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Dräger Medical Systems, Inc.: Technology for Life

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INTRODUCTION

Bill Nicholson, Strategic Operations Manager for Dräger Medical Systems, Inc., faced a daunting task…or was it a great opportunity? Dräger management recently announced plans to close the company's Danvers, MA, production facility and move the patient monitoring production operations currently in Danvers to its Monitoring and IT Product headquarters in Andover, MA, if possible while meeting desired criteria. In announcing this decision, management noted the many benefits associated with co-location of R&D and production operations. Bill also knew that management anticipated significant cost savings after absorbing the consolidation costs. Cost savings, co-location benefits, all good news…so where was the challenge?

For starters, the Danvers site was a 33,000 sq. ft. production facility and Andover had approximately 18,000 sq. ft. of available space. Despite the reduction in space, management also made it clear that the new facility must be capable of producing the same output volume as the Danvers production site. In fact, management also anticipated that the new facility would be positioned to meet higher production volumes if market demand grew. Bill wondered aloud, "*We're operating at a high utilization level today. There's simply no slack in the system. And, we have no extra space here in Danvers. How can we move the entire production system to a facility with 45% less space and maintain or expand our capacity? Of course, if we can do this, we could serve as a model for operating system design and redesign for other Dräger facilities.*"

COMPANY PROFILE

Dräger, headquartered in Lübeck Germany, is an international leader in medical and safety technology. Founded in 1889, Dräger is now a fifth generation family-run business. The Dräger website[1] attributes the organization's long-term success to an ongoing commitment to "a value-oriented corporate culture with four central strengths: close collaboration with our customers, the expertise of our employees, continuous innovation and outstanding quality. Technology for Life is our guiding principle and our mission. Wherever they are deployed – in clinical settings, industry, mining or emergency services – Dräger products protect, support and save lives."

Dräger's two main business units are safety products and medical products. The Safety Division provides its customers with complete hazard management solutions with a special focus on personal safety and protecting production facilities. The current product portfolio includes stationary and mobile gas detection systems, respiratory protection, firefighting equipment, professional diving gear, and alcohol and drug-testing instruments.

[1] www.draeger.com

The authors are grateful to Dräger Strategic Operations Manager Bill Nicholson and Dräger's Manager of Production Engineering, Mahesh Lawande, for their cooperation and assistance in the preparation of this case.

The Medical Division's product suite encompasses anesthesia workstations, ventilation equipment for both hospital-based intensive care and home care, emergency and mobile ventilation units, warming therapy equipment for infants, patient monitoring equipment, and clinical IT and software solutions. Dräger's customers are increasingly interested in purchasing integrated solutions as opposed to individual products; therefore, the monitors produced today in Danvers must be viewed as a component to a solution, rather than a discreet product. This focus on integrated solutions is also raising the importance of Dräger's clinical IT and software products. In the past, monitors typically captured and displayed information related to one aspect of patient care. Many of today's monitors assimilate data from multiple patient tracking devices and display an amalgam of synthesized patient information.

SOCIAL RESPONSIBILITY AND ENVIRONMENTAL PROTECTION

Dräger management stresses that all employees carry the responsibility of protecting lives, noting that *"whenever our products are used, people entrust us with their most valued possession—their life. That's why we get involved in issues far beyond the boundaries of our company grounds—for our customers, our employees, our investors, and for society as a whole."*

Dräger's strategy encourages the design of processes with sustainability in mind and a goal to utilize all resources sparingly. Since 1998, all operations at the Lübeck site have been certified in accordance with DIN EN ISO 14001[2] as part of a group certification. In the future, this certification will be continuously extended to all Dräger subsidiaries. The company focuses considerable attention on waste prevention and recycling, reducing water consumption, and redesigning production lines to meet high environmental standards. In addition, the company regularly pursues projects dedicated to reducing carbon dioxide emissions. Examples of these projects include:

