

## BIOPHARMA: MANAGING SHIFT SCHEDULES EXERCISE

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Scott Irving, the Manufacturing Manager for BioPharma's main pharmaceutical production facility, looked in on the Wednesday afternoon meeting between shift changes. The day shift ended at 4 p.m. and the swing shift began at 2 p.m., which enabled the two shifts to meet during the overlapping period. Wednesday meetings were not only important for managing the handover between the day and swing shifts, but also for managing the handover between work weeks. On Wednesday afternoon, two crews finished their work weeks and two other crews started their work weeks. The BioPharma plant had a total of six crews working 4 ten-hour days per week. Scott understood the challenges of working long shifts, having moved up from a production job himself.

The atmosphere of the handover meetings varied depending on whether the crews were addressing critical problems, reviewing processes and procedures, or simply socializing because everything had gone smoothly throughout the work week. Regardless of the type of meetings, Wednesday afternoons could be chaotic simply because twice as many people were on duty. The overlap between the shifts on Wednesdays was originally planned for maintenance, training, and special projects. Due to increasing process automation, there was not much for technicians to do during the actual production runs.

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Scott thought about the various challenges that faced BioPharma. The patent on one of its best-selling therapeutic drugs had recently expired, opening up competition from other manufacturers. That was not unexpected, but some legacy products had also been facing stiff price competition from generics manufactured in India. Furthermore, some of the company's new products had been slower than anticipated in getting through the challenges of clinical trials. BioPharma needed to gain approval by the Food and Drug Administration of these new products before ramping up to full production.

Amidst the current national debate on healthcare and new public policies aimed at controlling costs, the future of the plant was less rosy than everyone had assumed. BioPharma had been expecting high demand and ample profit margins. Although the company had never needed to be focused on production costs, Scott wondered if change was inevitable. Operational priorities were to maximize the yields on batches and to avoid scrapping batches due to contamination. The company had just ramped up its new production facility with twice the batch size of the original plant which (was still in operation next door).

When Scott returned to his office at the end of the day, he pondered the challenges facing the company. He recalled the Wednesday handover meeting, and wondered if it remained essential for operational efficiency and effectiveness. When the facility had first started two years ago, the meetings were necessary and very valuable. But now, after all the "bugs" had been worked out of the system and much of it was automated, he wondered if these meetings were needed. Perhaps they had served their intended purpose during the start-up phase of operations and could now be discontinued. Could he take steps to reduce the cost of labor and thereby improve the plant's efficiency, or was he looking to fix a problem that didn't exist?

### **BioPharma's Production Process**

BioPharma, a biotechnology firm that produced therapeutic drugs for various diseases including breast cancer, asthma, and non-Hodgkin's lymphoma, opened a manufacturing facility in 1998. In the production process, cells were cultured over a period of several days and then extracted to create the final product. There were three major steps in the process, each performed by a different group. First, Cell Selection selected the initial cells for starting production batches. Next, Cell Growth took those cells and gradually increased the volume over the course of several days. Finally, Cell Separation separated the cell culture solution from the final product.

The production process was supported by three other functions: Quality, Facilities, and Manufacturing Services. The Quality group performed continuous checks during production, testing the total organic carbon in the product as it moved through the culturing process. Facilities was the largest group. It maintained the manufacturing and testing equipment, and ran the utilities operations, using pumps, stills and boilers to inject distilled water for cell growth, storage, and cleaning. Manufacturing Services cleaned all the hoses, clamps, etc. that were used in the production process. Of course, sterile equipment and environments were critical for a successful production process. The "kitting" team within Manufacturing Services also supported the production process. Before a production run, the various components needed to start a batch were weighed, dispensed, and placed on pallets. Kits varied considerably for different products. Some required only a few ingredients; others required many items and took time to compile. The kitting team worked standard eight-hour shifts Monday through Friday, but it prepared kits for all of the production shifts. The basic organization is shown in Exhibit 1.

