CIRCADIAN® Report

Increasing Production Beyond the Five Day Operation

CIRCADIAN®
24/7 WORKFORCE SOLUTIONS

Introduction

There are many reasons why some companies operate their facilities 24 hours a day, 7 days a week, including the cost or inability to stop a manufacturing process (e.g., oil refining, steel making), the around-the-clock needs of the customer (e.g., hospitals, utilities), or because manufacturing demand is high enough to sustain continuous production.

Alternatively, many companies operate on a 24/5 schedule (e.g., 24 hours a day, Monday to Friday)[1] or some similar variant (e.g., many food manufacturing facilities run two 10-hour shifts, Monday to Friday [20/5] due to sanitation requirements). These companies often meet temporary increases in demand by then adding overtime hours on the weekend. If the demand is sustained, or increases further, this "bolt-on" overtime can cause a number of negative effects when employees are asked (or required) to work more hours, including the following:

- Excess costs due to overtime and premium pay
- Fatigued workers who are less productive
- Increased human error and production mistakes
- Increased safety incidents
- Decreased morale
- Higher turnover and absenteeism
- Poorer quality

The obvious (and seemingly straightforward) solution is to change the schedule to allow more running time and to better utilize capacity. However, if not properly planned and implemented, this type of change can have huge ramifications for your employees and, consequently, downside risks for the company. Moreover, before choosing to make such a dramatic change, it is best to experience and foresee a sustained demand for production, otherwise you'll risk having to scale back when demand drops. Thus, there should be a clear business case for expansion to avoid the risk of alienating the workforce as a result of the major disruption to their lives—for what turns out to be an unnecessary reason.

[1]Throughout this white paper, the term "5- to 7-day expansion" will be used as this is the most common approach for companies that need more capacity. However, many of the points in this paper also refer to those companies that add more shifts during the week, expand from a 6- to 7-day operation, or any other schedule expansion that significantly increases the hours of operation per week. While it is usually manufacturing companies that expand in this manner, the advice given is pertinent to all industries.

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Establishing the Business Case

As illustrated in Figure 1, an operation that runs for 8 hours a day, Monday through Friday, only utilizes 40 hours of capacity or about 24% of the available time in the week. Further, a plant running 24/5 only uses 71% of its available capacity.

As the workplace becomes more technologically advanced, and the amount of money invested in assets increases, it becomes more critical to fully utilize and maximize the benefits of those assets. At the end of the work week, or in downtime between shifts, operations that shut down and restart will be less productive as compared to continuous operations. This lower productivity further contributes to higher unit costs and poorer customer service quality. The figure below shows that converting to a 24/7 operation from 24/5 increases asset utilization (capacity) by 40% (an increase of two more days of production over the existing five day operation, two-fifths = 40%).

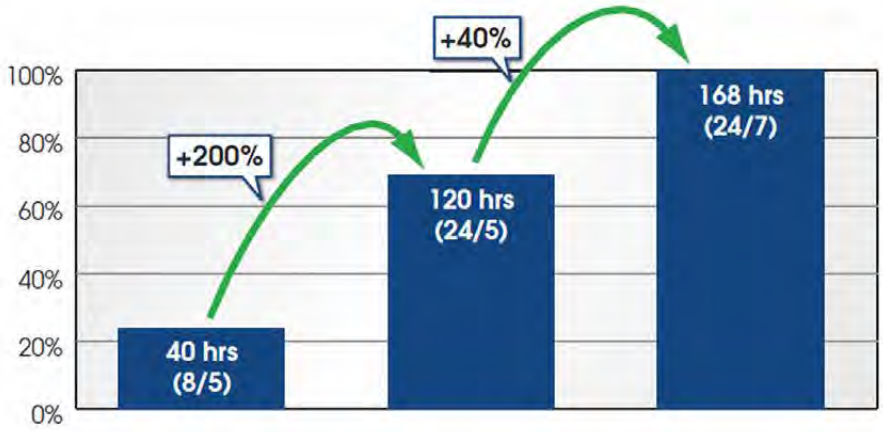

Figure 1. Percent asset utilization vs. number of operating hours per week.

The arrows indicate the percent step increase in capacity/asset utilization when increasing production from 5 x 8 hours per day, to 5 x 24 hours per day, to 7 x 24 hours per day.

Prior to increasing the number of work hours per week, a company should consider if it is possible to make the current work schedule more productive by asking the following questions:

- How does productivity vary by shift?
- Are employees fully engaged in their jobs?
- Are absenteeism, turnover, and health status affecting productivity?
- Are employees overly fatigued?

