



HOW DO CLINICIANS SELECT PROSTHETIC FEET?

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Choosing Feet Is Becoming More Difficult

A recent count of available prosthetic feet revealed more than 120 different designs. Although significant research has been conducted on gait analysis, energy consumption, and kinetic movement, very little quantitative research data has permeated to the clinical level that would aid the prosthetist in selecting a prosthetic foot for his or her patient. With the increasing number of designs promising an ever-widening spectrum of functions, the prosthetist faces an overwhelming number of decisions regarding prosthetic foot recommendations.

Along with assessing length, weight, activity level, and unique functional goals, practitioners currently rely on empirical data when recommending a prosthetic foot.

Prosthetists evaluate the patient's dynamic function using basic gait analysis, with particular emphasis on the presentation of the rocker motions during the stance phase of gait. Based on a self-assessment of sensation, the patient confirms and provides feedback about the clinician's observations and assessments. Similar to the selection of running footwear



*U.S. Navy photo by Mass Communication Specialist
1st Class Anastasia Puscian/Released.*

that is both functional and fashionable, prosthetic feet are chosen based on a number of selection factors including high-tech design, aesthetic appearance, and functional advantages.

This has led some prosthetists and researchers to question the subjective nature of the prosthetic foot selection process—not to mention the role that fashion plays. Examining the clinical paradigms by which a prosthetist selects a prosthetic foot plays an important role in understanding what current practices and information are most helpful to the clinician.

Performance Assessment Factors

In a previous sample survey, done in 2005 in preparation for the American Academy of Orthotists and Prosthetists (the Academy) State-of-the-Science Conference on Prosthetic Foot/Ankle Mechanisms, 19 pre-selected certified prosthetists, representing technology innovators, early adopters, early majority, late majority, and traditionalists, were interviewed by telephone regarding their individual foot-selection criteria. Of the more than 105 foot designs currently available at the time, the interviewed prosthetists said they chose from only four to five "mainstay" designs, deviating only when special needs or functions dictated a unique solution (Figure 1).

Predominant prosthetic foot performance assessment factors were identified in the 2005 telephone interviews, including cadence speed, uneven terrain, stability and balance, amputation level, weight, size of foot, special functions, effect of alignment, product warranty and maintenance, and cost. While the 2005 survey identified these factors to formulate questions in

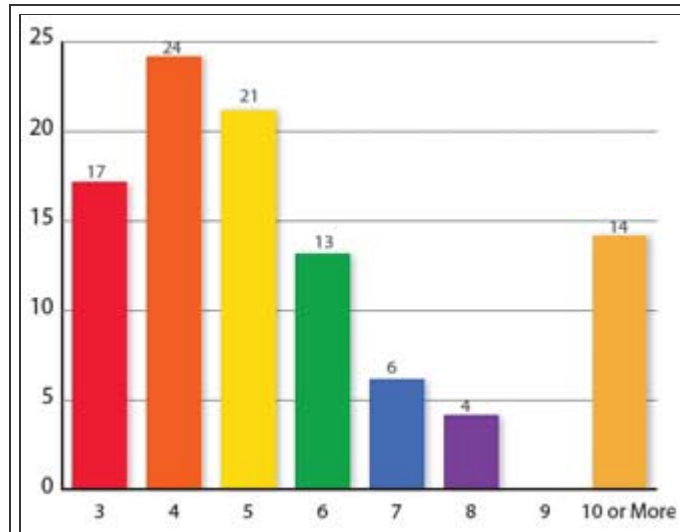


Figure 1: Mainstay Prosthetic Foot Designs

this survey about the factors that affect foot selection, it did not provide any additional information from which to develop a more detailed and weighted profile of prosthetic foot selection criteria. It did function to formulate the standard terms and questions for the June 2011 survey.

Methods

The 2011 survey was developed using common terminology, delineated functional subsets, and clinical priorities with mutually exclusive and weighted responses. Selection factors from the 2005 telephone interviews were used to quantify some of the processes involved in prosthetic foot recommendation. The 2011 survey was hosted by an independent, third-party, web-based service for three weeks. An invitation to participate in the survey was also posted to the OANDP-L listserv.

Of the 130 participants who logged into the survey, 31 did not complete the second page and were excluded from the sample group, leaving 99 participants. The third-party, web-based service allowed only one entry from each IP address to eliminate repeated data collection from a single user.

