greedy Randomized Adaptive Search Procedure) that helps immensely with scheduling high school class schedules in Brazil and can act as a model to help structure the proposed program. The system creates a lecture, assigns it random resources, and then evaluates the priority of that combination ("Solving School Timetabling"). The system then holds higher priority lecture combinations so that subsequent ones have to fit around them unless the subsequent one ends up having higher priority. A second procedure then reranks the lectures, followed by a third procedure called the "path-relinking strategy" which spots almost optimum solutions and uses them to guide the program to a final solution ("Solving School Timetabling"). Such a program structure could be useful for scheduling within the proposed program for time management.

11. Conclusion

Fixing time management deficiencies is a pressing and complex issue. From astronauts, to the general population, problems with time management and a sense of time fatigue are everywhere. There are many ways to help foster good time management like breaking down tasks and scheduling. A computer program that uses these and other solutions would be ideal. The program would use many subscales and indicators of time management such as Perceived Control of Time, flow, deadlines, leisure, stress, and sleep. It would measure, record, quantify, and analyze these subscales and indicators. More research should be done on ways to help achieve good time management so that everyone can fill time with productive work.

References

[1] Ariely, Dan, and Klaus Wertenbroch. "Procrastination, Deadlines, and Performance: Self-Control by Precommitment." *Psychological Science*, vol. 13, no. 3, May 2002, pp. 219–224, doi:10.1111/1467-9280.00441.

[2] Bartholomew, Christine P. "Time: An Empirical Analysis of Law Student Time Management Deficiencies." University at Buffalo School of Law, 2013.

[3] Geisel, Theodor Seuss. "How Did It Get so Late so Soon?"

[4] Henley, Jon. "Life before Artificial Light." *The Guardian*, Guardian News and Media, 31 Oct. 2009, www.theguardian.com/lifeandstyle/2009/oct/31/life-before-artificial-light.

[5] Hiltzik, Michael. "The Day When Three NASA Astronauts Staged a Strike in Space." *Los Angeles Times*, Los Angeles Times, 28 Dec. 2015, www.latimes.com/business/hiltzik/la-fi-mh-that-day-three-nasa-astronauts-20151228-column.html.

[6] "How Scheduling Takes the Fun out of Free Time." *ScienceDaily*, ScienceDaily, 9 Mar. 2016, www.sciencedaily.com/releases/2016/03/160309094759.htm.

[7] Macan, Therese Hoff, and ComilaShahani. "College Students' Time Management: Correlations with Academic Performance and Stress." American Psychological Association, 1990.

[8] Misra, Ranjita, and Michelle McKean. "College Students' Academic Stress and Its Relation to Their Anxiety, Time Management, and Leisure Satisfaction." *Research Gate*, ResearchGate, Jan. 2000, www.researchgate.net/publication/209835950_College_students'academic_stress_and_its_relation_to_their_anxiety_time_management_and_leisure_satisfaction.

[9] "Research Spotlight on Block Scheduling." *NEA*, National Education Association, www.nea.org/tools/16816.htm.

[10] Rodríguez-Sánchez, Alma M. and Wilmar B. Schaufeli. "Running head : DAILY FLOW PATTERNS Enjoyment and Absorption : An Electronic Diary Study on Daily Flow Patterns." (2012).

[11] Selby, G, et al. "A Comparison of Teaching Methods: Interactive Lecture versus Game Playing." *Current Neurology and Neuroscience Reports.*, U.S. National Library of Medicine, Nov. 2007, www.ncbi.nlm.nih.gov/pubmed/18158674.

[12] Siegel, J M. "Sleep Viewed as a State of Adaptive Inactivity." *Current Neurology and Neuroscience Reports.*, U.S. National Library of Medicine, Oct. 2009,

www.ncbi.nlm.nih.gov/pubmed/19654581?ordinalpos=1&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_DefaultReportPanel.Pubmed_RVDocSum.

[13] "Solving the Problem of School Timetabling." *ScienceDaily*, ScienceDaily, 11 Jan. 2010, www.sciencedaily.com/releases/2010/01/100106093631.htm.

[14] Stack, Laura. "Time Management in Space? Productivity for Astronauts?" *The Productivity Pro*, 5 Feb. 2007, the productivity pro.com/blog/2007/02/time-management-in-space-productivity-for-astronauts/.

[15] Vasagar, Jeevan. "Two Hours' Homework a Night Linked to Better School Results." *The Guardian*, Guardian News and Media, 29 Mar. 2012, www.theguardian.com/education/2012/mar/29/homework-linked-better-school-results.

[16] Yi, Wong Wai. "The Relationship between Time Management, Perceived Stress, Sleep Quality and Academic Performance among University Students." Hong Kong Baptist University, 23 May 2008.