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There are business solutions to help solve these problems that are likely to be more cost-effective and less disruptive to the business and employees than an unnecessary conversion that simply spreads these inefficiencies over 7 days. If the additional operational hours are indeed necessary, then it is important to carefully plan for the change, and to understand the likely consequences in terms of employee attitudes and morale, as well as key performance metrics, including productivity, absenteeism, turnover, safety risks and health costs.

The case study below demonstrates the typical plant evolution from a 5- to 7-day expansion.

CASE STUDY: Plastic Injection Molding Company

As is the case with many U.S. manufacturers, this plant employed a 5-day (Monday to Friday), 3-crew x 8-hour schedule. Following an upturn in business, the production demand exceeded the 5-day capacity and the company called for weekend overtime. As demand increased even more, the plant split each of its day, evening, and night shifts into two sub-crews. One sub-crew worked both days one weekend and the other crew worked the next weekend, providing 50% productive capacity for Saturday and Sunday. This schedule resulted in employees working 12 straight days once a month. Overtime and weekend premiums reduced operating profit, and demand continued to increase to the point that 100% capacity was required every day.

Despite the mandatory overtime requirement, covering 7 days of production with 3 crews proved inefficient. Productivity levels were low due to the inevitably high level of absenteeism because of the extended work hours. Weekend absences were especially high, as some employees rejected the extra hours and refused to come to work. Other employees, taking advantage of double-time pay on Sundays, worked every Sunday and then called in absent during the week. These employees soon realized that they could obtain the same level of weekly compensation for working fewer hours. From the employer's perspective, the 5-day schedule with "bolt-on" overtime for the weekends limited the ability to maximize weekend capacity and also decreased efficiency during the week.

To resolve the situation, the company decided to move to a continuous 24/7 schedule that was supported with 4 crews. And by engaging the workforce in the selection of the new schedule, the company succeeded in transferring the ownership of that schedule to the people who had to work it. Absenteeism dropped dramatically, operating costs were reduced, and the plant achieved the full capacity needed to meet customer demand.

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Aside from increased asset utilization, increased production, and greater customer satisfaction, there are many additional benefits to a well-executed 7-day conversion, including the following:

- Reduced unit costs
- Deferred capital investment
- Improved work teams/efficiency
- Benefits for the union
- Benefits for the employees
  (For more information on these benefits, please contact Circadian.)

Scheduling Possibilities

An employer who has established a legitimate business case for a 5 to 7 conversion, and has successfully positioned the need with its workforce, is now confronted with a myriad of different scheduling possibilities to achieve this. All are fraught with pros and cons. Historically, the week-end-warrior schedule was the path of least resistance. These schedules involve the addition of two new crews of employees who work only the weekends, either on 12-hour days or night shifts. It is also possible to continue using a three-crew system for 24/7 coverage, if sub-crews are formed. Finally, there is literally an infinite number of four-crew, 24/7 schedules that can be employed to efficiently support continuous production operations.

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WEEKEND WARRIOR SCHEDULES

It is common for employees who currently work a 5-day schedule to ask why the company cannot simply hire a weekend crew to achieve its goals. Thus was born the "weekend warrior" schedule, as illustrated in Figure 2.

Figure 2: A "Weekend Warrior" Schedule

Crew	Mon	Tue	Wed	Thu	Fri	Sat	Sun
1	d	d	d	d	d	–	–
2	e	e	e	e	e	–	–
3	n	n	n	n	n	–	–
4	–	–	–	–	–	d12	d12
5	–	–	–	–	–	n12	n12

d = 8-hour day shift, typical start and end times of 7 a.m. and 3 p.m.
e = 8-hour evening shift, 3 p.m. to 11 p.m.
n = night shift, 11 p.m. to 7 a.m.
d12 = 12-hour day weekend warrior crew, 7 a.m. to 7 p.m.
n12 = 12-hour night weekend warrior crew, 7 p.m. to 7 a.m.
Note: Some schedules require that the weekend crews work an 8-hour shift on Fridays or Mondays.

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In this scenario, the existing crews (1, 2, and 3) are not disrupted, while crews 4 and 5 are recruited to work 12-hour shifts on Saturday and Sunday, with a possible fill-in day on Fridays or Mondays.