The participants answered the ten-question survey with single, multiple, grouping, Likert rankings, percentage distribution, and weighted ratings. The data was collected

showing distributions for each answer. The weighted responses were collected to produce a Pareto diagram.

Results

Clinical Experience

Respondents who completed the survey had an average of 11.9 years of clinical practice experience, with the largest group reporting that they have 20 or more years of clinical experience (22.2 percent) and the smallest group (7.1 percent) reporting they have two years of clinical practice experience. More than 80 percent of respondents reported that they have between five and 20 years of clinical experience.

With respect to the number of feet recommended per week, the largest group (53.5 percent) reported that they recommend zero to two prosthetic feet per week. The second largest group (43.4 percent) recommend two to five prosthetic feet per week.

Patient Activity Level

When asked to estimate the percentage distribution of their patients by activity level, responses reflected a symmetric distribution curve. Clinicians reported that 38.2 percent of their patients walk at one speed only, with occasional fast-speed walking; 27.18 percent of patients stand or walk at one speed only; and 19.25 percent of patients frequently walk at a fast speed, or occasionally run.

Selection Criteria

Clinicians were asked to choose among and rank the following list of criteria they use when selecting a prosthetic foot:

- Multiple cadence speed
- Uneven terrain
- Maximum stability and balance
- Amputation level
- Weight of foot design

- Evidence-based quantitative data
- Special vocational/avocational feature
- Warranty and maintenance
- Ease of static/dynamic alignment
- Cost