BioPharma's production process was highly automated and controlled by computers, but technicians initialized batches and monitored the individual production steps. At least three technicians were scheduled per shift in each of the production groups to cover for vacations and sick days. The plant would likely lose output if only one operator were present because one

person could not complete all the necessary tasks when a problem arose. All the various production systems were linked, so if one system went down, they could all fail in a domino effect. It took about ten hours to clear out and sterilize all production steps when the entire system needed to be restarted, and the cost of scrapped production was significant. Thus, the company preferred to keep more technicians on hand than strictly necessary to avoid such problems. There were a total of eleven technicians and two supervisors per shift in the production area. The average hourly wage was \$28 for technicians and \$38 for supervisors.

**Exhibit 1. Production Process and Work Groups**

1. Cell Selection	2. Cell Growth	3. Cell Separation
Quality		
Facilities		
Manufacturing Services		

### Shift Schedule

When BioPharma opened the original production facility, it developed a schedule for its employees that provided overlap between shifts to ensure that important information was passed from one crew to the next. Sharing of information was crucial in the start-up phase, and management wanted to create a sense of community among the workers that would facilitate cooperation between crews. Scott Irving explained:

*The current shift structure was developed by a team with representatives from the different manufacturing departments to research and propose solutions to the eventual need for round-the-clock staffing, specifically in Cell Selection and Cell Separation. Several shift structures were researched and weighed against the business needs of the organization at that time. We wanted to make sure to create and maintain a safe work environment, achieve the target success rates for operations, comply with state and federal regulations, and operate most efficiently.*

The production facility operated 24 hours per day, seven days per week and the workload was generally constant across all shifts. The original shift schedule, developed in 1998, was referred to as a “6-crew offset 4 x 10” schedule (see Exhibit 2). There were six crews that each worked four consecutive days for ten hours each. There were two hours of overlap between each shift plus a full day of overlap between crews once per week. Two crews started the work week on Sundays, one at 6 a.m. and the other at 2 p.m.; two crews started on Wednesdays, also at 6 a.m. and 2 p.m.; one crew started on Saturdays at 10 p.m.; and one crew started on Tuesdays at 10 p.m.

**Exhibit 2. Current 6-Crew Offset 4 x 10 Shift Schedule**

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
<b>Crew 1</b>	6am-4pm	6am-4pm	6am-4pm	6am-4pm			
<b>Crew 2</b>				6am-4pm	6am-4pm	6am-4pm	6am-4pm
<b>Crew 3</b>	2pm-12am	2pm-12am	2pm-12am	2pm-12am			
<b>Crew 4</b>				2pm-12am	2pm-12am	2pm-12am	2pm-12am
<b>Crew 5</b>	10pm-8am	10pm-8am	10pm-8am				10pm-8am
<b>Crew 6</b>			10pm-8am	10pm-8am	10pm-8am	10pm-8am	

Employees were paid 50% overtime for hours beyond the standard eight-hour work day, as required by federal and state laws. In addition to overtime pay, employees received “shift differentials” of 11% for swing shifts and 16% for grave shifts. From an employee perspective, one of the key advantages of the schedule was that it allowed for three days off in every week. Compared to a standard eight-hour day, five-day work week, it provided more days off per year. BioPharma found that the longer shifts did not adversely affect safety or performance and employees appreciated fewer commuting days.

All new manufacturing employees at BioPharma attended a four-hour seminar called “Coping with Shift Work” within their first few weeks at the company. This training covered the health and social aspects of shift work, and offered some pointers on how to adapt to non-traditional work schedules. The seminar offered strategies for maintaining a healthy lifestyle and routine interactions with family while working atypical shift patterns. This seminar was the only one given and no follow-up training was provided.

Some employees preferred swing and graveyard shifts because they were full-time college students and could attend classes during the normal work day. They were hired to work as probationary “interns” while they finished their technical degrees, providing the company a valuable source of labor along with the opportunity to screen these employees through on-the-job training.