Depending on required output and the shift length, two additional crews are typically employed. This type of 5-crew schedule has proven to be highly inefficient for most operations, given the following issues:

- Employees who work just weekends are less likely to be committed to the company
- Most have other jobs and view the weekends as part-time gain
- Annual turnover often exceeds 100%
- Work skills and quality are lower
- Safety incidents are higher
- It is difficult to recruit and retain employees onto this type of shift due to the increased social and family problems associated with working weekends, as well as fatigue and burnout
- There is a lack of teamwork and continuity between the weekday and weekend employees, who never become part of the mainstream organization
- Weekend crews are difficult to supervise by the weekday supervisors
- The costs of weekend-warrior schedules are excessive due to weekend premiums and incentives (i.e., work 32 hours for 40 or more hours of pay)

Some companies may also use weekend warriors as an interim solution to a full 24/7 schedule, but if the business case is well established, it is usually advisable to convert directly to a 4-crew system. It only prolongs the agony and increases the degree of difficulty to defer the change.

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THREE CREW SYSTEMS

The mathematical problem with using 3 work crews to cover 24/7 production requirements is that people will have to work every single day of the week, as illustrated below in Figure 3, which is neither healthy, safe, productive, or cost-effective.

Figure 3: 3-crew, 24/7 coverage with mandatory overtime

Crew	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Work Hrs	Pay Hrs
1	d	d	d	d	d	d	d	56	64
2	e	e	e	e	e	e	e	56	64
3	n	n	n	n	n	n	n	56	64
							Annual	2,912	3,328

Moreover, most 24/5 operations run 3 x 8-hour fixed shifts Monday through Friday. Employees who are accustomed to working fixed shifts are extremely resistant to rotating schedules and equally opposed to working every weekend. One solution to this dilemma is to hire a fourth crew and run a "Grasshopper Shift," also known as the "Swing Shift" or "Mad Dog" crew.

With this scheduling approach, your three fixed crews stay fixed (although their days off change each week), but the new fourth crew becomes their relief. Thus, on the days that each of your fixed crews are off, the relief crew covers for them creating a fast-rotating schedule whereby they work days, evenings, and night shifts in any given week. Below, Figure 4 illustrates the fixed 4-crew
"swing shift" schedule.

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Figure 4: 4-crew swing shift schedule (3 crews fixed, one "swing")

DAY CREW

Week	Mon	Tue	Wed	Thu	Fri	Sat	Sun
1	d	d	d	d	d	d	d
2	–	–	d	d	d	d	d
3	d	d	–	–	d	d	d
4	d	d	d	d	–	–	–

EVENING CREW

Week	Mon	Tue	Wed	Thu	Fri	Sat	Sun
1	–	–	e	e	e	e	e
2	e	e	–	–	d	d	d
3	e	e	e	e	–	–	–
4		e	e	e	e	e	e

NIGHT CREW

Week	Mon	Tue	Wed	Thu	Fri	Sat	Sun
1	n	n	–	–	n	n	n
2	n	n	n	n	–	–	–
3	n	n	n	n	n	n	n
4	–	–	n	n	n	n	n

"SWING" CREW

Week	Mon	Tue	Wed	Thu	Fri	Sat	Sun
1	e	e	n	n	–	–	–
2	d	d	e	e	n	n	n
3	–	–	d	d	e	e	e
4	n	n	–	–	d	d	d

While this solution may be acceptable for your 3 current fixed crews, it will be difficult for those on the "swing shift." The fast rotation is both inherently disruptive to sleep and difficult for family and social planning. Consequently, recruiting, retention, and absenteeism are major issues with these types of schedules, not to mention safety and productivity.

One other method is to maintain the three fixed shifts but utilize sub-crews, as illustrated below in Figure 5. In this scheduling choice, each fixed crew is split into a number of sub-crews (usually 3, 4, or 7). On each day of the week, some of these sub-crews do not work. The number of sub-crews is chosen based on the multiples of the number of employees required.

In the example below, a 7 sub-crew system is employed. The number of people needed by job classification must be divisible by 5. Thus there are 7 sub-crews covering the day shift, 7 for evenings, and 7 for the night shift. On any one shift, 5 of the 7 sub-crews work. The number of employees must be increased so that for every five who worked previously there are now seven employees. This system is mathematically the only way to maintain 8-hour fixed shifts for everyone and avoid the "Mad Dog" rotation (see Figure 4). However, it still requires having additional people to support the 5 days on, 2 days off work pattern.

