Product Design Decisions

Explanations – Cause-Effect Relationships – Suggestions and Tips

This two-part decision page—the left-side for AC cameras and the right side for UAV drones—involves specifying (1) the components, design elements, and extra performance features to be incorporated in your company's cameras/drones, (2) the number of models to have in each line, and (3) how much to spend on product R&D. The numbers showing in the decision entry boxes are those made in the prior year until your company's management team enters changes. ***The decisions here are important because they determine the P/Q ratings that will be assigned to your cameras and drones and because they also have a major bearing on production/assembly costs.***

Each time you make a new decision entry on this screen, an assortment of on-screen calculations will instantly show the ***projected*** effects on P/Q ratings, the costs of components and features, total production costs, and production costs per unit. ***All of these on-screen calculations are there to help you evaluate the relative merits of one decision entry versus another***. The challenge here is to arrive at product designs and specifications that will result in the desired P/Q rating and entail acceptably low total production/assembly costs per camera/drone.

Use the links below to quickly access the topic on which you want explanations, guidance, and suggestions.

Parts, Components, and Product Specifications Decision Entries

The better the caliber and performance capabilities of the parts and components used for action cameras (image sensor size LCD display screen, image quality/resolution, camera housing, software editing/picture sharing, and included accessories) and for drones (the built-in camera, GPS/WiFi/Bluetooth, battery pack, body frame, rotor performance/flight controller, and so on) the better the product's performance and quality (but the higher the production costs per unit assembled).

All of the needed parts and components are purchased from outside suppliers; these suppliers sell essentially the same items at the same prices to all companies. Suppliers have ample capabilities to furnish whatever quantities are needed; no shortages will be encountered.

Impacts on Product P/Q Ratings. *Each time you make an entry for a particular part or component, the resulting effect on the P/Q rating is shown on the line just below the section containing the decision entries*. As you can observe, upgrading/downgrading *some* parts/components/specifications has a bigger effect on the P/Q rating than upgrading/downgrading *other* parts/components/specifications, indicating that ***some design-related features have a bigger impact on product performance and quality (P/Q ratings) than others***.

There is a whole universe of different combinations of decision entries on this page that will produce a given P/Q rating (say 5.0-stars or 6.7-stars or whatever), but the different combinations of achieving a given P/Q rating typically have different production costs per unit, often *significantly different costs*—as you can see from the on-screen calculations in the section labeled "Projected Production Costs." So, *expect to spend some time*

trying out different decision-entry combinations to discover the lowest cost combination of achieving the desired P/Q rating.

Special Note: The number of units your company is projected to sell in the upcoming year is almost certain to differ from the prior year number. How many cameras/drones your company is projected to sell is determined based on the entries your management team makes on the decision pages for AC Camera Marketing and UAV Drone Marketing. *After you complete your decision entries for these two pages, there is much merit in returning to this Product Design page to view the updated projected production costs and searching for a combination of decision entries that yields lower production costs per unit.*

Decision-Making Tip: *It is normal, indeed necessary, to cycle back-and-forth through the decision screens a number of times in order to arrive at a cohesive, well-aligned set of decision entries with credible prospects of achieving good profitability.*

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Extra Performance Features

You can have up to 10 extra performance features for action-capture cameras and up to 15 special features for UAV drones. The extra performance features for action-cameras include such things as media ports, touch screen menus, appealing built-in GPS/Wi-Fi/Bluetooth capabilities, and enhanced autofocus. Extra performance features for drones include spare battery packs for rapid battery swapping, mapping software that converts digital camera images into two-dimensional maps and/or 3D models, assorted industry-specific applications, and such capabilities as position hold, automated return-to home, follow-me flight path, just-land-this-thing, programmable flights, camera angle adjustment capability, additional automatic flight modes, transmission of live video feeds, and the ability to lock the drone's camera on a moving target.

The number of extra performance features has a *major* impact on product P/Q ratings. The costs of extra performance features vary with the number selected—the costs of the first five features are considerably lower than the costs of the last five features. You can try various numbers of extra performance features entries, observe the impact on the P/Q rating and the per unit cost consequences and then settle on what number of extra performance features is acceptable in terms of P/Q contribution and unit cost.