Employee satisfaction was important to BioPharma. Historically, the company promoted a positive work culture and enjoyed high profit margins. When the VP of Strategic Planning was asked about the high levels of inventory that were carried, she responded, *“We don’t really worry about the cost of carrying inventory, or if we are carrying too much inventory. Our margins are so high that we don’t need to be concerned about it. We want to make sure we always have ample supply of products for our customers.”*

Despite the advantages of the current shift schedule for employees, Scott Irving could not ignore the drawbacks. The biggest problem was the amount of overlap between shifts, especially on Wednesdays. Also, because BioPharma’s manufacturing facility was no longer in start-up mode, Scott thought that perhaps the assumptions on which the original schedule was based were no longer valid:

*It has been nearly ten years since the first organizational structure for manufacturing was researched and implemented. I think it’s time for a change, especially with the increased focus on costs and maximizing operational efficiencies. The site is currently undergoing an expansion, and senior leadership seems ready to revisit organizational structures and scheduling in manufacturing.*

*It has been nearly ten years since employee feedback was gathered on work schedules. Input from current employees is necessary to determine whether an alternative structure better matches their needs.*

### **Survey of Employees**

Scott Irving recalled hearing that the managers of BioPharma's San Francisco site, where products for clinical trials were produced, had tried various schedules in the past couple of years. He vividly remembered their horror stories of problems with repeated transitions between the various shift schedules that were tested.

Scott did some quick calculations to compare the labor costs using his plant's schedule with the one in use at the San Francisco facility, a "3 x 12, alternating Wednesdays" schedule. Employees worked three 12-hour days one week and four 12-hour days the next week, with every other Wednesday off. He computed annual labor cost savings of over \$2 million with this alternative schedule. This finding inspired him to explore more alternatives. Scott knew that he would have to obtain "buy-in" from the employees on any changes that were made. Somehow he needed to balance the business requirements with the employees' needs.

Scott decided to develop and send a survey to obtain the employees' input on alternative shift structures. In the survey, he presented four different shifts schedules to the employees for feedback. Scott's shift schedule alternatives are shown in Appendix 1 and summarized below. His survey questions are provided in Appendix 2.

#### **Option 1: 6-Crew Offset 4 x 10**

The current schedule had six crews each work 4 consecutive 10-hour days. Two crews started the work week on Sundays, one beginning at 6 a.m. and the other at 2 p.m.; two crews started on Wednesdays, also at 6 a.m. and 2 p.m.; one crew started on Saturdays at 10 p.m.; and one crew started on Tuesdays at 10 p.m.

**Option 2: 3x12, Alternating Wednesdays**

This schedule was used at the San Francisco plant. It had four crews work 12-hour shifts, alternating three and four work days per week with alternate Wednesdays off. This schedule had no overlap between shifts.

**Option 3: 4x10 & 3x10 Hybrid**

This variation of BioPharma's current schedule eliminated the overlap on Wednesdays by having half of the workers on each of the six crews put in three shifts per week instead of four, thereby reducing those workers' hours to a total of thirty per week. This schedule maintained the two hours of overlap between shifts.

**Option 4: 4x10 Plus 3x13 Weekend Wrap**

This alternative had three crews working four ten hour shifts Monday through Thursday, with two additional crews covering Friday through Sunday in three thirteen hour shifts. It had two hours of overlap on Monday through Thursday shifts and one hour of overlap on Friday through Sunday shifts.

Scott received 38 responses to his survey. He conducted some simple statistical analyses, summarizing the data and investigating correlations. The sample size was small, and he wondered how the survey could help him with his decision. Appendix 3 summarizes the responses for selected questions and Appendix 4 provides Scott's statistical analysis. Employees provided comments in the open-ended portion of the survey and a subset of these is shown below. A complete list of comments is shown in Appendix 5.

- *Overlap days make it possible for each shift to get time for project work and team assignments that they may not otherwise get on single-shift days with a busy schedule. They also foster a sense of camaraderie between shifts, which helps to nourish a familiarity within the department and company overall.*
- *It is important to be able to update the following shift on what has occurred, which state the process is in, and enough time to inform the following shift what to keep an eye out for.*