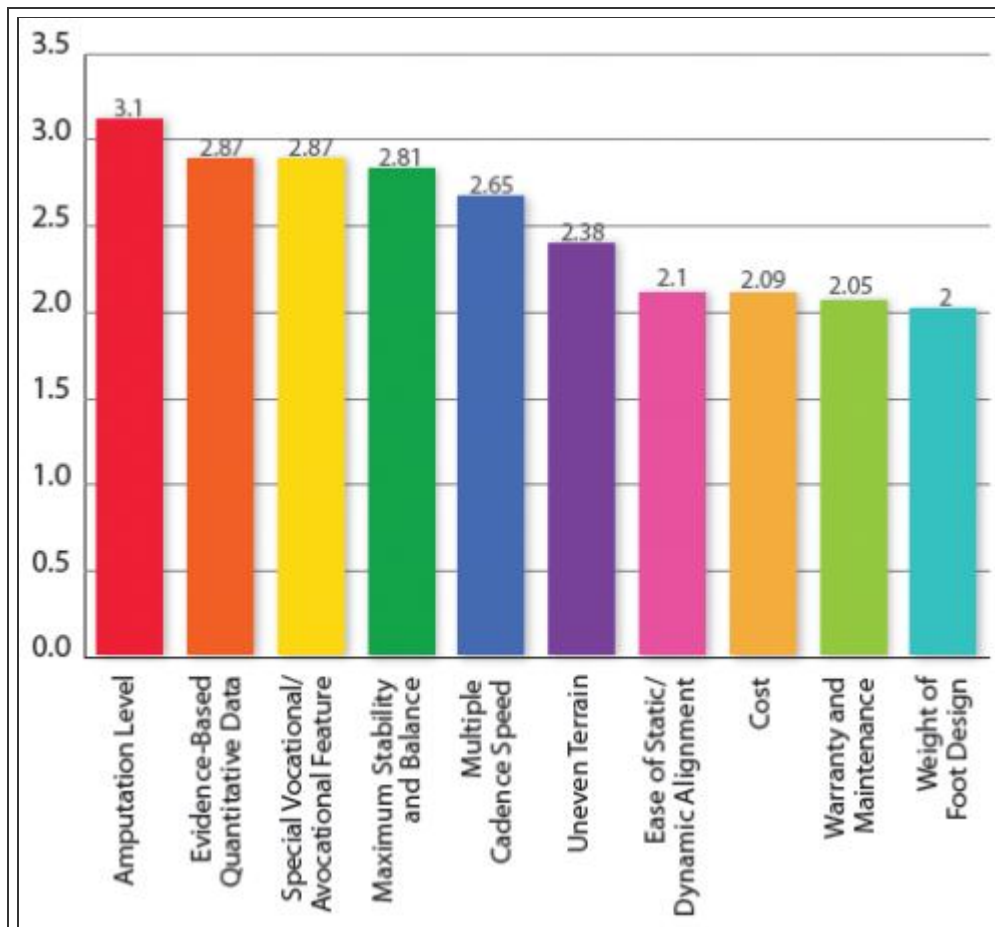


Figure 2: Clinical Selection Features

Respondents were asked to choose their top four criteria and rank each criterion on a scale of one to four, with one being the highest priority (Figure 2). Using the count of the top #1 and #2 rankings only, maximum stability and balance and amputation level were ranked as the highest priorities, followed by multiple cadence speed, uneven terrain, cost, and weight (Figure 3).

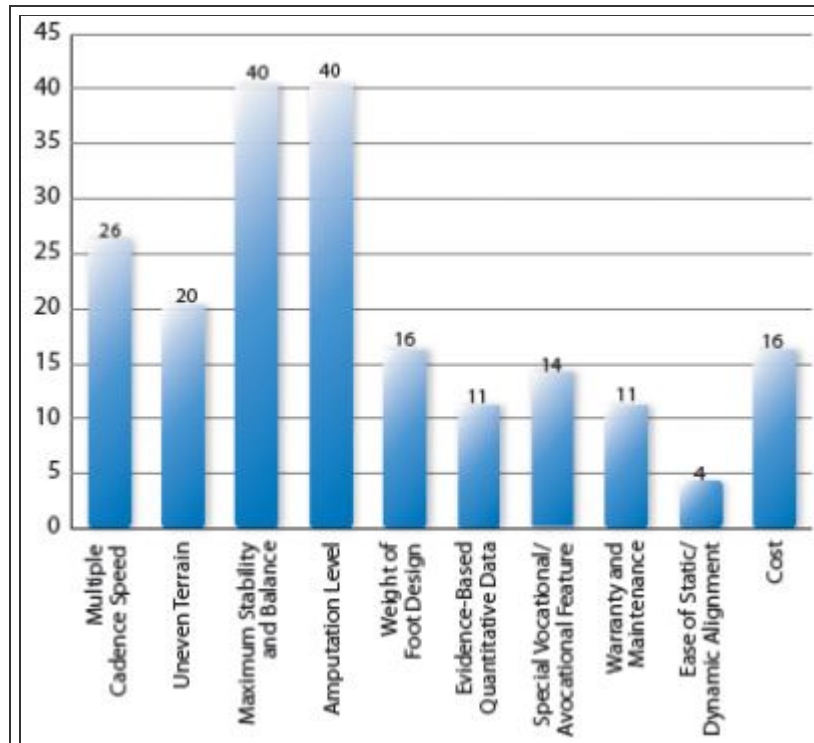


Figure 3: Highest Priority Clinical Selection Features (Ranked as #1 and #2)

Clinicians were then asked how they would rank features typically found in dynamic response feet on a one-to-five scale, with five being the most important and one being not important. Inversion-eversion (split-toe) forefoot and mid-foot rolling mechanism received the highest rankings, followed by integrated shock absorber, multi-axis hindfoot, and composite heel. A cushion foam heel was ranked the lowest (Figure 4).

"Rules of Thumb" and Lifespan Expectations

Prosthetists generally follow one or more "rules of thumb" to guide them in their prosthetic foot selection process. When asked to choose four from a list, the top three included "the more parts, the more maintenance will be required" (79.8 percent); "reimbursement level greatly influences component choice" (57.6 percent); and "more proximal the amputation requires a softer heel" (53.5 percent) (Figure 5).

The question, "How long should a dynamic response foot last?" received a variety of answers. The majority of respondents indicated that three years was adequate,

followed by five years (these two groups accounted for 82.9 percent of responses). One percent of respondents felt that a dynamic response foot should last six to seven years.