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Number of Models

While there's certainly merit in trying to expand sales by adding more models to better satisfy diverse buyer preferences and user requirements, increasing the number of models is not cost-free.

- *Increasing the number of models* ***negatively*** *impacts the P/Q rating* because of increased opportunities for faulty assembly and increased chances for parts/components defects during the warranty period (as can be seen by watching what happens to the P/Q rating when the number of models is increased). Newly-designed models are likely to have design and/or performance shortcomings/flaws that have to be worked out over time. In addition, the increased number of different parts and components that the company must purchase to accommodate the differing designs and specifications associated with a wider model line-up means increased chances for parts/components defects to appear during the warranty period, which raises warranty claims. All of these factors are considered in determining the upcoming year's P/Q rating.

  The negative impact on P/Q ratings of increasing the number of models can, however, be countered by upgrading certain parts/components, adding more extra performance features, and/or

increased spending on product R&D. But such countermeasures, of course, have costs—as can be tracked by checking the projected production costs per unit displayed in the Projected Production Costs section of the screen.

- *Increasing the number of models raises warranty costs*—Because a greater number of models is accompanied by higher warranty claims (due to increased opportunities for faulty assembly/testing and greater frequency of defective parts/components), warranty costs are also higher. The effects of increasing/decreasing the number of models on warranty costs are displayed in the section on Projected Production Costs—see the line labeled "Allowance for Warranty Repairs."
- *Increasing the number of models reduces the number of units that PATs can assemble annually*—PATs cannot assemble and fully test 5 models as proficiently and as problem-free as they can assemble and fully test 3 models. This is because different models use somewhat different parts and components, different assembly and testing procedures are required for different models, and PATs lose some work time in switching from assembly/testing of one model to assembly/testing of another. Observe the changes to "Assembly Labor Costs" displayed in the Projected Production Costs section that occur when the number of models is increased/decreased.

Reducing the number of models has the reverse effects—higher P/Q ratings, lower warranty costs, and better PAT productivity. It is easy enough to track the effects of increasing/decreasing the number of models by observing the changes in the on-screen calculations of the P/Q rating, warranty costs, and labor costs. Projected warranty claim rates associated with different number of models are shown on the Marketing Decisions screens for cameras and drones.

The Benefits of Increasing the Number of Models. Increasing the number of models will definitely have a positive impact on a company's unit sales and market share in each geographic region. But the sizes of benefits of a wider product selection are not readily discernible from this decision page—the benefits (higher sales and revenues and potentially higher profitability) are best evaluated in conjunction with the decision entries and projected outcomes shown on the marketing decision entry pages for cameras and drones.

It is up to the company's management team to weigh the pros and cons of increasing the number of models. This will probably involve some cycling back-and-forth between this page and the two marketing decision pages. How many cameras/drones your company is projected to sell in the decision round for which you are now making decision entries is based on the P/Q rating and number of models shown on this page ***plus*** the entries your management team makes on the two marketing pages: (1) the Marketing Decisions and Competitive Assumptions for Action Cameras and (2) the Marketing Decisions and Competitive Assumptions for Drones. Thus,

Suggestion: *After you complete your Marketing/Competitive Assumptions decision entries, there is much merit in returning to this page to view the updated projected production costs and perhaps* ***searching for a different combination of product design-related decision entries that entails lower projected production costs per unit****.*

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Product R&D

The combination of *current year* spending and *cumulative* spending over time for product R&D acts to:

1. *Provide a pipeline of tested ways* to (a) add more features, (b) improve product performance, (c) build the company's proficiencies in designing new and improved camera/drone models, and (d) make the company's camera/drone models easier and quicker to assemble.
2. *Reduce the costs of components, accessories, and enhancement features* used in assembling cameras/drone because company R&D personnel work closely with suppliers to identify ways to

reduce such costs without impairing their quality, durability, and performance—cost reductions are realized as soon as current and cumulative R&D expenditures reach levels sufficient to produce greater cost savings.