- *The overlap allows us to participate in other non-floor related opportunities. In many instances, these outside opportunities have been helpful in an individual's career growth.*
- *Overlap days are a waste of my time as well as the company time.*
- *To me overlap is not important. I know some people use it as a crutch so that they can get "off the floor work" complete. In my opinion, the "off the floor work" can be done opportunistically.*
- *I like the option of working only 30 hours per week. I don't like the idea of 12 hour days. All you would do is eat, sleep, work.*
- *Some shifts have the luxury of having both Saturday and Sunday off, some have one of the two days, and some have neither. Because of this, one shift becomes an "ideal" shift because of the hours and the days off. By design, most senior technicians will strive to move to that shift and junior technicians have to bear with the less than ideal shifts. Senior technicians are a valuable resource and it would be better to have at least two per shift. In addition, not having days off when the rest of your family has their days off tends to make it difficult to find work/life balance.*
- *Graves needs to be treated less like second-class citizens of the company. Keep the cafeteria open 24/7, make meeting times more accommodating for off shift workers so their sleep cycles aren't completely messed up.*
- *Please consider that working on a new shift may not be a decision made by the technician but rather a product of shift moves made by senior technicians and thus, junior technicians are forced to work on a new shift.*

Scott wondered if he could successfully change the shift structure to save money while maintaining the culture that made BioPharma's manufacturing group such a desirable place to work.



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Dr. Wilson's current research addresses the environmental impacts and sustainability reporting of supply chains, concentrating on transportation and sourcing decisions. She has written a textbook for an undergraduate course in Operations Management, develops cases for classroom use, and conducts research on pedagogical methods.



**Maureen Lojo** is an Associate Professor in the Marketing and Supply Chain Management group at California State University, Sacramento. Her work experience includes founding a microbrewery as well as working for a biotechnology company. She has taught undergraduate and graduate courses on operations management, quality, supply chain management, service operations, and management of technology. Prior to joining the faculty at Sacramento State, Dr. Lojo taught at Cornell University, Universidad Torcuato di Tella in Buenos Aires, and Brandeis University. She earned a BA in History at U.C. Berkeley, a Master in Public and Private Management at Yale University, and a doctorate in Operations Management at M.I.T.

**Appendix 1. Alternative Shift Schedules**

Option 1: Current Shift Schedule, 4x10

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Crew 1	6am-4pm	6am-4pm	6am-4pm	6am-4pm			
Crew 2				6am-4pm	6am-4pm	6am-4pm	6am-4pm
Crew 3	2pm-12am	2pm-12am	2pm-12am	2pm-12am			
Crew 4				2pm-12am	2pm-12am	2pm-12am	2pm-12am
Crew 5	10pm-8am	10pm-8am	10pm-8am				10pm-8am
Crew 6			10pm-8am	10pm-8am	10pm-8am	10pm-8am	

Option 2: 3x12 plus alternating Wednesdays

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Crew 1	7am-7pm	7am-7pm	7am-7pm				
Crew 2					7am-7pm	7am-7pm	7am-7pm
Crew 3	7pm-7am	7pm-7am	7pm-7am				
Crew 4					7pm-7am	7pm-7am	7pm-7am

Option 3: 3x10, 4x10 hybrid; half of each crew works 30 hour weeks (not on Wednesdays)

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Crew 1	6am-4pm	6am-4pm	6am-4pm				
Crew 2					6am-4pm	6am-4pm	6am-4pm
Crew 3	2pm-12am	2pm-12am	2pm-12am				
Crew 4					2pm-12am	2pm-12am	2pm-12am
Crew 5	10pm-8am	10pm-8am					10pm-8am
Crew 6				10pm-8am	10pm-8am	10pm-8am	

Option 4: 4x10, 3x13 "weekend wrap"

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Crew 1		6am-4pm	6am-4pm	6am-4pm	6am-4pm		
Crew 2		2pm-12am	2pm-12am	2pm-12am	2pm-12am		
Crew 3		10pm-8am	10pm-8am	10pm-8am	10pm-8am		
Crew 4	7am-8pm					7am-8pm	7am-8pm
Crew 5	7pm-8am					7pm-8am	7pm-8am

**Appendix 2. Survey Questions**

1. How long have you been employed at BioPharma?

Less than 1 year

Between 1 and 3 years

Between 3 and 6 years

Between 6 and 10 year

2. What shift(s) within manufacturing have you worked on? (Choose all that apply.)

Tuesday-Friday Graves

Saturday-Tuesday Graves

Wednesday- Saturday Swings

Sunday-Wednesday Swings

Wednesday-Saturday Days

Sunday-Wednesday Days

Other \_\_\_\_\_

3a. Indicate the importance of each of the following factors when determining which shift to work.