- Implementing a cogeneration power plant: Dräger developed a gas-powered cogeneration power plant in Lübeck. This plant entered service in 2008, generating electricity with the most modern combined heat and power generation technologies while simultaneously producing heat, which reduces energy consumption and carbon dioxide emissions.
- Implementing reusable packaging systems: Dräger has been using "commuter" packaging systems for many years. These environmentally friendly reusable packaging solutions "commute" between suppliers, production, logistics, as well as customers—helping Dräger to avoid large amounts of wood and cardboard waste. This also results in less exposure to dust, preserves the health of employees through ergonomic design and, due to its long life cycle, reduces both packaging and handling costs.
- Activated carbon production: Dräger's activated carbon production facilities play a major role in helping to reduce air emissions and guarantee effective explosion protection and high safety standards when dealing with chemicals. By effectively cleaning the dust-laden flue-gas, state-of-the-art flue gas scrubbers, integrated gas measuring and control technology, as well as numerous high performance filters, ensure environmentally compatible and fail-safe operations of production facilities.

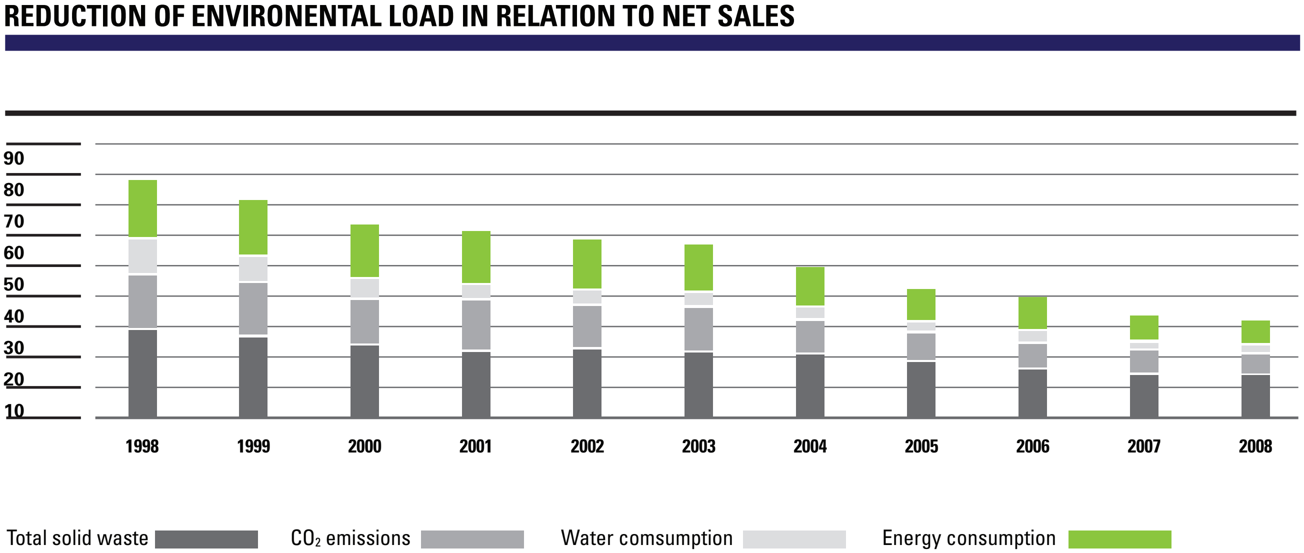
See Exhibit 1 for summary results of Dräger's sustainability efforts.

THE CHALLENGE…OR OPPORTUNITY

The Danvers facility became part of the Dräger operating infrastructure when the company entered into a joint venture with Siemens Medical Solutions in 2003. Upon entering this joint venture, Dräger management considered closing the Danvers facility and either moving monitor production to an existing Dräger facility in Telford, PA, or outsourcing production to a third party located in Asia. At the time, management opted to keep monitor production in the Danvers facility. One reason for this was that product integration and software integration were becoming increasingly important factors in creating differentiated products. The decision to keep production in Danvers allowed Dräger to maintain a production presence in close proximity (~20 miles) to its nearby Andover, MA, offices. The Andover facility housed research and development, product management, marketing, and software engineering personnel who were responsible for a variety of Dräger products, including monitors. Andover also designed and developed the monitor testing stations used in the Danvers production facility.