3. *Increase a company's camera/drone P/Q ratings* (higher P/Q ratings are realized as soon as current and cumulative R&D spending reach levels sufficient to produce better camera/drone performance and quality).
4. *Gradually increase the productivity of PATs in assembling camera/drone models* (because some of the company's product R&D effort goes into developing product designs for the company's camera/drone models that are easier/quicker for PATs to assemble)—productivity gains are realized as soon as a company's R&D effort reaches a level sufficient to discover and test easier-to-assemble product designs and to implement faster camera/drone assembly methods.
5. *Reduce warranty claims and costs* (because of the positive impact of product R&D expenditures on camera/drone P/Q ratings).

There are separate spending entries for product R&D for cameras and drones so that you can place more/less R&D emphasis on one product versus the other in achieving the desired P/Q ratings.

Be aware that a company's ***cumulative spending on new product R&D*** (shown on the page just under the decision entry field for new product R&D expenditures) is the chief driver of the benefits of R&D expenditures, not current year spending—***the value of current year spending comes mainly from the contribution it makes to cumulative spending for product R&D***.

Substantial R&D spending is typically required to improve product performance/quality and to develop more sophisticated and useful software capabilities for both cameras and drones. ***The R&D challenges for improving drone performance and user benefits are more formidable than for AC cameras***, partly because video camera technology is better understood and more mature, partly because drones are a relatively new product with wide open opportunities for improving drone technology/performance and software analysis of the video data collected during drone flights, and partly because the company just recently entered the drone marketplace and has yet to fully develop its drone designs and discover how best to enhance the performance and quality of its drones. Drone buyers, of course, are highly interested in drones that can stay up in the air longer than the current norms of 15-20 minutes, fly distances well beyond the view of the person operating the flight controller, are equipped with obstacle sensors to avoid crashing into obstructions in their flight path, and have a bigger variety of performance-enhancing features and capabilities—such capabilities present formidable R&D challenges that cannot be conquered without substantial and sustained R&D efforts.

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P/Q Ratings

P/Q ratings for AC cameras are based on an array of factors: (1) image sensor size, (2) size of the LCD display screen, (3) image quality of the pictures/video, (4) number of modes for videos and still photos, (4) camera housing, (5) editing/sharing capabilities, (7) included accessories (such as capacity of flash memory card, rechargeable batteries, a plug-in battery-charger, and carrying case) (8) the number of extra performance features, (9) the number of camera models a company offers, (10) a company's *cumulative spending* on new product R&D, and (11) the annual amount a company spends on training each PAT in the use of best practice assembly methods, post-assembly product testing, and ways to reduce warranty claims.

P/Q ratings for UAV drones are a function of (1) the caliber of the built-in action-capture camera, (2) the caliber of the built-in GPS/Wi-Fi/Bluetooth components, (3) battery life (maximum flight time per charge), (4) number of rotors, (5) motor-prop performance and flight controller features/capabilities, (6) body frame construction, (7) obstacle sensor capabilities and performance, (8) quality of the camera stabilization device, (9) the number of extra performance features, (10) the number of drone models a company offers, (11) a

company's *cumulative spending* on new product R&D, and (12) the annual amount a company spends on training each PAT in the use of best practice assembly methods, post-assembly product testing, and ways to reduce warranty claims.

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Projected Production Costs

The lower section of the page showing the *projected* production costs for cameras/drones contains two columns of cost numbers. The first column shows total dollars and the second shows cost per unit. Both calculations are based on the number of cameras/drones to be assembled and shipped to buyers displayed at the bottom of the decision page.

> ***Decision-Making Tip:*** Bear in mind that the assembly numbers are updated by the entries your management team makes on the AC Camera Marketing and UAV Drone Marketing decision pages. Thus, *after you make decision entries for the two marketing pages and obtain current-year projections of the number of cameras/drones that buyers are likely to purchase (and which will need to be assembled and shipped), there is much merit in returning to this page to view the updated projected production costs and searching for a combination of decision entries that yields both the desired P/Q ratings and the lowest achievable projected production costs per unit*.

What follows is an explanation of how these cost projections on this page are calculated:

- The total cost number for each of the parts/components/design elements is simply the cost per component multiplied by the annual number of cameras/drones that need to be assembled and shipped to fill the expected number of buyer orders (as displayed on the last line of the screen). The unit costs for each of the parts/components/design elements are based on the price that is paid to suppliers for the particular grade of part/component/design element you have entered in the respective decision entry boxes. If you think the cost per unit for one or more design elements is too high, then you can alter your decision entries and search for a lower-cost combination (or cut back on the target P/Q rating).
- Total production costs for extra performance features are determined by multiplying the cost of each extra performance feature by the projected number of cameras/drones to be assembled and summing these amounts for all the extra performance features you have decided to incorporate; the cost per unit number for extra performance features represents the average cost of all the extra performance features that are to be incorporated in each camera/drone. The unit costs of extra performance features vary with the number selected—there not a specific cost per utility feature, rather the incremental cost of each additional feature is a variable that rises gradually for each added feature.