	Not important at all	Not very important	Somewhat important	Very important
Compatibility with school schedule	1	2	3	4
Quality time with family	1	2	3	4
Shift pay/differentials	1	2	3	4
Shift leadership	1	2	3	4
Personal health	1	2	3	4
Which days you have off	1	2	3	4
Shift length	1	2	3	4

3b. Please enter any additional factors not listed above.

4. Rate your current level of satisfaction with the shift structure within manufacturing.

Not satisfied at all

Not very satisfied

Somewhat satisfied

Very satisfied

Briefly explain, noting any particular benefits/drawbacks to the current structure.

5a. Are there any schedules listed above that you would at least initially consider as potential replacements for our current shift structure and would like more information on? Check all that apply, and briefly describe why you chose them.

Option 2

Option 3

Option 4

No way, I like the current shift structure too much

5b. From your experience, would you recommend another shift structure that allows for 24/7 coverage that is not mentioned above? If so, please describe.

6. Would working a shift for 30-36 hours a week (3x10, 3x12) appeal to you?

Yes

No

7a. The current level of overlap between shifts (daily and on Wednesdays) is:

About right/time well spent    Too much/could be lowered

7b. Other opinions? Please comment on how important/unimportant overlap is in your day to day work.

8. Do you have any other comments on shiftwork in Manufacturing?

### Appendix 3. Summary of Responses for Selected Survey Questions

Question 3a.

Please rate the importance of the following factors in your decision to work a new shift	Not At All Important	Not Very Important	Somewhat Important	Very Important
Compatibility with school schedule/education	11	8	12	5
Quality time with family	2	0	5	29
Shift pay/differentials	1	7	20	8
Shift leadership (leads, supervisors, managers)	3	6	14	13
Personal health	3	4	11	18
Which days you have off	2	5	10	19
Shift length	5	9	17	5

n=38

Questions	Responses	Count
4. Rate your satisfaction with the current shift structure within Manufacturing	Somewhat satisfied	10
	Very satisfied	14
	Not very satisfied	6
	Not satisfied at all	1
5a. Are there any schedules that you would consider as replacements for our current shift structure? Check all that apply	No way. I like the current schedule	3
	Option 2	11
	Option 3	7
	Option 4	17
6. Would working a shift for 30-36 hours a week (3 x 10, 3 x 12) appeal to you?	No	11
	Yes	18
7. The current level of overlap between shifts (daily and on Wednesdays) is:	About right/time well spent	14
	Too much/could be lowered	15

n=38

### Appendix 4. Statistical Analysis

#### 6a. Average Importance Ratings for Factors in Question 3a

Factors in decision to work a new shift:	Average Importance Rating
Compatibility with school schedule/education	2.361
Quality time with family	3.694
Shift pay/differentials	2.972
Shift leadership (leads, supervisors, managers)	3.028
Personal health	3.222
Which days you have off	3.278
Shift length	2.611

n=38

#### 6b. Significant correlations (p-values less than 0.10)

Factor 1	Factor 2	Correlation coefficient/p-value
Length of employment	Satisfaction with current schedule	0.375/0.041
Compatibility with school schedule	Shift pay/differentials	0.357/0.033
	Shift leadership	0.287/0.089
Quality time with family	Shift length	0.284/0.093
Shift pay/differentials	Shift leadership	0.414/0.012
	Personal health	0.616/0.000
	Which days you have off	0.309/0.067
Personal health	Which days you have off	0.384/0.021
	Shift length	0.399/0.016
Which days you have off	Shift length	0.689/0.000
Length of Employment	Option 4	0.322/0.048