Finally, prosthetists were asked to choose four of the following statements that they use to describe the feet they recommend most often:

- Predictable performance
- Rugged durability
- High-tech design
- Optimized alignment
- Smooth rollover
- Positive patient perception
- Dynamic response
- Physiologic motion
- Energy efficiency
- Manufacturer warranty and reputation
- Positive past experience
- Consistent operation

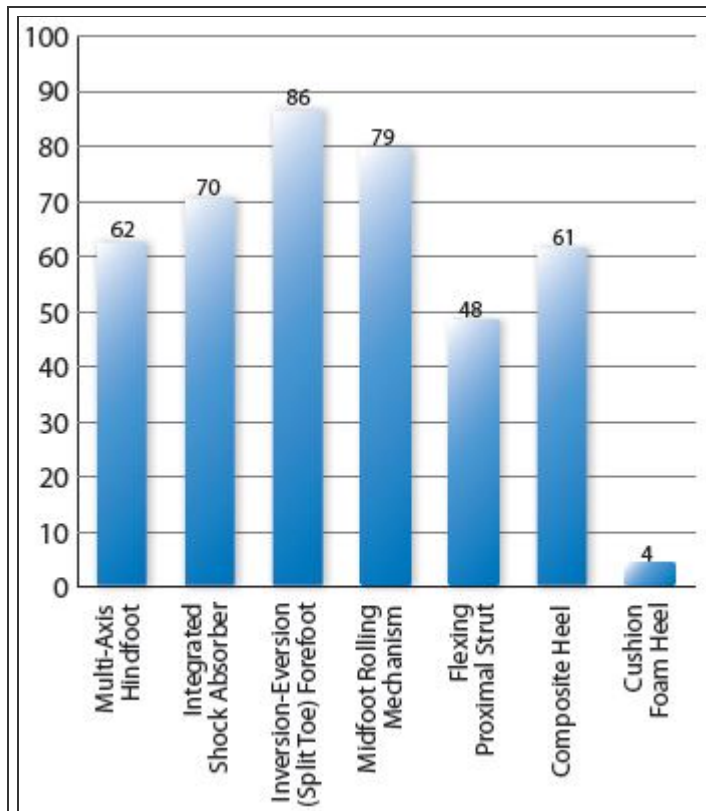


Figure 4: Most Important Dynamic Response Features (Ranked as #4 and #5)