[2] The ISO 14000 standards are practical tools for the manager who is not satisfied with mere compliance with legislation – which may be perceived as a cost of doing business. They are for the proactive manager with the vision to understand that implementing a strategic approach can bring return on investment in environment-related measures. Source: ISO Web site.

Exhibit 1
Summary Results of Dräger's Sustainability Efforts



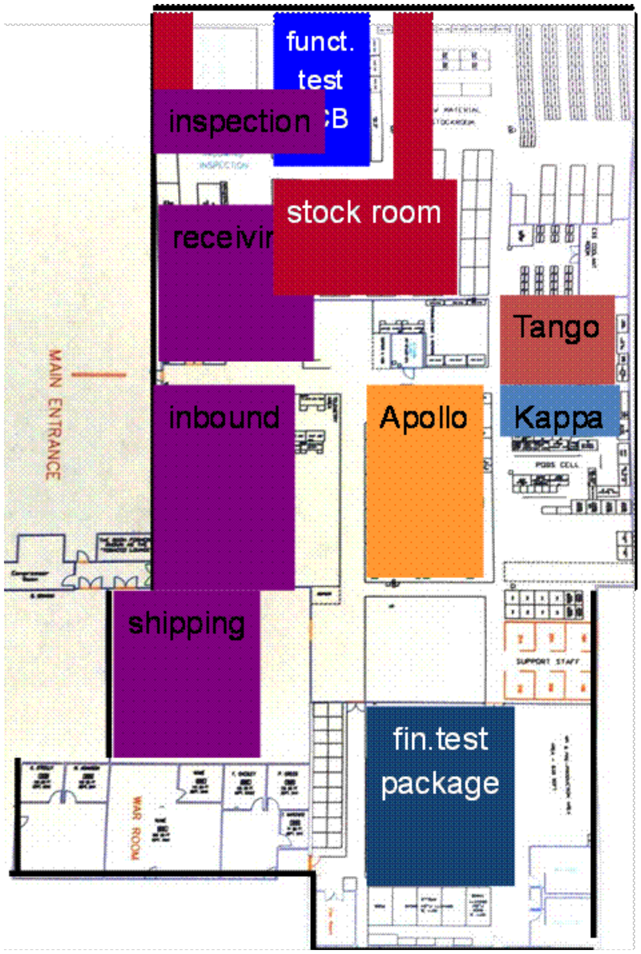
A continuous decline in environmental load indices at the Lobeck site as measured against revenues

For the Danvers workforce, management's commitment to their facility always felt tenuous, and considerable uncertainty as to the longevity of the plant enveloped the workforce. The 2007 arrival of new operations chief, Dr. Fehrecke, marked a renewed focus on effectiveness and efficiency in both production and product design. Dr. Fehrecke visited the Danvers plant and directed management to form a task force to study relocation options. Dr. Fehrecke declared that remaining in Danvers was not an option. The lease on the Danvers facility was coming due for renewal and Dräger management did not want to extend the lease for extraneous, outdated facilities. As currently constituted, the Danvers operation did not reflect the corporate commitment to highly productive, lean operations. The current operations reflected the state of the capabilities prevalent in the industry during late 90s, not the state-of-the-art that Dräger strove to achieve throughout its global operating facilities. It was no surprise, therefore, that the charge for this task force also stipulated that proposed solutions must incorporate significant improvements in process capabilities and operational performance. An important criterion for the new operations facility was that it should be able to do more with less. Leaving Danvers was one way to force the issue. Space allocation and a high-level footprint for the Danvers facility can be found in Exhibit 2 and Exhibit 3 respectively.

Exhibit 2
Current Danvers Space Allocation (square feet)

Receiving	1,521	Sq. feet
Raw materials processing	1,222	Sq. feet
Stock room 1	511	Sq. feet
Stock room 2	7,977	Sq. feet
Stock room 3	2,456	Sq. feet
Packing	1,491	Sq. feet
Shipping	2,773	Sq. feet
Production area 1	832	Sq. feet
Production area 2	1,152	Sq. feet
Production area 3	1,100	Sq. feet
Production area 4	589	Sq. feet
Production area 5	721	Sq. feet
Production area 6	931	Sq. feet
Rework and repair	1,237	Sq. feet
2nd Rework and repair	540	Sq. feet
Test Lab	547	Sq. feet
Calibration Lab	225	Sq. feet
Offices	2,178	Sq. feet
Aisles	5,249	Sq. feet
TOTAL SQUARE FOOTAGE	**33,252**	**Sq. feet**

Exhibit 3
Current Danvers Facility layout (approx. 33,000 sq. ft.)