n=38

### **Appendix 5. Survey Comments on Questions 7b and 8.**

#### **Question 7b.**

1. 36 hour weeks would need to keep benefits. I get a lot accomplished during overlap time.
2. It is good to catch up with the other members but I think it results in some wasted time.
3. Everyone needs to help out on the floor before working on projects.
4. The overlap allows us to participate in other non-floor related opportunities. In many instances, these outside opportunities have been helpful in an individual's career growth.
5. Overlap days make it possible for each shift to get time for project work and team assignments that they may not otherwise get on single-shift days with a busy schedule. It also fosters a sense of camaraderie between shifts, which helps to nourish a familiarity within the department and company overall.
6. There are shifts that have a lot of overlap between shifts, such as the swing shift. With shifts that get less overlap, it's more difficult for technicians to pursue projects or work on reports, etc. Wednesdays are a great day to get to work with the other side of the week and is thus good for team-building. However, double coverage does not mean that twice the amount of work gets done. More often than not, there are either too many technicians on the floor or far too few. To get the best out of Wednesdays, maybe half of one shift and half of the other shift can work on the floor and the other shift can work on projects so that we have team-building and that people have time to take care of what needs to be done.
7. From a convenience standpoint, the current structure is great. A lot of "off the floor" work, such as debug, team project work, etc. can be done without having to worry about floor coverage. However, there is more downtime than necessary for some.
8. Actual overlap is smaller than it looks. Previous shift leaves as soon as on coming shift arrives on floor. Question 7 does not allow for "not enough actual overlap" response.
9. It is important to be able to update the following shift what has occurred, which state the process is in, and enough time to inform the following shift what to keep an eye out for.
10. To me overlap is not important. I know some people use it as a crutch so that they can get "off the floor work" complete. In my opinion the "off the floor work" can be done opportunistically.
11. Some time is required. I have worked with a 2.5 hour overlap and a 1.5 hour overlap. 1.5 is more than adequate.
12. Overlap only affects me when I need to work on a computer and I can't find a free one.
13. Overlap is important. It should include 30 intense minutes and that is all.
14. Overlap days are a waste of my time as well as the company time.
15. I like the option of working only 30 hours per week. I don't like the idea of 12 hour days. All you would do is eat, sleep, work.
16. Waste of time as many people take advantage of it and flee from work and hide.

17. Some overlap is great, but our current level is inefficient. With the current process team model, though, this works out very well because we let a lot of people leave early on Tuesday nights to attend these meetings. If we revise the shift structure, then the process team structure would have to be revisited.

**Question 8.**

1. I like the grave shift. Getting off at 0630 in the morning is much better (in my opinion) than getting off at 0830.
2. Graves needs to be treated less like second-class citizens of the company. Keep the cafeteria open 24/7, make meeting times more accommodating for off shift workers so their sleep cycles aren't completely messed up. The facility is 24 hours, even if every department isn't, and this should be taken into consideration. The 5% differential Graves makes in comparison to Swings is nowhere NEAR enough to compensate for the effect it has on your outside life. Better pay and better perks (cafeteria, etc.) will help people be content on the shift, give more back, and hopefully reduce turnover on the shift.
3. The current differential for graveyards is very inadequate. The 10% for swings is fine, but the step up to graves should be another 10% not 5%.
4. Working in and of itself on an off shift is not difficult because you eventually get used to the hours and you eventually adjust your lifestyle. Part of the reason why people don't work off-shifts is because of the lack of support. Some examples include not having supplies for a test or sanitized gaskets at 3 a.m., not having automation on site 24/7 and not having the cafeteria open among other things.
5. There should be at least one shift or side of the week that has both Saturday and Sunday off to match their family's schedule.
6. If we have a shorter shift structure would we still receive benefits?
7. Some shifts have the luxury of having both Saturday and Sunday off, some have one of the two days, and some have neither. Because of this, one shift becomes an "ideal" shift because of the hours and the days off. By design, most senior technicians will strive to move to that shift and junior technicians have to bear with the less than ideal shifts. Senior technicians are a valuable resource and it would be better to have at least two per shift. In addition, not having days off when the rest of your family has their days off tends to make it difficult to find work/life balance.
8. Please consider that working on a new shift may not be a decision made by the technician but rather a product of shift moves made by senior technicians and thus, junior technicians are forced to work on a new shift.