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Figure 5: 3-shift, sub-crew scheduling system

DAY CREW

Sub Crew	Mon	Tue	Wed	Thu	Fri	Sat	Sun
1	d	d	–	–	d	d	d
2	d	d	d	–	–	d	d
3	d	d	d	d	–	–	d
4	d	d	d	d	d	–	–
5	–	d	d	d	d	d	–
6	–	–	d	d	d	d	d
7	d	–	–	d	d	d	d

EVENING CREW

Sub Crew	Mon	Tue	Wed	Thu	Fri	Sat	Sun
1	e	e	–	–	e	e	e
2	e	e	e	–	–	e	e
3	e	e	e	e	–	–	e
4	e	e	e	e	e	–	–
5	–	e	e	e	e	e	–
6	–	–	e	e	e	e	e
7	e	–	–	e	e	e	e

NIGHT CREW

Sub Crew	Mon	Tue	Wed	Thu	Fri	Sat	Sun
1	n	n	–	–	n	n	n
2	n	n	n	–	–	n	n
3	n	n	n	n	–	–	n
4	n	n	n	n	n	–	–
5	–	n	n	n	n	n	–
6	–	–	n	n	n	n	n
7	n	–	–	n	n	n	n

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There are several inherent difficulties associated with this type of shift scheduling system, including the following:

- Requires good cross training, so works best for interchangeable jobs
- Not equitable in terms of weekends off if you are on a crew whose fixed days off come in the middle of the week (no weekends off ever). Only one of the sub-crews would get the full weekend off
- If the schedule chosen rotates days off from week to week, a maximum of one full weekend off per seven weeks can be obtained (in this example)
- No team concept, as different people work together each day
- Complex to keep track of and fill overtime and absence
- Problem for one- or two-person jobs such as:
  - Supervisors / Team Leaders
  - Higher skilled positions
  - Key support individuals
  - Small departments

There are also some 3-crew 12-hour schedules possibilities, but these are costly to run as each employee works an average of 56 hours per week (which pays 64 hours with federal overtime).

FOUR-CREW SYSTEMS

Facilities that have always run 24/7, such as the continuous process industries, have demonstrated the benefits of four crew-scheduling systems, and it is the method of choice for most processing companies. The average 42-hour work week created by the 4-crew schedule is both sensible for the employees and cost-effective for the company. They are also relatively easy to manage. Figure 6, on the following page, is a typical 4-crew, 8-hour rotating schedule.

Figure 6: 4-crew, 8-hour shift schedule.

Week	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Work Hrs	Pay Hrs
1	d	d	d	d	d	d	d	40	40
2	–	e	e	e	e	e	e	48	52
3	e	–	–	n	n	n	n	40	40
4	n	n	n	–	–	–	–	40	40
							Average	42	43

(In this example, the pay week starts on Saturday a.m., resulting in the work hours as listed, and pay hours as required under U.S. overtime regulations.)

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The addition of the fourth crew makes the schedule self relieving. When one crew is off, another takes its place. Employees work an average of 42 hours, and are paid 43 with federal overtime (with this schedule). There are literally thousands of variations of 4-crew shift schedules, enabling employers and employees to choose a schedule that fits the operational needs of the business and the personal needs of the employees (although this can often become a daunting challenge). Examples of combination 8 and 12-hour schedules and straight 12-hour shifts are illustrated below.

Figure 7: 4-crew, 12-hour schedule.

Sched 1	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Work Hrs	Pay Hrs
1	d	d	–	–	n	n	n	48	52
2	–	–	d	d	–	–	–	36	36
3	e	n	–	–	d	d	d	48	52
4	–	–	n	n	–	–	–	36	36
							Average	42	44

(Pay week starts Sunday a.m.)

Figure 7, above, is a fast rotating EOWEO schedule (Every Other Weekend Off). Note how the 12-hour schedule averages 44 hours of pay per week, compared to the 43 hours on the 8-hour schedule. This is due to the fact that there are two 48-hour work weeks per cycle with 12-hour schedules vs. one with 8-hour shifts increasing the amount of federal overtime for straight hours worked. There are several methods to "pay neutralize" a 12-hour schedule so that it costs the same as to run a 7-day, 8-hour schedule.

Combination schedules provide for both some 8 and 12-hour shifts to serve as a compromise for a "polarized workforce." (Figure 8) By working what is essentially a "holdover" on Saturdays and Sundays (i.e., 12 hours of work), two out of every 4 weekends off can be provided — and both are long weekends. In addition, the breaks between shift turns are longer. While the average workweek is still 42 hours, it pays 43–43.5 hours (depending on the schedule) with federal overtime.

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Figure 8: 4-crew, combination 8 and 12-hour schedule.

Sched 1	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Work Hrs	Pay Hrs
1	n	–	–	–	d	d12	d12	40	40
2	d	d	d	d	–	–	–	44	46
3	e	e	e	e	e	–	–	40	40
4	–	n	n	n	n	n12	n12	44	46
							Average	42	43

(Pay week starts Sunday a.m.)