Three primary alternatives were available. As in 2003, monitor production could have been relocated to Telford or outsourced to Asia. Both of those options, however, made the strategically important connection between production, process engineers, IT integrators, and product engineers difficult. Co-location of these functions was clearly the preferred alternative, if feasible and financially advantageous. The third option, moving the monitor production to Andover, would allow co-location. It was unclear at the outset whether this could be done, however, and, if so, whether satisfactory reductions in total operating costs would be realized as a result.

Dräger's Andover facility had available unused space. At one time, Dräger considered subletting this space but rejected the idea based on a desire to closely control the type of operations that would fill the space. A chemical spill at a neighboring (non- Dräger) facility only heightened these concerns further. Dräger wanted to control the types of operations that would be present in Andover, and subletting the available space would strip the company of this control. In the past, management never considered moving the Danvers operation to this location to be a viable option because the space available was significantly smaller (45%) than the current Danvers operation. The task force opted to revisit this alternative, based upon their observation of process improvements created through the company's commitment to a new process improvement program entitled PRIME. PRIME (Production Improvement and Manufacturing Excellence) was a relatively new initiative focused on process innovation and the adoption of lean processing concepts. Task force members believed that improvement generated through the adoption of PRIME principles could include substantial reduction in space requirements, thus making relocation to Andover a viable option.

The task force, in collaboration with a third party consulting firm, completed a detailed assessment of the Danvers operation. Their analysis identified numerous opportunities for process improvement. Monitor assembly and testing was largely, though not entirely, a single unit operation – i.e., each worker completing his/her task on one unit at a time. Yet the production units moved through the system in relatively large (60-unit) production lots. This meant that each production step completed an order lot of 60 production units prior to moving that lot on to the next production station. The task force and the consulting partners observed this to be quite contrary to lean production principles and believed that transitioning to a more JIT (Just in Time) single-unit production philosophy for moving units through the system could generate a considerable portion of the space savings necessary to fit the operation into the available space. As a result, the task force designed a process that would eliminate the use of those 60-unit production lots and allow monitors to flow through the system as individual units.

The task force knew that it was important to complete any process relocation without causing any disruption in the existing monitor supply chain. The monitor supply chain was relatively straightforward, and the task force believed that it would not be significantly impacted by a move to Andover. The Danvers plant currently received raw materials and components from a variety of sources. Several of these suppliers already shipped product to Andover. On the outbound side, Danvers shipped all finished product daily. Danvers did not ship finished goods directly to customers. Monitors produced in Danvers first went to Dräger's main facility in Lübeck, Germany. The Lübeck site performed final customization and integration testing. Final customization included labeling, software integration, documentation to support 22 different languages, consolidation with accessories, and final packaging. Integration testing involved system testing the monitors together with additional Dräger products that comprised the final, complete product shipment to end customers. Dräger's U.S. market share was relatively small, with approximately 80% of the monitors produced in Danvers ultimately shipped to customers outside of the U.S., so sending monitors to Germany did not create significant excess or unnecessary shipping expenses. Dräger hoped to expand its U.S. presence and market share in the near future and may consider shifting customization, integrative testing, component kitting, and customer shipment responsibility to the Andover facility in the future. This shift would only apply to monitors destined for the North American (U.S. and Canada) market. Dräger would continue to ship all monitors ordered by non-North American customers to Lübeck for final processing and customer shipment.

Exhibit 4
Apollo Platform Delta Model Patient Monitor

Exhibit 4a
Apollo Platform Delta XL Model Patient Monitor

CURRENT AND PROPOSED OPERATING DESIGN

Dräger's Danvers facility operates one production shift that works five days per week. Dräger conforms to company standards that define work schedules – the production workday is 7:30 – 4:30 with a one-hour (unpaid) lunch break and two (paid) 15-minute breaks. The company does not currently allow overtime and does not wish to implement a second production shift. These constraints on overtime and second shifts are consistent with corporate management's global operating policies and cannot be violated. There are 250 workdays per year, but all personnel are paid for a full year, including 10 paid holidays; therefore payment is computed for 260 days.