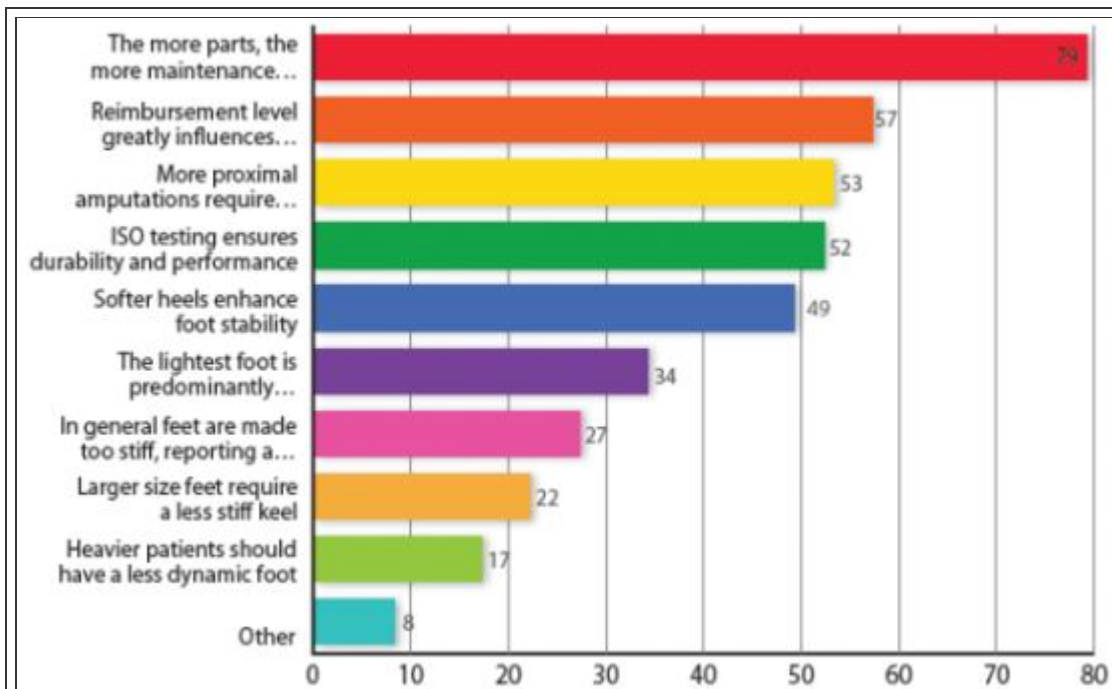


Figure 5: Rules of Thumb

After choosing their four statements, respondents were asked to rank those statements on a scale of one to four, with one being the most important. The responses that received the highest number of #1 and #2 rankings were past positive experience and smooth rollover, followed by energy efficiency, positive patient perception, and predictable performance. Optimized alignment and consistent operation were rated quite low (Figure 6). Because the mean values were not normalized, the responses receiving the highest number of #1 and #2 rankings were used. Several clinicians indicated that there are other statements not included among the choices that they use to describe the feet they recommend the most often; however, they were not provided a text field in which to detail their responses.

Discussion

The main limitation of the survey is that it did not rank all of the choices on the same five-point Likert scale. This led to non-normalized means that were misleading. While counting the highest scores helped to identify the highest values, it did not reveal lower-order values. Some of the scales needed definitive responses rather than ranges;

for example, the years of clinical experience each respondent had and the number of feet each respondent recommended. There was no opportunity for clinicians to input their own suggested categories, but this was done to achieve more consistent responses. Soliciting participants via the OANDP-L listserv limited the type of respondents to those who subscribe to and read the listserv.

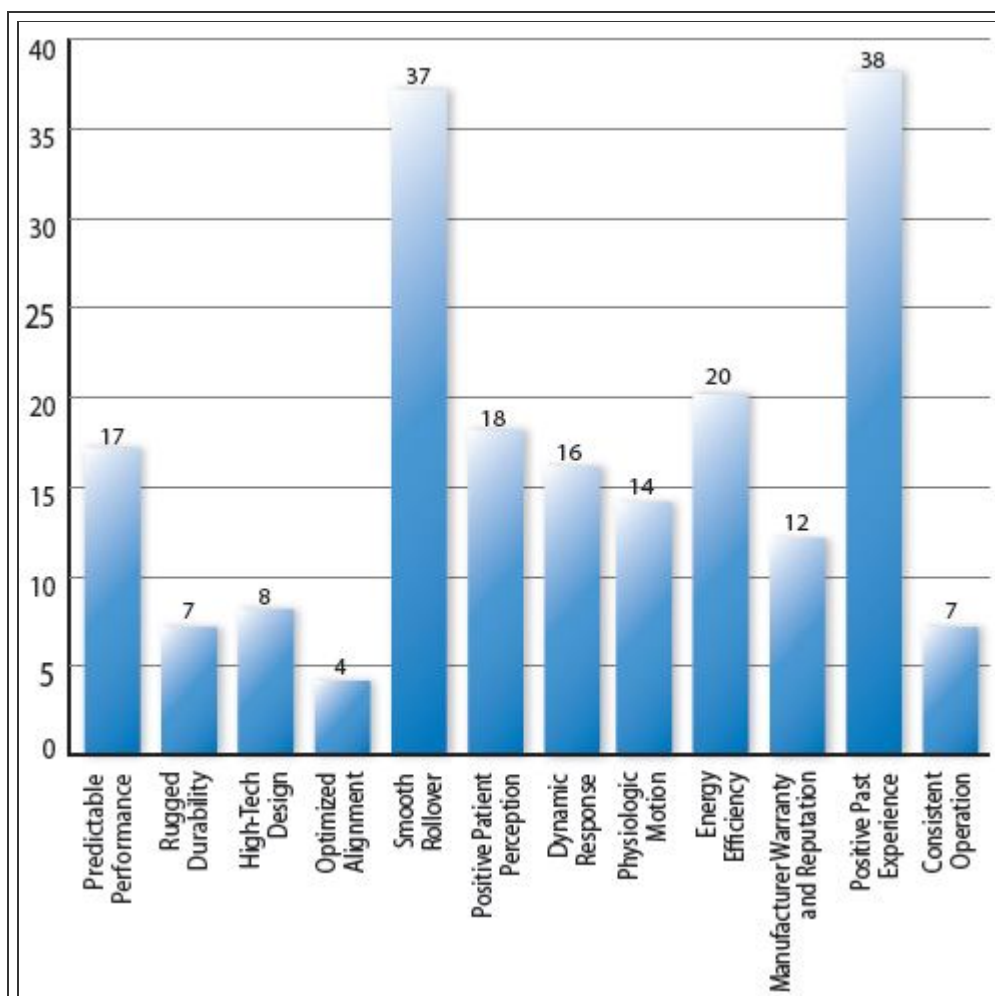


Figure 6: Statements Used Most Often about the Feet Clinicians Recommend (Ranked #1 and #2)