Employee Benefits and 24/7 Schedules

While employees do have to work some weekends, there are several benefits, including more predictable work days, less mandatory overtime, and Mondays off with 7-day schedules. This scheme is illustrated in the following mathematical features of 3-crew x 5-day schedules vs. 4-crew x 7-day systems.

Schedule Feature (per year)	3-Crew 5 Day: 8-Hour	4-Crew Continuous: 8-Hour	4-Crew Continuous: 12-Hour
Days worked	261	274	182
Difference		13	-79
Days off	104	91	182
Difference		-13	78
Hours Worked	2,080	2,184	2,184
Difference		104	104
Hours Paid	2,080	2,236	2,288
Difference		156	208
Full Weekends Off *	52	13	26
Difference		-39	-26
Long Weekends Off	0	13	26
Difference		13	26

* Assuming no overtime

While more days are worked after changing to an 8-hour continuous schedule, fewer days are worked with a 12-hour continuous schedule. Similarly, a 12-hour schedule results in more days off than a 5-day 8-hour schedule. Average weekly work hours increase from 40 to 42, resulting in 104 extra hours per year with continuous schedules. The hours paid can increase even more because of federal or state overtime regulations. Unless they are pay neutralized, 12-hour schedules pay 208 hours extra per year.

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While the move to a continuous schedule results in fewer weekends off on paper, probably just as many weekends were being previously worked through overtime. In addition, most weekends are now long weekends. Therefore, when provided in a factual light, the expansion to a 5 to 7-day operation can provide many benefits for the employees.

Potential Problems with a 5- to 7-day Expansion

Unfortunately, conversions to 24/7 are not straightforward. In fact, they are extremely complex and fraught with pitfalls that can have disastrous consequences if not properly planned and managed. To achieve all of the benefits of having continuous operations requires major cultural, organizational, and operational change. Many internal and external "customers" will be impacted, and all of the various production support groups (i.e., maintenance, materials and supplies, shipping and warehousing, payroll, etc.) will be significantly affected as well, in addition to your production employees: the managers, supervisors, and shiftworkers, who will now be required to work through the weekends on a regularly scheduled basis under different pay policies.

There are very few other workplace changes that can cause more employee discontent and union concern than a poorly implemented 5 to 7 change. By changing to work schedules that require regularly scheduled weekends or more evening or night hours, a company is directly affecting the employee's entire lifestyle and family and social structure. For example, childcare needs may be affected or there may be questions over the ability to attend religious services. Typical employee concerns include the following:

- Less desirable work schedule
- Regularly scheduled Saturdays and Sundays
- Regularly scheduled holidays
- Potential loss of overtime
- Major pay issues / fear of loss of pay
- Break-up of current work teams
- Issues with child care and domestic responsibilities
- Difficult lifestyle change for family
- Loss of traditional 5-day workweek
- Feelings of separation from organization
- Feelings of exploitation

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Employees who do not fully understand the business reasons for the change and are not involved in the change process will typically experience the emotional cycle of denial, anger, bargaining, and (with luck) acceptance. Those who do not accept the schedule change may leave, become less productive, or, in a non-organized facility, may try to initiate a union drive. If the change is forced upon employees with little discussion input, it is likely that the operation will experience significant turnover, decreased morale, and poor performance.

However, these downside risks can be avoided with proper planning and positioning of the business case, followed by an employee involvement process to determine the preferred work schedule. In this fashion, your business objectives can be achieved with minimal disruption of the workforce.

Conclusions

There are indeed substantial benefits to non-stop production 24 hours per day, 7 days per week. In fact, it is difficult for most companies to compete today with 40% of their capacity idle during the weekends or being inefficiently used with weekend overtime. Moreover, weekly start-ups and shutdowns further reduce productivity and efficiency, and the extent of weekend overtime and minimal time off takes its toll on the employees.

However, while the opportunity to increase profits, achieve greater asset utilization, defer capital expenditures, and better meet customer needs is alluring, the dramatic effects on the people throughout the organization will require solving many problems before most employees will accept the new schedule. Unless the entire organization understands and accepts the business needs for the change, and can truly support the result, it will not succeed. Taking the time to properly evaluate, plan, and implement the expansion to 24/7 production will greatly minimize these downside risks. Moreover, by adopting a people-friendly approach and involving your workers in a collaborative effort to facilitate the required changes, your production goals and objectives can be achieved with a win-win resolution.

For more information about expanding your operation from 5 to 7 days, or any other questions you may have concerning scheduling and shift work, please call CIRCADIAN at 1-781-439-6300 or email a specialist at info@circadian.com.

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ABOUT CIRCADIAN™

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THIRD EDITION
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