The Danvers plant produced multiple monitor types, each a product platform. These monitor types include Apollo, Tango, Kappa, and the M300.[3] The Apollo platform is among the higher volume products produced in Danvers, and Nicholson believed that the Apollo production system was representative of the overall production environment at Danvers. Apollo is a product platform that includes the Apollo Delta (see Exhibit 4) and Apollo Delta XL (see Exhibit 4a) models. The task force therefore focused initial process assessment, redesign, and new process beta testing efforts on the Apollo line. Exhibit 5 contains a detailed description of the seven-step production process for Apollo monitors. (Exhibit 6 presents a process flow for the current process) Current demand for all Apollo monitors (Delta and Delta XL) averages 64 units per day, and Dräger does not store any significant finished goods inventory. Therefore, the production rate for the Apollo product was set at 64 units per day in 2008. Dräger did not anticipate significant short-term change in Apollo demand and planned to maintain the production rate at 64 units per day in 2009.

Details of the proposed design for the new 6-step Andover production process can be found in Exhibit 7. The work schedule and constraints on overtime and second shifts that exist in Danvers will also be applied to the proposed Andover operation. Dräger management anticipates growth in demand for all monitors, including Apollo, in 2010 and beyond. The expansion of U.S. market share would also add to demand growth and require that the Andover facility be capable of

[3] Apollo and Tango are internal references to a family of products. For example, the Apollo family includes the monitors sold under the product name Delta, Delta XL, and Vista XL.

Exhibit 5
Process Description for Danvers Facility[5]

1. **Monitor assembly:** This step fits critical components into the housing of the monitor. It is critical to properly align components in the monitor in order to achieve the desired luminance (brightness) of the monitor's display panel. There are two different configurations for Apollo monitors and each requires a different amount of processing time at this step. The standard monitor or Delta product, which represents 55% of demand, requires 4 minutes of set-up time per monitor and 6 minutes of processing time. The newer "Delta XL" monitor, which comprises the other 45% of demand, requires 5 minutes of set-up time per monitor and 10 minutes of processing time. There are two workers and two machines, each working independently, at this process step. The flow of product is based upon demand, so both workers process a mix (55% & 45%) of Delta and Delta XL monitors.

2. **Initial ambient test:** The ambient test is an extended run in test of the assembled monitor and its assembled components at room temperature. Workers test monitors in batches of six. It requires eight minutes of set-up time per monitor to prepare a unit for testing (connecting components to test equipment). Once the six monitors are connected to the testing equipment it then requires 240 minutes of ambient (run) test time. There are ten testing stations, each capable of supporting six monitors, and two workers (working independently) at this stage. The only labor requirement at this stage is for the set-up time. Once the set-up is complete, the test runs with no worker (labor) involvement. The testing equipment will automatically shut down upon completion of a test, so you can assume that workers set-up and initiate tests for the full workday. (In other words, it is not necessary to stop initiating tests so that all tests are completed by 4:30 pm – the end of the workday.)

3. **Ambient offset:** The ambient offset step is a 1-minute 48-second process that occurs upon completion of the ambient test. This task involves disconnecting the monitor from the testing station and moving the monitor to the lot rack. When the rack is full (60 units) the worker moves the rack to the next production step (Step 3). The 1-minute and 48-second time is a per-unit time, as the worker disconnects and moves one set of components at a time. There is one person assigned to this step and there are no machinery requirements.

4. **Front-end parameter testing:** The FE parallel connection step requires 10.5 minutes of processing time. There are two workers and two machines, each working independently, at this process step. .

5. **Label and final assembly:** There is one worker and one machine at the labeling and final assembly step. In total, labeling and final assembly requires five minutes of processing time per monitor.

6. **Final inspection:** The final inspection step requires 1 minute of set-up time and 3.3 minutes of processing time. There is one worker and one machine at this processing step.