Respondents who reported having more than 20 years of clinical experience further skewed the survey results. It may be difficult for a majority of clinicians to take time to fill out surveys, and the sample may not have been representative of a full cross-section of prosthetists. Perhaps a sample of the values of clinicians at large would yield more representative results.

As with all research, the survey results generated a number of additional questions: Why do O&P clinicians choose from so few feet? The survey indicates that 62.6 percent of clinicians choose from three to six prosthetic feet, and 17 percent choose from just three. Does that mean clinicians are overwhelmed with the choices, or does it mean that the prosthetic foot product is becoming largely commoditized, or price-based? Are clinicians receptive to new designs, or are they fairly rigid in deciding from which feet to choose? Could it be that there are just too many designs to remember and each practitioner can only remember three to six?

A number of respondents indicated that quantitative evidence-based data (EBD) influences their prosthetic foot recommendation, but the survey did not ask what specific data they use or would use because so little EBD is readily available to the clinician.

Outdoor terrain appears to be the most significant reason to pursue multi-axis feet, while indoor activities are rated lower. This could imply, from the prosthetists' perspective, that household ambulators are not typically indicated for multi-axis feet. However, if multi-axis feet are used for greater stability, shouldn't clinicians be concerned with changes in terrain in the interior environment? Many falls can occur with changes in walking surfaces such as carpeting, slopes, or stairs.

When asked to choose their top four clinical selection criteria from a list of options, amputation level, stability, multi-cadence, and uneven terrain ranked higher than EBD; however, those who choose EBD as a selection criteria ranked it as the second most important factor. Why has the value of EBD not permeated to the clinical selection process? Is there just too little of it, or is it not applicable to the decision-making process?

O&P clinicians seem to live by a number of highly subjective "rules of thumb" when evaluating feet, but International Organization for Standards (ISO) testing takes into consideration the upper tier of choices because of its more rigorous standards using ISO 22675, which tests the entire rollover of the foot. Does this show that we are looking for EBD but haven't found it?

It also appears that prosthetists tend to choose feet based on past positive experience and smooth rollover, followed by energy efficiency, patient perception, and predictable performance. This seems to indicate a degree of reluctance to try new designs, which is consistent with the 2005 telephone interviews. It could also indicate that there is a degree of saturation with the number of designs on the market.

Future prosthetic foot research should correct the experimental error of this survey with respect to the scoring and investigate prosthetic foot recommendations. It also seems important to understand how receptive prosthetists are to using more foot designs and what it is we hope those designs will do for our patients.

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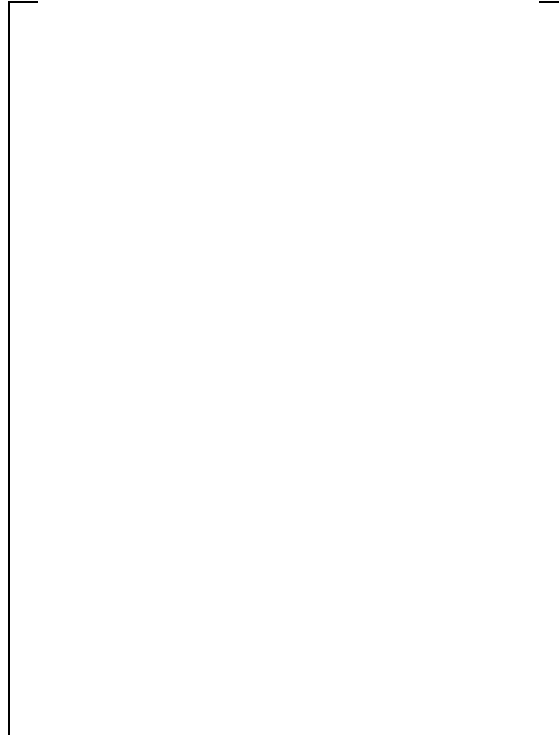
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