  The total cost number for extra performance features is simply the cost per camera for extra performance features multiplied by the annual number of that type of camera scheduled to be assembled and shipped.
- The total dollar and cost/unit calculations for "total cost of product components and features" equal the sum of all the costs for all parts/components/design elements and extra performance features.
- The projected total costs and costs/unit numbers for "Assembly Labor Costs" are based on decision entries on the Compensation, Training, and Product Assembly screen. They represent the projected compensation costs for base wages, assembly quality incentives, perfect attendance bonuses, fringe benefits, and overtime pay for all of the camera/drone PATs that will be needed to assemble the numbers of cameras/drones it will take to satisfy projected buyer demand.
- The projected total costs for "Product R&D Expenditures" are equal to the amounts entered in the decision entry fields for product R&D expenditures. The cost per unit number is equal to total R&D

expenditures for cameras/drones divided by the total number of cameras/drones projected to be assembled.

- The projected total costs and costs/unit numbers for "Allowance for Warranty Repairs" represent the costs of handling expected warranty claims for cameras/drones. Projected annual warranty costs in both the total dollars and per camera columns are a function of the warranty period entry on the marketing decisions page for cameras/drones, the anticipated warranty claim rate on cameras/drones to be assembled and shipped, and the warranty claim cost per defective camera/drone ($50 for cameras and $300 for drones).
- The projected costs for "Maintenance of Plant and Equipment" for the action-capture camera assembly facility represent $4 million annually for exterior and grounds-related maintenance of the facility itself, plus interior maintenance costs that average $8,500 for each camera assembly workstation space, plus $7,500 in annual maintenance and refurbishment costs for each workstation that has been installed to assemble cameras. The projected costs for "Maintenance of Plant and Equipment" for the drone assembly facility represent $4,000,000 annually for exterior and grounds-related maintenance of the facility itself, plus interior maintenance costs that average $7,500 for each drone assembly workstation space, plus $6,000 in annual maintenance and refurbishment costs for each workstation that has been installed to assemble drones.
- The company's annual depreciation costs for camera-related plant and equipment and drone-related plant and equipment are always equal to 5% of the gross fixed asset investments the company has made over the years in its camera assembly facility and its drone assembly facility. These facility-related investments include capital expenditures for land, facility space for workstations, installed workstations, other assembly-related equipment, office furnishings, servers, computers, and so on for each of the two products. Companywide gross investment in plant and equipment is reported on the company's balance sheet (the amount as of the end of Year 5 was $250 million), but company accountants always allocate capital expenditures for plant and equipment to either camera operations or drone operations. At the end of Year 5, gross investment in camera operations was $150 million and gross investment in drone operation was $100 million, which resulted in annual depreciation costs for cameras of $7,500,000 and annual depreciation costs for drones of $5,000,000. Depreciation costs per unit are equal to annual depreciation costs divided by the total number of units projected to be assembled (as shown on the last line of the Product Design decision screen)
- The projections of "Total Production Cost" equal the sum of the above-listed costs, with the $/unit number being the total production cost amount divided by the total number of units projected to be assembled.

The last line on the Product Design decision page displays the number of units expected to be assembled at regular time, the number at overtime, and the total. The total number of units is always equal to the number that buyers are projected to purchase during the upcoming year. This total is divided between the assembly at regular time and assembly at overtime according to how many workstations the currently has available for assembly. Units are assembled at overtime only if there are insufficient workstations to assemble all of the needed units at regular time. On a later decision page (Compensation, Training, and Product Assembly), there are entries for increasing assembly capacity by adding workstation space and workstations as may be needed to avoid (if you desire) overtime assembly and to be in position to fill all of the projected buyer orders (should projected buyer demand exceed assembly capacity with maximum use of overtime).

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