7. **Packaging:** Packaging requires two minutes of processing time. Packaging involves boxing the monitor and adding it to the pallet for shipment to Lübeck. There is one worker and one machine at this processing step.

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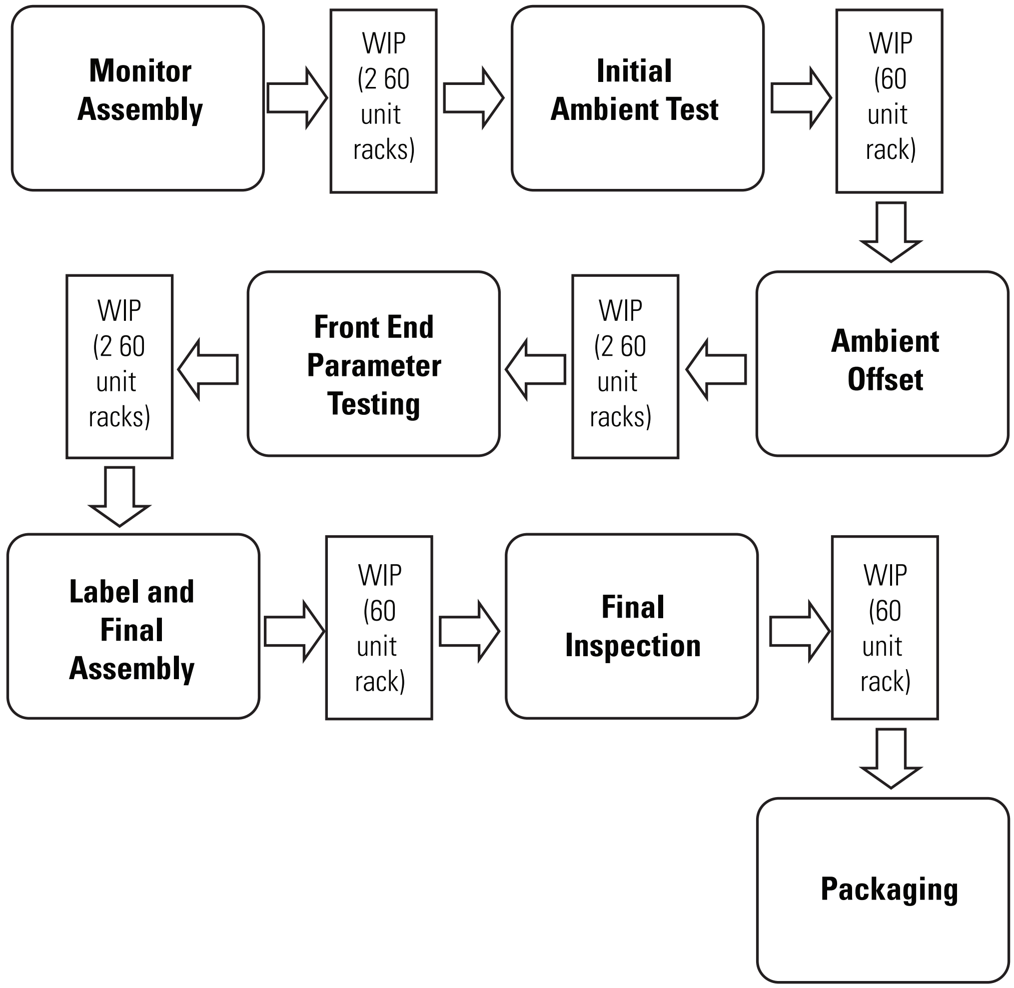
[5] Production steps, process times, and resource allocation, while representative of actual processes at Dräger, are disguised for competitive and confidentiality purposes.

Exhibit 6
Process Layout for Appolo Line at Danvers Facility



producing at higher volumes in the future. Management in Lübeck also expressed concerns with order turnaround performance for 2008 at the Danvers plant. Orders sent to Danvers often arrived in Lübeck 8-10 days after order placement. This appeared illogical, given that Danvers shipped (overnight air) all finished goods daily. The critical process design question before the task force remains simple and straightforward: Can we produce similar or possibly higher volumes of monitors in a facility that is 45% smaller than our current site and improve our turnaround times? The answer to that question is less simple, and perhaps not so straightforward.

ASSESSING THE FINANCIAL BENEFITS OF THE MOVE[4]

While the move to Andover was conceptually appealing, other options were available. For example, the entire assembly operation could be outsourced. Ultimately, the decision about the fate of the monitor production operation would be determined based on profitability criteria. Would the move to Andover produce improved financial performance? Certainly, the move would require some investment and some moving cost. Any savings realized in the operations would have to pay that cost back relatively quickly.

[4] Some specific details in this section have been modified for the purposes of confidentiality and to permit increased pedagogical effectiveness.

Exhibit 7
Process Description for Andover Facility[6]

1. **Production set-up:** The new process begins with components coming direct to the line from the receiving area and prepared for production. This includes collecting and aligning all components for the monitor in advance of assembly. There is one worker assigned to this task and no machinery requirements. It requires 4.9 minutes of process time to complete this step.

2. **Monitor assembly:** The new process and equipment allows workers to complete the fit housing process with four minutes of set-up time and six minutes of processing time. These processing times apply to all monitors – there is no longer a need to have different process times based upon the monitor type (i.e. Delta vs. Delta XL). There are two workers and two machines, each working independently, at this process step.

3. **Ambient test:** The new process for ambient test has 50 single-unit testing connections and each connection supports the testing of one monitor. There is one worker at this step. This worker is responsible for setting up the components for test (3.5 minutes) and, upon test completion, disconnecting components (1 minute) to facilitate movement to the next production step (Step #3). The ambient test is a 240-minute process – same running time as the Danvers process. As was true in Danvers, there is no labor requirement during the 240-minute test period and test equipment will automatically shut down upon completion, so the worker can initiate tests for the entire workday.

4. **Initialization and front-end parameter testing:** This combined step of initialization, a form of final component test, and FE parallel connection requires 10.1 minutes of processing time. There are two workers and two machines, each working independently, at this process step.

5. **Label and final assembly:** The labeling and final assembly process requires 5.1 minutes of processing time. There is one worker and one machine at this processing step. .

6. **Final inspection and packaging:** The final inspection and packaging step requires 4.8 minutes per monitor. The inspection is simply a visual (external) check of the monitor, and packaging involves boxing the monitor and adding it to the pallet for shipment to Lübeck. There is one worker and one machine at this processing step.

[6] Production steps, process times, and resource allocation, while representative of actual processes at Dräger, are disguised for competitive and confidentiality purposes.

Basically, the job of the assembly plant in Danvers was to manage costs while producing high-quality product in requisite volume. Dräger Medical management, however, wanted to make sure that each plant utilized its asset base well, too. Therefore, the Danvers plant was treated as an investment center. Corporate management set specific transfer prices for each of the monitor models. Annual plant operating expenses were subtracted from the transfer price revenues to determine a measure of plant margin. A capital charge was subtracted from plant margin, resulting in "plant economic income." The capital charge reflected the cost of capital multiplied by total fixed plant assets plus inventory, since only these assets were under control of the plant manager. (Current assets and liabilities other than inventory were all managed at corporate headquarters.) There was a target return on sales of 12% after the capital charge. The rationale of this apparent double-hurdle was explained as follows:

> *All of the plant expenses become part of the final manufacturing costs for our products. Therefore, all of the plant costs pass through finished goods inventory and are expensed as cost of goods sold. The plant needs to generate income to cover its own investment, but then has to contribute to covering the overall corporate administrative costs. The 12% economic contribution accounts for the basic value created in the manufacture of the core instruments. Configuration, software loading, and accessory bundling in Lübeck contribute the remainder of the value of the final delivered product.*

The performance results for 2008 operations in Danvers are shown in Exhibit 8.

Demand volume in units at Danvers had risen by double-digit rates through 2006, but tumbled by 5% in 2007. Plant margin had fallen. There was a variety of factors that may have accounted for this. General economic conditions had led to diminished demand recently as hospitals and other health care facilities decided to defer purchases of new equipment. Lower market prices had restored demand volume in 2008, but not plant margin. Those lower market prices had, in turn, pushed back the transfer prices for Danvers, resulting in a drop in margins. Not only would the new arrangement in Andover have to cope with the lower prices, but it would also be beneficial if the plant margin were less sensitive to changes in demand.

Bill Nicholson's PRIME team reviewed a wide array of effects that the proposed move would have. Exhibit 9 contains a table specifying the expected headcount reductions. Exhibit 10 contains some excerpts from the team's written report related to costs and savings.

Exhibit 8
Income Statements for Danvers Assembly Business Unit[7]

Revenue		$ 37,540,000	100%
Less Variable Costs:			
Direct Materials	$ 27,302,000		73%
Variable Manufacturing OH	357,000		1%
Variable Support & Logistics OH	4,925		0%
Contribution Margin		$ 9,876,075	26%
Less Fixed Costs:			
Assembly Labor	1,872,000		
Support & Logistics Labor	1,144,000		
Plant Administration and Management	480,000		
Occupancy	928,000		
Depreciation - Assembly Equipment	456,000		
Depreciation - Furnishing and Fixtures	259,800		
Depreciation – Administration Assets	4,800		
		$ 5,144,600	14%
Plant Margin		$ 4,731,475	13%
Capital Charge (cost of capital = 10%)		$ 1,805,600	
Plant Economic Income		$ 2,925,875	8%

7 The quantitative data in Exhibits 8 through 10, while representative of actual observations at Dräger, have been disguised for competitive and confidentiality purposes.

Exhibit 9
Estimates of Headcount Changes from PRIME Reconfiguration

	Current/Danvers	Projected/Andover
Assembly Labor	30	24
Support & Logistics Labor	22	12
Plant Administration and Management	4	4
	56	40

Exhibit 10
Excerpts from the Report on Potential Costs and Savings from Move to Andover

Some of the costs and savings related to the move are obvious. Certainly, a move to Andover would eliminate the need to pay the $400,000 per year lease in Danvers. Additionally, the costs of maintaining, heating, cooling, and securing the Danvers facility would be eliminated by the move. If the assembly operation could be successfully fit into the available space in Andover, it would simply be allocated a share of the current Andover facility occupancy costs. Based on space occupied, we estimate the assembly operation's share of Andover's occupancy cost to be $499,000 per year.

There will have to be some investment in preparing the Andover facilities to house an assembly operation, including some equipment modification. The major expenditure will be for new ambient testing systems. Each system, consisting of a server and 50 test stations, will cost $600,000 to build and install. All of the old testing machines will be fully depreciated by the end of 2008 and sold for their salvage value for a net effect of no gain or loss. We estimate the economic life of these systems to be 10 years. We can move and reuse about half of the furnishings and fixtures currently in Danvers in the new facility in Andover. The remaining fixtures are leasehold improvements made to the building and cannot be moved. Those assets would have to be written off, except, luckily, they will be fully depreciated at the end of 2008. In Andover, we will have to spend $100,000 on new furnishings and fixtures to prepare the building for the assembly operation. Following company policy, those new leasehold improvements will be depreciated over 10 years. We can move all of the administration and management assets, which are primarily desks, computers, and other office furnishings. These were all replaced recently, so annual expenses related to their depreciation will remain unchanged.

We have planned the logistics on the move itself to be possible to execute over a three-day holiday weekend. There should be no loss of productive time. This will require several weekends of preparation and planning, however. There will be an out-of-pocket cost of $157,000 attached to the move.

The move will create savings in Andover. One immediate effect will be the removal of the need to shuttle engineers, parts, and equipment back and forth between Andover and Danvers. We estimate this savings to be $300,000 per year in combined out-of-pocket costs and recovery of lost engineer's time. The out-of-pocket costs are the shuttle driver, whose fully-loaded annual cost is $35,000, and the annual lease, maintenance, and operating costs of the van. These costs are $10,000 per year. Another savings in Andover will come from the reassignment of occupancy costs currently covered by the existing business to the assembly operation. As detailed elsewhere in this report, we estimate that $499,000 per year will be reallocated to the assembly operation.